The Formulation of a Spatial Planning Support System used for the Sustainability Attainment Assessment of the Land Use Planning Process in the Egyptian Cities

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MSc. Eng. Niveen Ghattas

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Abstract

The research problem is that the land-use (re-)planning process in the existing Egyptian cities does not attain sustainability. This is because of the unfulfillment of essential principles within their land-use structures, lack of harmony between the added and old parts in the cities, and other reasons. This leads to the need for developing an assessment system, which is a computational spatial planning support system-SPSS. This SPSS is used for identifying the degree of sustainability attainment in land-uses plans, predicting probable problems, and suggesting modifications in the evaluated plans.

The main goal is to design the SPSS for supporting sustainability in the Egyptian cities. The secondary goals are: studying the Egyptian planning and administrative systems for designing the technical and administrative frameworks for the SPSS, the development of an assessment model from the SPSS for assessing sustainability in land-use structures of urban areas, as well as the identification of the improvements required in the model and the recommendations for developing the SPSS.

The theoretical part aims to design each of the administrative and technical frameworks of the SPSS. This requires studying each of the main planning approaches, the sustainability in urban land-use planning, and the significance of using efficient assessment tools for evaluating the sustainability in this process. The added value of the planning support systems-PSSs for planning and their role in supporting sustainability attainment in urban land-use planning are discussed. Then, a group of previous examples in the sustainability assessment from various countries (developed and developing countries) are selected, which have used various assessment tools. This is to extract some learned lessons to be guides for the SPSS. And so, the comprehensive technical framework for the SPSS is designed, which includes the suggested methods and techniques that perform various stages of the assessment process.

The Egyptian context is studied regarding the planning and administration systems within the Egyptian cities, as well as the spatial and administrative problems facing the sustainable development. And so, the administrative framework for the SPSS is identified, which includes the entities that should be involved in the assessment process.

The empirical part focuses on the design of a selected assessment model from the comprehensive technical framework of the SPSS to be established as a minimized version from it. This model is programmed in the form of a new toolbox within the ArcGIS™ software through geoscripting using Python programming language to be applied for assessing the sustainability attainment in the land-use structure of urban areas. The required assessing criteria for the model specialized for the Egyptian and German cities are identified, for applying it on German and Egyptian study areas.

The conclusions regarding each of PSSs, the Egyptian local administration and planning systems, sustainability attainment in the land-use planning process in Egyptian Cities, as well as the proposed SPSS and the developed toolbox are drawn. The recommendations are regarding each of challenges facing the development and application of PSSs, the Egyptian local administration and planning systems, the spatial problems in Egyptian cities, the establishment of the SPSS, and the application of the toolbox. The future agenda is in the fields of sustainable urban land-use planning, planning support science, and the development process in the Egyptian cities.

Zusammenfassung

Die dieser Arbeit zugrunde liegende Forschungsfrage befasst sich mit dem Fehlen des Nachhaltigkeitsaspekts beim (Neu-)Planungsprozess der Flächennutzung in bestehenden ägyptischen Städten. Dieses liegt unter anderem an der Nichteinhaltung essentieller Prinzipien in den Flächennutzungsstrukturen und einer fehlenden Harmonie zwischen hinzugefügten und alten Teilen der Städte. Dies wiederum führt zur Notwendigkeit der Entwicklung eines Bewertungssystems in Form eines computerbasierten Unterstützungssystems für die Raumplanung (*„spatial planning support system“* – SPSS). Dieses SPSS wird zur Identifizierung des Grads an Nachhaltigkeit in Flächennutzungsplänen, der Vorhersage wahrscheinlich auftretender Probleme, sowie zur Ableitung möglicher Modifizierungen der ausgewerteten Pläne verwendet.

Das Hauptziel besteht in der Entwicklung des SPSS, um Nachhaltigkeit in den ägyptischen Städten zu unterstützen. Weitere Ziele sind die Untersuchung der ägyptischen Planungs- und Administrationssysteme, um den technischen und administrativen Arbeitsrahmen für das SPSS zu bestimmen, die Entwicklung eines Bewertungssystems im SPSS um die Nachhaltigkeit von Flächennutzungsstrukturen in den Stadtgebieten zu bemessen, sowie die Identifizierung der im Modell nötigen Verbesserungen, und die Empfehlungen zur Entwicklung des SPSS.

Im theoretischen Teil soll der administrative und technische Arbeitsrahmen für das SPSS ausgearbeitet werden. Dies erfordert die Analyse aller hauptsächlichen Planungsansätze, der Nachhaltigkeit in der urbanen Flächennutzungsplanung und der Bedeutung, die der Nutzung von effizienten Bewertungstools zur Bemessung der Nachhaltigkeit in diesem Prozess zukommt. Der Mehrwert der Planungsunterstützungssysteme („*planning support systems*“ – PSS) für die Planung und ihre Rolle bei der Unterstützung des Nachhaltigkeitsgedankens bei der städtischen Flächennutzungsplanung werden diskutiert. Im Anschluss werden ausgewählte Beispiele vorangegangener Nachhaltigkeitsbewertungen aus verschiedenen Ländern (Industrie- und Entwicklungsländern) vorgestellt, die unterschiedliche Bewertungstools verwendet haben. Hieraus sollen einige Erkenntnisse als Orientierungshilfe für das SPSS gewonnen werden. Schließlich wird der umfassende technische Arbeitsrahmen für das SPSS ausgearbeitet, welcher die vorgeschlagenen Methoden und Techniken enthält, die verschiedene Stufen des Bewertungsprozesses darstellen.

Der ägyptische Kontext wird bezüglich der Planungs- und Verwaltungssysteme innerhalb der ägyptischen Städte betrachtet, ebenso wie in Bezug auf die räumlichen und administrativen Probleme, die einer nachhaltigen Entwicklung entgegen stehen. Hierdurch wird der administrative Arbeitsrahmen für das SPSS identifiziert, welcher die Instanzen einschließen, die in den Bewertungsprozess involviert sein sollten.

Im empirischen Teil steht die Erstellung eines ausgewählten Bewertungsmodells aus dem umfassenden technischen Arbeitsrahmen des SPSS im Mittelpunkt, das als minimierte Version desselben aufgebaut ist. Dieses Modell ist in Form einer neuen Toolbox innerhalb der ArcGIS™ -Software programmiert mit Geo-Scripting unter Nutzung der Programmiersprache Python, erstellt um bei der Bewertung von Nachhaltigkeitsaspekten bei der Flächennutzungsstruktur der Stadtgebiete zum Einsatz zu kommen. Die nötigen Bewertungskriterien des Modells speziell für ägyptische und deutsche Städte werden identifiziert, um es in deutschen und ägyptischen Untersuchungsgebieten anzuwenden zu können.

Schlussfolgerungen werden bezüglich der PSS, der ägyptischen lokalen Verwaltungs- und Planungssysteme, der Berücksichtigung von Nachhaltigkeitsaspekten im Prozess der Flächennutzungsplanung in ägyptischen Städten, sowie des vorgeschlagenen SPSS und der entwickelten Toolbox gezogen. Empfehlungen werden ausgesprochen in Bezug auf die Herausforderungen bei der Entwicklung und Anwendung von PSS, die ägyptischen lokalen Verwaltungs- und Planungssysteme, die räumlichen Probleme in ägyptischen Städten, die Einrichtung des SPSS, und die Anwendung der Toolbox. Zukünftige Maßnahmen sind in den Bereichen der nachhaltigen städtischen Flächennutzungsplanung, der Planungsunterstützungswissenschaft und dem Entwicklungsprozess in ägyptischen Städten zu ergreifen.

THE THEORETICAL PART

Chapter 1
Approach to the Research
(1.1) Background and Problem Definition:
(1.1.1) Introduction to the General Topic and Motivator for the Research's Idea:

Most of the existing[1] Egyptian cities were spontaneously generated in absence of the urban planning process. Even after, the General Organization for Physical[2] Planning (GOPP) was established in 1973 with the consideration of the first planning principles in the urban management process in the Egyptian cities, and the first law concerning the physical planning in Egypt "law 3 for the year 1982"[3] was applied. There are still some administrative and spatial problems inhibiting the development goals attainment in Egypt in general and in the Egyptian Cities in particular[4]. Examples for these problems are the gaps in the laws affecting the physical development process and difficulties in the development and upgrading of the existing parts in the cities[5].

The previous refers to the unfeasibility of the "re-planning" of existing Egyptian cities due to the spatial constraints of the current state of the cities and gaps in managing the physical development process in Egypt, as well as a funding problem as it is illustrated in details in chapter 7. Despite the adoption of the strategic planning approach in Egypt, which supports the public participation in planning, this has not solved the dilemma of the administrative and spatial problems.

The planning process can support the development of sustainable communities, in which the balance among the social, environmental, and economic values is attained. Berke and Conroy confirm that the sustainability concept is strongly connected to the planning process, as this concept affects the agenda of this process. (Berke and Conroy 2000, p.30). So, the city's plan can be the base for all the development types in it, which is considered one of the well known research fields that is "sustainable planning". Therefore, there is a need for studying the attainment of sustainability within the planning process in the Egyptian cities.

(1.1.2) Problem Statement and Justification of the Research Project:

The research problem is summarized in that the land-use (re-)planning process in the existing Egyptian cities does not attain sustainability because of many reasons. The most important one is that the current land-use structures[6] of most of these cities cannot attain essential principles in land-use distribution process like the synergy[7] and compatibility between land-uses. Also there is no harmony between the added and old parts in the cities,

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[1] After the 6th October 1973 War, the government established many new cities and villages to invest the huge unused area of deserts in Egypt. So, there are two kinds of communities in Egypt, which are existing and new communities. For instance, there is "existing or old Asyut City" and also "new Asyut City". This dissertation focuses on the existing communities because the problems in these communities are the motivator of the research.

[2] It is important to explain what is meant by the term "physical planning". The word "physical" means urban and rural. As GOPP deals with both urban and rural areas, i.e. cities and villages, the term "physical development" includes both the urban and the rural development.

[3] This law was cancelled by the application of the "unified construction building law" in 2008.

[4] The researcher worked as a planning engineer in the GOPP for more than 12 years. This gave her a wide experience in the physical planning problems in Egypt.

[5] The problems facing the development goals attainment in Egypt are illustrated in details in chapter 7.

[6] The current land-use structures in the existing cities are difficult to be changed through the re-planning process in the contrast with the new cities planning.

[7] Synergy means: when two or more actors cooperate, there is a positive result for both of them.

and there is no balance between the land-uses distribution and the roads and infrastructure networks' capacities.

This leads to the need for developing an assessment system, which is a Spatial Planning Support System-SPSS[8]. This SPSS is used in identifying the degree of sustainability attainment in suggested land-uses plans, predicting probable problems, and suggesting modifications in the evaluated plans to avoid future problems in the land-use structures of Egyptian cities. This SPSS can help in raising the degree of sustainability attainment in the land-use planning process.

(1.1.3) The Importance of the Research Field in General and for Egypt in Particular:

The urban land management is not a well-structured issue in developing countries in general because of different reasons. The most prominent reasons are the multi-criteria decision in the land-use planning process, e.g. spatial, economic, social, and environmental criteria. Also there are several objectives that must be dealt with at the same time, which may have conflicts, e.g. conflicts between the targeted benefits of different groups of land users like government and private owners. These are in addition to the complexity in the land-use planning process. As there are various factors or parameters, processes, and variables, which are inter-related in most times in this process. (Vlad 2002, p.1).

Vlad sees that there are complex and dynamic relations between the land-use system with other systems within cities like industry and transport systems. These dynamic relations change on a long run, which leads to difficultly in monitoring these relations by researchers. And so, this causes their neglecting by decision-makers. (Vlad 2002, p.4).

All the previous refer to the importance of the sustainable land-use planning**.** This is the usage of land-use planning as a tool for sustainability attainment through applying the suitable planning polices in the planning process on one hand. And it is the assessment of sustainability attainment in land-use planning to avoid practices, which oppose the sustainability, and to suggest directions or policies for modifying the land-use plans to make them more sustainable on the other hand.

For the Egyptian case, the importance of this research for the urban development is represented in the following:

- The sustainability concept is still a theoretical concept in Egypt without practical steps. So, there is an urgent need to involve or formulate tangible practices to attain sustainability in Egyptian cities' plans.
- There is a need for applying computational tools in the field of physical development to benefit from the recent technological development.
- There is a shortage in the data-bases concerning cities especially geographic data-bases. Therefore, this requires a systematic procedure to organize the establishment and development of these data-bases.
- There is a lack in assessing and monitoring practices of urban development. However, there is a national urban observatory (NUO) within the GOPP but its focus is mainly on housing issues.
- There are several advantages in using the proposed SPSS like saving money, efforts, and time through identifying and avoiding inappropriate development practices.

[8] To avoid any confusion, there is a known software called "Statistical Package for the Social Sciences " that has the same abbreviation "SPSS". However, the abbreviation "SPSS" is used by researchers in the planning support science field, as mentioned in chapter 4.

- There is a simplicity in using the proposed SPSS for the decision makers, who do not have a wide experience in urban planning.
- The scientific materials concerning standards of sustainable planning will be beneficial for researchers in urban planning field in Egypt.

(1.2) Hypothesis, Goals, and Research Questions:

(1.2.1) Research Hypothesis:

The research is based on the main hypothesis that:

"*If there is a computational spatial planning support system, which includes sustainability indicators and is based on Geographic Information System-GIS. This system is used in the assessment of the sustainability attainment degree in the land-use planning process in the Egyptian cities. This will provide the decision makers with an interactive reliable simple tool to confirm sustainability attainment in the land-use planning process in these cities. And at the same time, this system can suggest modifications for raising the sustainability attainment degree in the land-use plans of these cities. However, the application of this system will not be feasible without the control of corruption problem. And also there is a need for dealing with the administrative problems facing the sustainability by improving the way of managing the physical development process and applying some required modifications in some laws in Egypt. The funds provision problem should be also solved for ensuring the execution the assessed plans* ".

(1.2.2) Research Questions:

The main research question is:

"How to attain sustainability in the land-use planning process in the Egyptian cities?"

There are several secondary research questions branched from this main question that should be answered within the dissertation, these are stated in the next table:

Table (1.1) Secondary research questions:

	Framing Research Questions
What	1.What does make a land-use plan of an existing small or medium Egyptian city sustainable? 2.What is the design procedure of the proposed SPSS, so that this system can assess the land-use plans, and suggest modifications to make these plans more sustainable in an interactive way with the users? (i.e. the modelling techniques and methods used)
Why	3.Why is there a gap between the planning practice and planning principles in the Egyptian cities?
How	4. How can the administrative and spatial problems facing the urban sustainable development in the existing Egyptian cities be taken into consideration in the design of the administrative and technical frameworks of the proposed SPSS? 5.How can a minimized version or a prototype from the proposed SPSS be established as an assessment model to apply it on case study areas?

Source: by own

(1.2.3) Main and Secondary Research Goals:

(1.2.3.1) Main Research Goal:

The main goal for this dissertation is to design a computational spatial planning support system for supporting sustainability in the Egyptian cities. This system is an interactive tool used for assessing the sustainability attainment degree in the land-use plans for the small or medium existing Egyptian cities. It can also provide suggestions for modifying any evaluated land-use plan to be more sustainable, if it does not totally attain sustainability. This is in terms of easily understood outputs like simple hot spots[9] graphic representation maps, charts and concise reports.

Notes:

-The proposed SPSS can be applied on land-use plans either on parcel level or zones level.

-The proposed SPSS can be applied on either parts of cities (areas) or cities

-The proposed SPSS can be also applied on the suggested plans for new cities to guarantee the sustainability attainment in these cities.

-The proposed SPSS can be applied on cities in other countries according to the assessing criteria of the target country and the administrative framework for the entities of this country.

(1.2.3.2) Secondary Research Goals:

There are three secondary goals that should be achieved for attaining the main goal. These are:

First goal: is the identification of the constraints for attaining sustainable land-use planning within the existing Egyptian cities through studying their planning and administrative systems, to be the base for designing the technical and administrative frameworks for the proposed SPSS.

Second goal: the development of an assessment model (a minimized version or a prototype from the proposed SPSS) for assessing sustainability in land-use structure of urban areas, and the application of this model on land-use plans of case study areas.

Third goal: is the identification of the improvements required in the assessment model and the recommendations for developing the proposed SPSS to be applied on medium or small Egyptian cities.

(1.3) Aspects of Intelligence in the Proposed SPSS:

The proposed SPSS is an intelligent or smart system, which means its ability to conclude information and perform self-learning. Its development will depend on the Artificial Intelligence-AI, so that not all procedures will be exactly pre-defined to this system. The following points illustrate the aspects of intelligence in the proposed SPSS:

- The system can suggest the suitable form for the outputs of the assessment process (e.g. maps, or charts, or reports) according to the user characteristics, (e.g. planner, or decision maker, or researcher). It can also change the output’s characteristics, depending on the inquiry or the request of the user, (e.g. maps with specific and detailed comments or simple maps).
- The system can deduce the nature of the city (under assessment) from its characteristics, (e.g. its economic base, built area density, etc.). It can consider these characteristics within the suggestions for planning modification.
- The system has the ability to interact with the user like performing changes in the assessing criteria according to the user request as it is illustrated in chapter 6.
- The system can deduce information, which is implied in the input data.

[9] The Hot spots map is a kind of simple graphical representation maps that depend on the idea of identification of the results in the form of coloured areas in a map. Example, the land-uses with red coloured edges are the uses that are not compatible with each other, yellow are partial compatible, and green are totally compatible.

- The system can learn from users’ feedbacks resulted from several resembling cases to add a new criterion to the assessing sustainability criteria. Or, it can extract criteria from successful cases that are entered to it for using them as benchmarking.
- The system can respond to any variation in the city current state, or its land-use planning or the residents' requirements.
- The system can provide more than one alternative for modifying the evaluated land use plan to be sustainable.

However, the proposed system will not replace the planner’s role, or make the planner totally dependent on technology. As the planner or the system’s user should make some decisions during the assessment process regarding some criteria specialized for each study area, as illustrated in chapters 6 and 7. The system’s user can also direct the assessment process to focus on definite aspects.

(1.4) Research Framework and Methodology:

(1.4.1) Research Methodology and Steps:

The research used the deriving methodology in its different steps that formulate the two parts of the dissertation, which are the theoretical and empirical parts:

(1.4.1.1) The Theoretical Part of the Research:

- A literature review for shifts in the planning theories and main planning approaches was done for identifying where is Egypt from these approaches. And the approaches for applying the proposed SPSS in assessing sustainability attainment in the land-use planning in Egyptian cities were discussed as well.
- The sustainability in urban land-use planning and the significance of using efficient assessment tools for evaluating the sustainability attainment in the land-use plans were discussed.
- The added value of the planning support systems for planning on various levels was illustrated and their role in supporting sustainability attainment in urban land-use planning.
- A group of previous examples or studies in the sustainability assessment were selected. These selected examples have used various assessment tools, and are from various countries (developed and developing countries).
- Learned lessons were extracted from the selected examples to act as guides for the proposed system.
- The comprehensive technical framework for the proposed SPSS was designed, which includes the suggested methods and techniques that perform various stages of the assessment process.
- The Egyptian context was studied regarding the planning and administration systems within the Egyptian cities, and the spatial and administrative problems facing the sustainable development. And so, the expectations from the proposed SPSS to deal with these problems were identified.
- The administrative framework for the proposed SPSS was designed based on the administrative problems within the Egyptian system.

(1.4.1.2) The Empirical Part of the Research:

- An assessment model was identified from the comprehensive technical framework of the proposed SPSS to be established as a minimized version from the SPSS. This model is in form of a new toolbox within the ArcGIS™ software to be applied for assessing the sustainability attainment in the land-use structures of urban areas.

- The flow charts of the tools within the toolbox were designed.
- The assessing criteria of the sustainability attainment in the land-use structures of urban areas specialized for each of the Egyptian and German cities were identified.
- The developed toolbox was applied on German and Egyptian cases study areas.
- The modifications in the model (or the developed toolbox) were identified.
- The general conclusions from the whole research, recommendations and future agenda were determined.

(1.4.2) Scale of Application:

Each of the comprehensive SPSS and the assessment model can assess urban spaces from the scale of an area or a part of the city to a whole small or medium[10] Egyptian city.

(1.4.3) Target groups from the Research:

The following groups are targeted to benefit from the SPSS:

- Decision makers.
- Local authorities in cities.
- Councils of public representatives in cities.
- Planning engineers in the GOPP, who are responsible on the revision and validation of land-use plans prepared by consultants and experts.
- Planning policies makers.
- Planning researchers.
- Residents in cities.
- Ministries or entities performing activities supporting the urban development like roads organization.
- Civil society, public sector, and non-governmental organizations-NGOs.
- Planning experts.

(1.4.4) Research Requirements:

The research has required studying the following for attaining the main and secondary goals:

- Literature review for many previous experiences or examples in the field of sustainability assessment for selecting 10 examples from these examples to be studied in details.
- The "unified construction law" (law 119 for the year 2008) and its executive regulations (2009).
- Laws affecting directly and indirectly the physical planning process in Egypt.
- Terms of reference - TOR for preparing the strategic planning for the Egyptian cities by GOPP.
- The available guides for the planning criteria and standards for services in Egypt by GOPP.
- The local administration system for Egyptian cities and problems within it.
- The planning system in Egyptian cities and its elements.
- The way of managing the physical planning and development processes in Egypt.
- The way of developing and implementing plans for the existing Egyptian cities.
- Problems facing the physical planning and development processes in Egypt.

[10] The large cities in Egypt are represented in Cairo, Giza, and Alexandria. These have special considerations in dealing with their land-use planning. So, the research deals with small or medium Egyptian cities to design SPSS to be applicable on the greater number of Egyptian cities as it is possible.

- The positive and negative effects of the 25th January revolution on the physical development process in Egypt.
- Criteria for sustainability attainment for land-use structure of urban areas for Egyptian cities.
- Geo-scripting in ArcGIS™ software through Python language
- Background on the German planning system.
- Criteria for sustainability attainment for land-use structure of urban areas for German cities.

(1.4.5) The Case Study Areas, Causes for Selecting Them, and Fields Trips:

Two areas were selected for applying the assessment model or the developed toolbox. The first is the planned state of an Egyptian area within “Asyut” City, “Asyut” governorate in the Upper Egypt. The second is the current state of a German area, which is a district in “Osnabrück” City, “Lower Saxony” state in the North West of Germany.

Despite the focus of the research being on the Egyptian cities, a German area beside the Egyptian area was selected for applying the toolbox. This is to show the flexibility and applicability of this toolbox for both developed and developing countries, which have many cultural and planning differences. It was also targeted to confirm that the toolbox is flexible to be applied on the land-use structure in either current or planned states.

Applying the toolbox on a German case required studying a background about the German planning system through an introduction to the planning and administration systems in Germany in chapter 9. This is to show some differences between the planning process of cities and the administration systems affecting this process in the two countries.

The researcher visited the two study areas, the Egyptian area was visited on August 2016 and March 2017, the German area on August 2017. The goal of the field trips was data collection, checking the locations of the available services and various land-uses types in the study areas, studying the urban patterns, and spatial relations between the study areas and the neighbouring areas.

(1.5) Benefits of the Research:

(1.5.1) Outputs of the Research:

- The technical framework for the proposed SPSS, i.e. the suggested methods and techniques that perform various stages and tasks of the assessment process using the SPSS, and the requirements for establishing it.
- The administrative framework for the proposed SPSS, i.e. the actors or entities that should be involved in each assessment process stage using the SPSS in Egypt.
- A developed assessment model as a new toolbox in ArcGIS™ software for assessing sustainability in land-use structures of urban areas.
- Sustainability criteria for assessing land-use structure of urban areas in the German and Egyptian cities.
- Results of applying the toolbox on the case study areas.
- The identifications of improvements required in the model or toolbox.
- The recommendations regarding:
  - Challenges facing the development and application of planning support systems.
  - The Egyptian local administration system.
  - The Egyptian planning system.

- Spatial and administrative problems facing sustainable urban land-use planning in Egypt.
- Establishment of proposed SPSS.
- Application of the developed toolbox.

(1.5.2) Contribution of the Research to Knowledge, Practice, and Researcher’s Skills:

(1.5.2.1) Contribution to Knowledge:

The research can represent a contribution for the planning knowledge in:

- Sustainability criteria for assessing land-use structure of urban areas in the German and Egyptian cities.
- The design of each of the technical and administrative frameworks for establishing and applying the SPSS for supporting sustainability in the Egyptian cities. However, the technical framework of the SPSS can be applied on the sustainability attainment of the land-use re-planning of the existing cities in any country, not only Egypt. This requires the formulation of the pre-defined criteria that are appropriate for the country of application.

(1.5.2.2) Contribution to Practice:

The research can represent a contribution for the planning practice in:

- A new toolbox in a GIS software for assessing sustainability in land-use structures of urban areas with many advantages like the flexibility for the input data language, any country standards, and data type, as well as the easiness to be used by non-expert users in the network analysis.
- Recommendations for dealing with each of the gaps in the local administration system, gaps in managing the physical planning and development processes, and the spatial problems facing sustainable urban land-use planning in Egypt.

(1.5.2.3) Contribution to Researcher’s Skills:

The research can represent a contribution for the researcher’s skills in:

- Geo-scripting in ArcGIS™ software through Python language.
- The way to design a computational SPSS as an interactive tool used for assessing the sustainability attainment degree in the land-use plans.

(1.6) The Dissertation Structure:

The theoretical part of the dissertation includes 7 chapters:

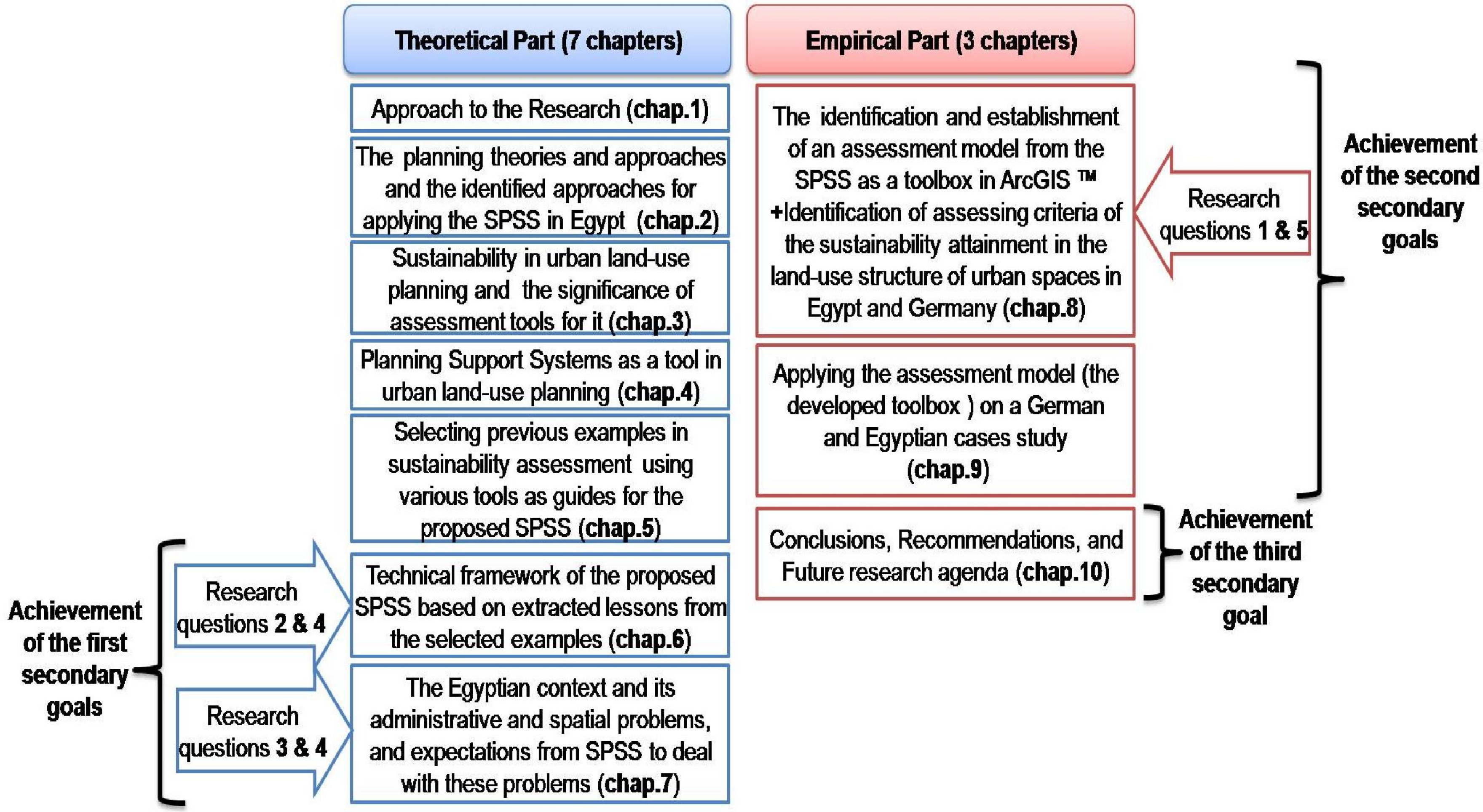
- Chapter 1 (the approach to the research).
- Chapter 2 (literature review for planning theories).
- Chapter 3 (sustainability in urban land use planning).
- Chapter 4 (planning support systems).
- Chapter 5 (previous examples in the field of sustainability assessment using various tools types).
- Chapter 6 (the comprehensive technical framework of the SPSS).
- Chapter 7 (urban planning process in Egypt).

The Practical Part of the dissertation includes 3 chapters:

- Chapter 8 (the establishment of an assessment model from the proposed system).
- Chapter 9 (the application of the developed “land-use sustainability analysis” toolbox on two German and Egyptian study areas).
- Chapter 10 (conclusions, recommendations, and future research agenda).

The next figure shows how the dissertation’s structure has achieved the research goals and answered the research questions:

Fig. (1.1) the structure of the dissertation clarifying the achievement of the research goals and answering for the research questions



Source: own design

Chapter 2
Literature Review for Planning Theories
(2.1) Introduction:

This chapter presents a literature review for planning theories. It browses the shifts that happened in planning theories beginning from the period after the Second World War till now. Then, it illustrates the planning approaches to identify where is Egypt from these approaches. The strengths and weaknesses of these planning approaches are also presented. And so, the current adopted planning approaches in Egypt and the approaches for applying the proposed SPSS in assessing sustainability attainment in the land-use planning in Egyptian cities are discussed.

(2.2) Historical Background for the Evolution of City Planning from the End of the Second World War Till Now in Britain and North America:

According to Taylor, the impacts of the planning theories emerged in Britain and North America are not limited by Britain and North America, but these impacts extended to other places (Taylor 1999, p. 327). Therefore, it is important to introduce an historical background regarding the evolution of city planning and the shifts in planning theories after the end of the Second World War till now in Britain and North America.

After the Second World War for about 20 years, the town or city planning was just a physical design practice or an art in the form of master or blue print plans in Britain and North America. The city planning was done by architects, so that the main consideration was the aesthetic aspect (Taylor 1999, p. 330). However, it linked the urban design to the functional requirements and the concept of ideal cities. (Pallagst 2007, p.41)

Then, the three paradigm[1] shifts (or evolutions) happened in city planning in Britain and North America beginning from the 1960s as follows (Taylor 1999, p. 330-340):

(2.2.1) The First Shift in City Planning in Britain and North America:

The first shift was in the late 1960s. It was a shift from planning as professional physical design to planning as system and rational process according to Brian McLoughlin’s book “Urban and Regional Planning: A Systems Approach” in 1969. The system and rational process is considered two theories. The first one sees the town or city or region as a group of systems of interrelated activities, whereas the second concentrates on the method of planning itself.

The system and rational process assesses the city by its social and economic activities (sociological conception of space). This requires rigorously scientific methods for analysis. In contrast to the period after the Second World War and before the 1960s, in which the cities were assessed as aesthetic and physical objects. However, the concept of the importance of design or aesthetic aspects was not completely overcome by the system and rational approach, especially for the local level of planning. But the shift to system and rational process approach was clearer on the strategic broader level or the long- term planning than on the local short term planning.

[1] The term “paradigm” (according to Thomas Kuhn view) does not mean gradual changes in any type of science. But it means a tremendous change that makes a breakthrough in this type, e.g. the discovery that the Earth is not flat. However, city planning is not considered as a science, but a social practice for reforming the physical environment. Therefore, the strong meaning of ‘paradigm’ devoted by Kuhn cannot be applied on planning. As none of the shifts in city planning from 1960s and over more than 50 years can be considered paradigm shifts as Kuhn’s view to the term “paradigm”. (Taylor 1999, p. 328)

With regards to the planner, the system and rational process approach adopts the principle that the planner (on the first hand) should have some specialist knowledge or skills to use it mainly in scientific analysis and rational decision making. On the other hand, there was a planning thought related to the system and rational process approach, which has considered judgements made by planners as valuable judgements and political. Both opinions confirm that the planner should possess some specialist skills to manage the process of decision making to attain public goals.

(2.2.2) The Second Shift in City Planning in Britain and North America:

The second shift was in the 1970s and 1980s. It was the shift from viewing the planner as a technical expert to viewing the planner as a manager and facilitator in the planning process and a moderator between different group interests. Therefore, the first shift of the planner’s role was from an urban designer to a system analyst, whereas the second shift of the planner’s role was from a system analyst to a decision making moderator.

John Friedmann developed the term “action planning” at the end of the 1960s, which describes how the policies get implemented. This term has become the focus of planners in the 1970s and 1980s. This has required planners to be effective in networking, communicating and negotiation with stakeholders to reach for the implementations of plans and policies. This has caused the shift in the planners’ role from system analyst to the decision making moderator, or networker, or manager.

Also Judith Innes has emphasized on two other terms “communicative action” and “interactive practice” as an image for this second paradigm shift in planning theory. This has confirmed the importance of the planner’s role as moderator.

The fact that a planner should be the decision making moderator is not contradict with the importance that a planner should have specialist skills and knowledge. These skills can help to lead the negotiations process between stakeholders to reach the most appropriate decision.

(2.2.3) The Third Shift in City Planning in Britain and North America:

The third shift was in the 1990s and 2000s. This shift happened as a result of the western shift in thought from modernism to post modernism, which has directly affected the general thought on architecture and planning. After the shift to functional and geometrical concerns of modernism, the postmodernism came with the concept of returning to the consideration of the aesthetic concerns. Robert Venturi calls the postmodernism the overcoming of the plain functional modernism or “bring back style”.

Jane Jacobs sees the modernism as a simplistic approach that does not consider the social and economic aspects of the existing cities, which cause the planning process to be more complex. Also Christopher Alexander does not agree with simplification of the modernism in cities planning. He advocates the opinion that the successful plan of any city should contain complex patterns of interrelationships.

Moreover, the postmodernism theory in planning is seen by many as a shift from the intellectual tradition of “European enlightenment world view”, which was connected to modernism. The main concept in the postmodernism is diversity, pluralism, and multiculturalism, (i.e. there is not one ideal environment for every person). In addition to that, the postmodernists encourage liberal and market-sensitive system of planning. This is in contrast of the modernists, who encourage the statism of socialist and social democratic forms of planning.

Leonie Sandercock sees that the postmodernism is not a shift from the modernism, but postmodernism is a complement to modernism. As she compared modernism and postmodernism with regards to each of the knowledge basis of planning and the normative or regulative theory of planning. Sandercock concluded that the modernism planning makes the public or the political decisions more rational and comprehensive, so that modernism has helped in evaluating alternatives available for planners. The modernism also relies on social sciences with the tendency towards the quantitative modelling and analysis. With regards to the normative or regulative theory of planning, she sees that the modernism is a top down process.

Sandercock believes that even though rationality in modernism is still useful, the postmodernism is more beneficial on the practical level. Because postmodernism is based on experience besides the knowledge, whereas, modernism is based on just scientific knowledge. Also Sandercock criticizes the top-down aspect of modernism, and emphasizes on the importance of the community based planning (bottom-up). This is one of the main advantages in the postmodernism that seeks community empowerment. And so she confirms that planning should be not only comprehensive and integrated, but also political and people oriented.

However, due to the importance of the scientific knowledge (modernism thought) besides the experience represented in the community sharing in the planning process on the local level (postmodernism thought). Sandercock's argument concerning the significance of the postmodernism states that the postmodernism is a complement to modernism.

With regards to the sustainable development, postmodernists emphasize that postmodernism in city planning should help in economically and environmentally sustainable development. In the same time, Sandercock's argument calls for a "bottom-up" community planning, which is based on social justice and negotiations between different groups. Therefore, the postmodernism with its community based-liberal thought can be considered as a paradigm shift from the modernism in city planning towards sustainability. In general, many confirm that the shifts in the planning theories all over the period after the Second World War can be considered as developments or improvements rather than shifts. As all the emerged planning approaches can be complements to each other as aforementioned.

(2.2.4) Comparison between the Three Paradigm Shifts in City Planning in Britain and North America:

To sum up the following table shows a quick comparison between the three significant paradigm shifts in city planning in Britain and North America from the1960s to 2000s:

Table (2.1) Comparison between the three paradigm shifts in city planning in Britain and North America from1960s to 2000s:

Shift	Period of emergence	Planning thought	Planner role
The first shift: to planning as system and rational process	In late 1960s	The system and rational process assess the city by its social and economic activities. This requires analytical scientific methods. However, the importance of design or aesthetic aspects was not completely overcome. This shift was more on the strategic broader level or the long-term planning than the local short term planning.	The planner should have some specialist skills to manage the process of decision making.

Shift	Period of emergence	Planning thought	Planner role
The second shift: to viewing planner as a manager, facilitator, and moderator	In 1970s and 1980s	The focus was on the terms “action planning”, “communicative action”, and “interactive practice”. These have required planners to work as decision making moderators, and to be effective in networking, communicating, and negotiation with stakeholders.	The decision making moderator, networker, and facilitator.
The third shift: to postmodernism	In 1990s and 2000s	The main concept in the postmodernism is the diversity, pluralism, multicultural, and the community based planning, which seeks community empowerment. Postmodernism encourages the liberal and market-sensitive system of planning.	A political moderator or manager in the planning process

Source: own design according to Taylor 1999, p. 330-340

(2.3) The Three Main Approaches in Planning:

There are three main planning approaches:

(2.3.1) System Analysis and Procedural Planning Approach or Modernism: (Pallagst 2007, p.41-46)

The system analysis or modernism approach is connected with several nominations like the “rational planning”, “physical planning”, and “comprehensive planning”. The modernism approach emerged in the 1960s-1970s. This approach aims mainly at solving problems by using analytical solutions and regulative strategies. The system analysis approach affected the general planning thought. This thought was transferred from the concept of planning as a design based products (plans) to the concept of planning as a process with various connected factors or parameters. This means that this approach has converted planning from just an art to be a science.

The planning approach of modernism is divided into three secondary approaches:

a. Physical planning and urban design (1950s/1980s/1990s), which views cities as static objects.

b. Procedural planning (1960s-1980s), which is called “rational decision-making process”. It aims at achieving an optimized outcome in planning, which is one of the basic considerations of modernism or rational planning theory.

c. Systems analysis (1960s-1980s), which views cities as complex systems.

The aim of these approaches is to see planning as a “means to ends” problem-solving process, which should improve the planning practice by providing analytical solutions and regulative strategies. The procedural planning and systems analysis apply certain procedures, models, or strategies to explore complex processes in a generalized way.

The main characteristics of modernism are:

- The system analysis approach of the modernism deals with the city as complex systems of interrelated sectors or parts. All these sectors or parts affect and are affected by each other. Moreover, these systems are flexible, which make the city non-static unlike the physical planning and urban design approach of the modernism, (i.e. the master or blue print plans).
- The modernism thought is idealistic.
- System analysis of the modernism influenced the planning thought to be transferred from the design product (plan) to planning as a process with different interrelated

variables. This is the cause of using the computer models and simulations as the basic features in this principally methodological approach.

- Planning (from the point of view of this approach) represents a rational decision-making process.
- The planning’s focus was on comprehensive plans, as these plans represent the typical rationalist planning product of this approach.

(2.3.2) The Postmodernism Approach: (Pallagst 2007, p.46-49)

The postmodernism emerged in the 1980s. It was inspired by the critical social theory. The postmodernism has challenged the modernism thought because it was considered as an “anti-enlightenment movement” since the “enlightenment movement” was connected with modernism as aforementioned. The main concept of postmodernism does not fit with any systematic rationalist framework, as the systematic rationalist is idealistic. However, the postmodernism thought concerns mainly with what is actually done in real life.

Therefore, the postmodernism thought criticizes the systems analysis and rational approach in planning. The postmodernism rejects the regulative known concept of planning. According to Pallagst, there are five principles in postmodernism in planning:

- Fragmentation, dispersion, and variance.
- The issue of power.
- The role of cultural influences in organizing society.
- The break-down of transcendental meaning.
- The digressive creation for objects.

(2.3.3) The Collaborative Approach:

This approach has emerged in (1990s-2000s). After the shift to systematic thinking in planning in the late 1960s and the early of 1970s (first paradigm shift), many theorists saw that the main mission of planners was to attain the welfare of the people and solving problems. This is through using systematic analysis that affects decisions, and using regulations and implementations of strategies. This shows the belief in the instrumental rationality, and the technology and knowledge, which can lead to a better world. Therefore, planning is considered as an important tool for social progress. And so, the attitude towards the collaborative planning began, which bases on the concept of planning as a communicative action. (Innes 1995, p.3).

The collaborative approach seeks to cope with the complexity of the planning process by including stakeholders in the planning process (Pallagst 2007, p.55). And so, planning thinkers consider the systematic analysis as a small part from what planners can do. As the planners’ potentials can go beyond the systematic analysis to the communicative action, so that planners are considered actors rather than observers or neutral experts. These planning thinkers are considered as social scientists and philosophers rather than systematic thinkers. As they focus more on qualitative, illustrative inquiries than on logical deducing analysis. (Innes 1995, p.3).

(2.4) Strengths and Weaknesses in the Three Main Approaches in Planning:

(2.4.1) The Modernism:

(2.4.1.1) Strengths in Modernism:

The strengths in modernism include:

- Modernism supports processes that deal with different interrelated variables. Therefore, the computer models and simulations are considered basic features in this principally methodological approach. These models have a variety of applications in planning process. (Innes 1995, p.3)

- This approach deals with all the sectors in the city. (Innes 1995, p.3)
- Various tools, which are applied in the current planning activities, are based on modernism concepts for regulations and the systems theory. (Pallagst 2007, p.46).

(2.4.1.2) Weaknesses in Modernism:

According to Pallagst, this approach is criticized as being too abstract and without content. (Pallagst 2007, p.46). The weaknesses in modernism include (Innes 1995, p.3):

- The modernism does not take political aspects of planning into consideration, and ignores the concerns of those who are non-specialized in the planning process. This leads to confusion among each of planners and politicians, as planning process is strongly connected to politics.
- Aspects of social inclusion, culture minorities, and feminism are not taken into consideration.
- The uncertainty is considered one of the main problems, which is faced by the planning process with this approach.
- There are limitations characterizing the decision making process in the modernism approach. Significant changes are required like activating communication practice within the planning process within this approach to make it remaining feasible.
- The system analysis process within the modernism is static and technocratic, and needs a more contemporary approach that can consider each of fragmented activities, multiple actors, uncertainty, and changes within society.

(2.4.2) The Postmodernism: (Pallagst 2007, p.46-49)

(2.4.2.1) Strengths in Postmodernism:

The strengths in postmodernism are represented in being more realistic than the modernism. The postmodernism is also socially oriented.

(2.4.2.2) Weaknesses in Postmodernism:

The weaknesses of this approach are represented in that the postmodernism in planning theory has shown its lack of usability for planning practice. Because it does not present effective solutions, and also it works on a very wide and general level. Moreover, the post-modernism does not allow possibilities for cross cultural interpretations.

(2.4.3) The Collaborative Planning:

(2.4.3.1) Strengths in Collaborative Planning:

The strengths in the collaborative planning approach include: (Pallagst 2007, p.49-54)

- It is an action-oriented approach.
- It considers the aspects of the social and cultural minority.
- The planner is a moderator within this approach.
- It links between modernism and postmodernism. However, the collaborative planning offers a methodological path to planning that is more similar to the rational choice or procedural planning (modernism) than the postmodernism thought.

(2.4.3.2) Weaknesses in Collaborative Planning: (Hoch 2007, p. 274)

The collaborative planning is based on the concept of planning as a communicative action. However, Charles J. Hoch considers the communicative action "naïve". Huxley and Yiftachel also see that the communicative action analysts concentrate only on ideas, talk, and actions of individual planners. This leads to the ignorance of the institutional and structural parameters that form what planners actually achieve or do.

Also Huxley and Yiftachel see that the communicative action analysts deal with planning in an idealistic, narrow, and abstracted way. Because these analysts work with the planning process, as if it is an ideal process. This makes the actual role of planning process just a social role rather than a more comprehensive role, which is supposed to include cultural, political, and spatial or geographic factors.

(2.5) The Interdependence between Approaches in the Planning Process:

The interdependence is the integration between different planning approaches in the planning process, which can lead to more beneficial results than using one approach only. For example, the integration between the collaborative approach and the strategic rationality can be a suitable solution for particular situations.

The definition of interdependence according to researchers' points of view is not the same. Innes and Booher focus on the collaborative activity without considering the rational concepts of planning. They see cities as living organisms, which work as complicated systems, so that they limit the interdependence's definition in just being a relation between actors within a network. Hopkin's view for the interdependence resembles to the view of Innes and Booher. However, Karina Pallagst sees the interdependence as a connection between each of the different planning theories and different activities of planning practice. These cannot work in a parallel way, but in an overlapping way (Pallagst 2007, p.55-57).

The interdependence does not mean the comprehensiveness. The interdependence represents the complexity of using various theories or tools within the planning process, whereas comprehensiveness is the inclusion of various aspects in the preparation of the plan. This means the comprehensiveness of entire community (regarding space) in the plan preparation, the comprehensiveness of different sectors of government activities (regarding function), and the comprehensiveness of several time intervals (regarding time). (Pallagst 2007, p.57).

(2.6) Where is Planning in Egypt from the Three Main Planning Approaches:

As mentioned in chapter 1, after the establishment of the GOPP in 1973. The planning principles have been considered for the first time in the urban management process in the Egyptian cities with the application of the first law concerning the physical planning in Egypt "law 3 /1982". The planning process at this time was done by using the physical design practice or art through the master plans, which is a kind of blue print plans. However, there were a lot of physical problems inhibiting the development goals attainment in Egypt in general and in the Egyptian Cities in particular. This led to the unfeasibility of these plans because these plans were not based on sustainability principles.

Nowadays, the planning process in Egypt is done according to the strategic planning approach. This is since the assignment and application of the "unified construction building law" (law 119 for the year 2008) and its executive regulations for the year 2009.

The methodology of the strategic planning approach adopted by the GOPP is based on analysing six interrelated main and secondary sectors within the city (proposed to planning). This is in order to attain an integrated development among these sectors. The main sectors are the shelter, local economy, and basic facilities sectors. The secondary sectors are the environment, social, and urban governance. This is with ensuring the representation of various development partners (stakeholders) in the city within the planning process especially the poor and marginalized groups like disabled and women.

Therefore, the planning process in Egypt (since applying the strategic planning) is based on each of the system analysis and procedural planning or modernism approach with the collaborative approach in its various phases[2]:

Table (2.2) Planning approaches adopted in various phases of cities' plans in Egypt:

The planning phase		Planning Approach	Reference
The plan preparation phase	A report concerning the needs and priorities of the physical development in the city proposed to planning and suggestions for projects is prepared by certain entities <u>with the cooperation of representatives</u> of the local society and non-governmental organizations -NGOs.	Collaborative Approach	Article 10, executive regulations-Law 119/2009, p.20
	The future vision for the city is formulated in a workshop including <u>different groups of development partners</u> such as the young, the elderly, the disabled, the representatives of businessmen, women, and non-governmental and civil society organizations. The aim of the workshop is to give the chance for the development partners to talk about their concerns and problems, and so transform them into a future vision.	Collaborative Approach	Article 13, executive regulations-Law 119/2009, p.23
The plan performing phase	The procedure of preparing the strategic master plan is done by using a systemic analysis process through <u>analysing the current situation</u> and suggesting the land use master plan and the new city's boundary with the <u>cooperation of the stakeholders</u> to achieve the city future vision.	System analysis and collaborative approaches	Terms of Reference-TOR, GOPP, 2010
The plan assigning phase	The plan is presented for the <u>stakeholders</u>, so that the responsible parties on the preparation of the plan can receive the notices of the stakeholders to modify the plan according to the stakeholders' notices.	Collaborative Approach	Article 12 Law 119/2008, p.12

Source: own design according to the stated references

The previous table shows the commitment towards the stakeholders of Egyptian cities. As the plans are formulated with regards to their requests and ideas, and cannot be validated without their agreement. However, the stakeholder's real role doesn't exceed sharing in meetings, land donation, and agreement of plan.

<u>(2.7) The Planning Approaches on which the Proposed SPSS Established:</u>

According to Taleai et al., deciding whether to adopt a top-down or bottom-up approach depends on the circumstances of each country. The top-down urban planning represents the system analysis approach. Because it is the approach, in which the government along with experts decide the planning standards and perform plans based on these standards. The main disadvantage in this approach is that the standards are general and not customized according to the actual needs and expectations of the residents of each city. (Taleai et al. 2014, p.58).

[2] The detailed illustration for the Egyptian cities planning process is mentioned in chapter 7.

On the contrary, there is the bottom-up urban planning, which represents the collaborative approach, in which the residents are involved in deciding the planning standards and so the planning process itself. Therefore, plans are done according to their expectations. However, the main disadvantage in this approach lies in the practical experience with the developing countries. Some problems emerged because of the adoption of a participatory attitude. These problems include objections from local authorities, the shortages in advanced land use planning models, which the local development partners can use in planning. The communications facilities for supporting negotiations between groups are weak and the unclear planning methodology guidance with the lack of qualified staff on the local levels. Therefore, Taleai et al. see that the top-down urban planning is more appropriate for many developing countries to limit the rapid growth problem (Taleai et al. 2014, p.58).

As aforementioned, the planning process in Egypt includes both the system analysis and the collaborative approach with the need for more support for the stakeholders role through the collaborative approach. Therefore, the proposed SPSS is also suggested to work through these two approaches. As its knowledge basis needs to be established through the system analysis approach. Because this approach is based on the top-down urban planning, in which planning standards are decided by urban planners according to various analyses and studies. This can practically be more appropriate for Egypt as a developing country with rapid growth problem in most Egyptian cities. However, the application of the proposed SPPS in assessing land-use plans should be through the interdependence between the system analysis (top-down planning) and the collaborative approach (bottom-up planning). This is in order that the SPSS gives more space for stakeholders to intervene and interact with the assessment process as illustrated in chapter 6.

(2.8) Reflection:

Despite the importance of the decentralization as a successful urban governance attitude, the planning process (in developing countries in general and Egypt in particular) is still not ready for applying decentralization in a total manner. The current situation in Egypt requires the interdependence between top-down planning and bottom-up planning attitudes. This is to attain the balance between the scientific base for urban planning process and the satisfaction of the residents with the outputs of this process by involving them in assessing and following up these outputs.

The next chapter presents in details the sustainability issue in urban land-use planning with all its aspects and the assessment tools of sustainability.

Chapter 3
Sustainability in Urban Land-use Planning

(3.1) Introduction:

This chapter focuses on the sustainability in urban land-use planning through illustrating six topics. It is important to first discuss the sustainability as a concept in general by clarifying how this concept emerged, then various definitions for it and the approaches for sustainable cites are browsed. The importance of good governance and the institutional aspect in sustainability attainment are discussed and the effects of the economic axis on the social and environmental axes of sustainability as well.

Then, this chapter illustrates the concept of sustainability in urban land-use planning and the importance of the land-use planning process for the three axes of the sustainable development. The contradictions among sustainable development axes and how the land-use planning process deals with them are presented. Then, the mixed land-use development policy as a way to sustainability attainment and the optimal approach for applying it are illustrated.

As the focus in this dissertation is on the existing Egyptian cities, the sustainability in urban land-use planning of the existing areas, challenges facing it, and problems facing the urban sustainability in developing countries are discussed.

Then, the assessment tools of sustainability and approaches to sustainability assessment are presented as well as the conditions and types of these tools. The importance of the assessment of sustainability attainment in urban land-use planning and the challenges facing this process are discussed. Finally, the importance of participation in the sustainability assessment is illustrated.

(3.2) Sustainability as a Concept:

The sustainability or the sustainable development has become a universal concept for all the researchers, who concern with the urban planning and development. (Wang et al. 2014, p.44). However, there are many debates over its definition, which is still vague (Mori and Christodoulou 2012, p.2). The sustainability concept has many alternatives for its theoretical formulations and applications that already were done according to the same principle, but with various perspectives (Pope et al. 2004, p. 598).

(3.2.1) The Historical Background of the Sustainability Development Concept:

The sustainability concept used to be a very known term in the field of environmental economics (Mori and Christodoulou 2012, p.2). However, it is difficult to trace all the modifications that happened in the sustainability concept. The sustainable development concept itself was initially based on global socio-economic systems without any spatial reference (Lee and Huang 2007, p.507). After the well-known Bruntland Report in 1987, many discourses were confirming that the economic interests and environmental concerns are not contradictory, if various parties in the development process agree on common interests. (Zhang et al. 2011, p.141).

In 1996, the main decision was by the international forum Habitat II (or what is called the “Habitat Agenda”) has focused on the availability of suitable shelter and sustainable human settlements. (Zhang et al. 2011, p.141). Then, Rogers R. (1997) identified the sustainability parameters, which include each of economic, environmental, social, and aesthetic parameters.

Each of Camagni R., Capello R., and Nijkamp P. (1998) saw that the city should be “a sustainable integration of economic, environmental, and technological elements” (Lee and Huang 2007, p.507). However, (parallel to this in the mid of 1990s) the known sustainability framework emerged, which is called “triple bottom line approach (TBL)” by John Elkington. The TBL is based on the economic, social, and environmental parameters (Slaper 2011, p.4). After that in 2005, the United Nations in its “World Summit Outcome Document” confirmed on what are called the “interdependent and mutually reinforcing pillars” of sustainable development. These pillars or axes are economic development, social development, and environmental protection. (Zhang et al. 2011, p.141).

Geertman et al. have stated in their book "Planning Support Systems for Sustainable Urban Development” (2013) that the term "sustainable urban development" was connected only with the idea of performing the development processes. These processes guarantee the attainment of some principles, which are the environment protection, producing of spaces with high quality, the economic efficiency, and social justice. Recently, this term is connected with new concepts within the spatial planning field especially like smart growth, network cities, ecological footprint, eco-cities, and new urbanism. However, it is still a great challenge to identify definite tasks to attain this term (Geertman et al. 2013, p.2,3).

<u>(3.2.2) Sustainability Definitions:</u>

The most known definition for the sustainability is mentioned in the report of “World Commission on Environment and Development” (Brundtland Commission) in 1987. It states that, “*the sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*” (Godschalk 2004, p.6). The definition of Brudtland Commission focuses on only two concerns, which are the environmental and development concerns. (Pope et al. 2004, p. 597).

As it is clear from the historical background, the sustainability concept was not a comprehensive concept in its beginning. For example, Allen R. (1980) has defined the sustainable development as the development that is likely to attain the satisfaction for all the human needs and improve the quality of life. This is conditioned with the usage of the ecosystems in a manner that makes them continuously renewable. So, this definition is only concerned with the quality of life with the preservation of ecosystems, which is not considered a comprehensive or integrative definition (Mori and Christodoulou 2012, p.3). However, the planners in the USA and other developed countries have managed to figure out the central value in the sustainable development in attainment of the balance among the three “E”s: environment, economy, and equity. This leads to the necessity to manage the conflicts among promoting each of environment, economy, and equity especially in the field of land-use planning. As the practical experience showed that the usage of the wide consensual principles of sustainable development in policies, methods, and decisions concerning the land-use planning has not solved the conflicts that will be mentioned later. (Godschalk 2004, p.6).

Pope et al. have considered the ‘triple bottom line’ (TBL) an interpretation of sustainability, (or as a new sustainability framework), which gives equal significance to each of environmental, social, and economic concerns in decision-making process. However, the TBL model has put a separation line between the social and economic factors in the development issues. This is to confirm that the volume of economic gains are not considered sufficient indicator for the development, as these gains are not the only human’s need. (Pope et al. 2004, p. 597).

Graham Haughton has defined the sustainable city with a global perceptive. He has stated that the sustainable urban development is a composition of integrated elements to attain a wide goal, which is the global sustainable development that includes some secondary goals. These goals are the environmental management, the equity among the current and the future generation, the social justice, and the spatial equity. Any improvement for the local environment will not succeed without studying the external impacts of this improvement on the urban behavior. These impacts are represented in the global issues like the ozone layer and the global warming. So, the issue of the sustainable city should be studied with its global context that includes a comprehensive analysis of the external impacts that are caused by the cities (Haughton 1997, p.189).

Other definition for urban sustainability states that the sustainability is a type of a sustain ability to live and grow of the urban living. This is due to the reduction or the control of the negative impacts on the environment that may result from the urban demography or population, the land use distribution, the urban structure, and the transport (Yigitcanlar and Dur 2010, p.324)

The U.S. National Research Council (1999) has adopted the idea that the sustainable development is based on three main elements. These are “what is to be sustained”, “what is to be developed”, and “the intergenerational element of the sustainability”, (i.e. the equity among the generation in benefiting from resources). Also this council has focused on three targets to be sustained, which are “the nature”, “life-support systems”, and “community”, as well as the three issues to be developed, which are “people”, “society”, and “economy” (Ness et al. 2007, p.498).

Zhang et al. have stated another definition for urban sustainability, which is connected with the land use. This definition is according to the Framework for Evaluation Sustainable Land Management (FESLM). They have defined the sustainability as a kind of measurement for the extent, in which the land use structure fulfills the requirements of the following five principles. These principles are the productivity, security, protection, economic viability, and social acceptability in the future. (Zhang et al. 2011, p.142).

(3.2.3) Approaches to Sustainable Cites and Critiques against Them:

In 1997, Haughton has presented four approaches for attaining sustainable cites, which are:

(3.2.3.1) The Self-reliant Cities:

This approach is based on the idea that the city has self-satisfaction for its needs. This means that the local demands are fulfilled through the local resources, activities, and cooperation within actors in the city. This is to save the resources outside the city to attain a more decentralized political agenda in the countries that adopt this approach (Haughton 1997, p.190). However, the challenge towards this approach is that the economic and environmental independence of the cities from the world will negatively impact the modern urban life. Moreover, the urban self-reliance requires huge modifications in the political attitude. (Haughton 1997, p.191).

(3.2.3.2) Redesigning Cities and their Regions: (Haughton 1997, p. 191)

This approach is based on the idea of more compact structures for cities. This means a higher residential density and the attitude of intensive mixed land-uses, as well as modifying the buildings' design. This is through the dependence on the solar energy and the improvement of the insulation of the buildings with utilization of less energy, as well as depending on the recycled materials, and others. This approach proposes an efficient structure of the urban settlement. This efficient structure can help in saving resources and reducing the travel distances, and so minimizing the energy consumption and preserving the local environment.

The critiques against this approach are all about targeting the internal efficiency of cities, without the consideration of the external impacts. For example, the focus is mainly on decreasing the internal resources consumption and decreasing waste generation without considering the external sources of these resources and the way of getting rid of the wastes outside cities.

<u>(3.2.3.3) Externally Dependent Cities:</u> (Haughton 1997, p. 192)

The main motivator for this approach is that the environmental costs of the urban consumption of environmental natural recourses (like water and air) are not considered. This is because they are not monitored by market mechanisms, as these natural resources are not valued in a proper way. Therefore, this approach focuses on the environmental costs connected with the cities growth "urban externalities" through managing the market mechanisms to support the environmental goals. The main idea is to identify the environmental costs of any polluting activity in the cities. This is through a market pricing mechanism by putting fees on the polluters to be paid for compensating the environmental costs resulted from their activities. This is to reduce the environment damages among the cities by improving the market system according to the geographical relations between the cities, and so sustainability attainment.

The main critique against this approach is that the pricing of the resources may lead to discouragement of investments or at least postponing them. Moreover, the focusing on the restricting market mechanisms may affect the social equity attainment because there is no consideration for marginalized categories like unemployment and homeless people. Therefore, the main challenge towards this approach is that the market system should be supported with rigid social justice programs with environmental standards to attain the balance between the social and environmental considerations.

<u>(3.2.3.4) Shares Cities:</u>

This approach tries to compromise between all the advantages in the three previous approaches. However, it mainly focuses on the environmental and social concerns in attaining sustainability. The main target for this approach is to attain the balance between the demands and rights among cities. (Haughton 1997, p. 192). This is through the evaluation of the environmental assets or resources and the regional exchanging of these resources among cities that have these resources and are affected by the pollutants resulted from using them. This approach considers each of the political, economic, social, and environmental considerations in managing resources among cities. (Haughton 1997, p. 193).

Despite the main idea is good, the main challenge towards this approach is the difficulty in collecting, analyzing, and interpreting the data required that covers all these considerations regarding all the sharing cities in the resources. However, the principles of the "shares cities" are considered essential and effective in the trading and managing of the resources in general (Haughton 1997, p. 193).

(3.2.4) The Importance of Good Governance and the Institutional Aspect in Sustainability Attainment:

According to the four previously mentioned approaches for the sustainable cities, Haughton sees that the sustainable urban development requires a good governance, efficient market system, and many regulation changes on the cities and countries levels. These are not only to preserve the environment of the cities, but also to preserve the environment of the hinterlands of these cities (Haughton 1997, p. 194).

Therefore, the sustainable development should attain the integration between the economic, social, and environmental goals on the one hand, and the institutional goals on the other hand. This is to reach to an integrated strategy, which supports the interests of each goal and the introduction of practices that attain balance among the international and domestic policies. These are in addition to the development extension to the distant regions (spatially) and to the future generations (by time). (Lee and Huang 2007, p. 506-507).

Sharifi and Murayama agree with Haughton on that the good performance of the institutions or the good governance is the way to attain sustainability. As it directly affects the community's sustainability, so Sharifi and Murayama use the term "the institutional sustainability". They confirm that both the governmental and non-governmental institutions should play the main role in managing the interactions and the relations between all the parties affecting and affected by the development process. This is provided by the support of a decentralized political system, legal frameworks, information systems, and sustainable development research activities (Sharifi and Murayama 2013, p.78). Therefore, Sharifi and Murayama consider the institutional sustainability criteria within the criteria for assessing the sustainability of any city, (as it is illustrated latter in the assessment tools of sustainability) (Sharifi and Murayama 2013, p.79).

This is because it was important to demonstrate in chapter 7 of this dissertation the gaps in the administration system in Egypt. As we will see that these gaps and the gaps in managing the planning procedure represent the main obstacle towards plans' success. This is despite of the adoption of the strategic approach in the planning in Egypt with all its advantages like public participation and inclusion of various parameters beside the spatial parameter in the planning process.

(3.2.5) The Effects of the Economic Axis on the Social and Environmental Axes of Sustainability:

The attainment of the economic efficiency does not contradict the attainment of the environmental preservation and social justice. However, Wang et al. state some examples for effects of the economic parameters on the environmental and social ones (Wang et al. 2014, p.45):

- The market-based economic system can support the social and environmental goals. This is because this system is characterized by the ability to balance the demand and supply, as well as allocating resources in an appropriate way with the motivation for innovations. On the contrary, the capitalist system hinders the sustainability because it leads to the concentration of wealth, and so opposing the social equity attainment. It also leads to the materials consumption, which contradicts with the environmental preservation goal.

- The economic system can guarantee each of the provision with the social services, affordable housing (especially to the margin groups), upgrading the old infrastructure networks, the brown-fields treatment, and balanced distribution of public transportation. These confirm that the economics parameters affect each of the social and the environmental sustainability. Therefore, the transformations of the economic values are critical for attaining the environmental and equity goals.
- The economic attitudes like the local self-reliance and the socially or collectively investments can support the social justice goal.

In general, the matter needs a long time to make a real balance among the three axes through an efficient growth-oriented economy with the attainment of the environmental preservation and social justice at the same time. (Wang et al. 2014, p.45).

(3.3) Sustainability in Urban Land-use Planning:

With the technological development, there are many spatial impacts that happen within cities. A good example is what happened within the German cities, which experience many changes resulted from the technological development. These changes include the cities expansion because of the increase of the distances between residence locations and work locations due to the progressing in transport technology and telecommunication. The technological development also led to the transformation of many agricultural lands into building lands because the cultivation is not a profitable activity. The increase of the population and traffic densities in areas that include institutions offering jobs opportunities is also one of the results of the technological development. All of these have led to the decreasing of the quality of life and the environmental deterioration in these areas because of the continuous decrease of the natural landscapes. These spatial development changes represent alarms for the importance of attaining balance between the economic parameters with the social and environmental parameters within the urban land-use planning. As the sustainable spatial development is considered an essential condition for maintaining a good quality of life. (Federal Office for Building and Regional Planning of Germany 2001, p.3).

However, the practical experience in the land-use planning shows that the land-use planning is considered one of the most significant fields, in which there are many conflicts regarding attaining the sustainable development. Even with the interpretation of the wide comprehensive principles of sustainability (into definite policies, procedures, and decisions) within the land-use planning process is performed. This interpretation has not totally solved these conflicts, but has showed the difficulty of the idea of sustainable development itself. (Godschalk 2004, p.6).

All the previous show the importance to study how the land-use planning process is used as a tool to attain the sustainability. Therefore, this section from this chapter concentrates on the sustainability in the urban land-use planning process, or what is called “sustainable urban land-use planning”.

(3.3.1) Concept of Sustainability in Urban Land-use Planning:

The environmental issues like water quality and energy use have become main concerns with the rapid growth of the cities. And so, many discourses connect these issues with the planning practices. These discourses call for the necessity of considering (as far as it is possible) the local ecosystems principles and the environmental regulations within the planning practices. This is in order that the planners apply environmental principles of the sustainability to attain various objectives like compact urban form and transit-oriented development. (Wang et al. 2014, p.45).

It was also concluded in a Chinese experience (illustrated in chapter 5) that the rational land-use structure is an inevitable element that can achieve the sustainable development. (Zhang et al. 2011, p.147)

Therefore, the application of the sustainability principles in the planning activities by using new planning approaches has become a must. It was proved that the traditional master-planning approach is not efficient in supporting the economic, social, and environmental sustainability of urban areas. (Musakwa and Niekerk 2013, p.143).

There is a connection between planning and sustainability, as the word ‘‘Planning’’ reflects a board range of systematic activities. These activities aim to achieve some goals including the urban development, environmental protection, the economic activation, social equity, and other goals that are related to the sustainability concept. So, the sustainable planning should base on five principles which are: long-term vision, comprehensive coverage, identifying and accepting the resources limits, the focusing on the location, as well as the active involvement of the planning in problems alleviation. (Wang et al. 2014, p.46)

Despite Musakwa and Niekerk see that the sustainable development and sustainable land-use planning are still fuzzy concepts. However, according to the previously mentioned definition of Bruntland Commission for the sustainable development, the sustainable urban land-use process can be defined as “*the meeting of the needs of both the current and future urban citizens*”. (Musakwa and Niekerk 2013, p.144).

The sustainable urban land-use planning can also be defined as: The urban land-uses arrangements and the activities of the environmental conservation and management that aim at attaining socioeconomic-environmental goals. This definition implies the increasing the variety of the land-uses types in the same location, which is called “the land-use intensification” as a way towards sustainable cities. It is seen as a factor that can minimize the pressures resulted from cities’ expansion, and so attain the sustainable urban land-use structure. (Zhang et al. 2011, p.142).

The “sustainable land management-SLM” concept is connected to the “sustainable land-use planning”. The SLM is a system that includes technologies, policies, and activities that propose attaining the integration between the socioeconomic principles and the environmental issues. (Zhang et al. 2011, p.142).

On the smallest level of land-use planning, the sustainable site planning is defined as a land-use planning activity by which the most appropriate land-uses are distributed in the land parcels. This is in order that the economic, social, and environmental concerns of the planning process are fulfilled through this distribution. (Wang et al. 2014, p.44).

There is a necessity to develop more detailed policy and perform institutional reforms in the land-use planning process of cities under the framework of sustainable principles (Zhang et al. 2011, p.147). However, the main challenge facing each of the sustainable development and sustainable urban land-use planning concepts is how to activate them into practice. Because this requires a comprehensive decision framework to manage each of the daily, personal, business, and policy decisions. This shall ensure that the land-uses are managed in the way that can affect positively the environmental, social, and economic factors. The problem is that these concepts are difficult to be executed and followed up, as these concepts are complicated and fuzzy (as aforementioned). And sometimes the principles of these concepts cannot be measured or monitored, and the stakeholders always need for the identification of what they should do to attain sustainability within land-use planning process. (Musakwa and Niekerk 2013, p.144).

(3.3.2) The Importance of the Land-use Planning Process for the Three Axes of the Sustainable Development:

This point clarifies how important is the efficient land-use planning process for the three sustainability axes:

(3.3.2.1) The Land-use Planning Process Role in Attaining the Economic Sustainability:

The economic sustainability can be understood as the preservation of various kinds of capital or resources for the benefits of the future generations. This attitude of the dependence on renewable resources rather than the non-renewable ones is considered the best way for not overtaking the future generation rights. However, some non-renewable resources cannot be replaced by the renewable ones including “the land”. Moldan et al. use the term “the sustained integrity of the resources[1]” for the principle of attaining sustainability through the dependence on the current resources in a way that preserve the future generations’ portion from these resources. (Moldan et al. 2012, p.5).

Therefore, we can conclude that despite land is non-renewable (exhaustible) resource, the efficient land-use process can manage lands in a sustainable way. This is enabled by identifying uses for them, which are economically sustainable for the future generations.

(3.3.2.2) The Land-use Planning Process Role in Attaining the Social Sustainability:

Spatial equity is theoretically derived from social equity. It means that the residents should be equally treated regardless of their location. It also means easy access to facilities regardless of the socioeconomic characteristics, satisfaction, or disability of the residents. Therefore, equity can be defined based on the equality in the spatial distribution for resources. (Dadashpoor et al. 2016, p.160).

There is no clear definition till now for the social sustainability, despite that (according to Moldan et al.) the social “pillar” or axis of sustainable development is the most significant pillar in the sustainability for the extending of the human civilizations’ survival (Moldan et al. 2012, p.5). However, the social sustainability always has the least priority in the development processes (Wang et al. 2014, p.45).

[1] Either renewable or non-renewable.

The efficient land-use planning can support the social sustainability by providing the people's needs from services, housing, infrastructure, and others, in a way that attain equity among them in this provision process.

(3.3.2.3) The Land-use Planning Process Role in Attaining the Environmental Sustainability:

There are many definitions for the term “environmental sustainability”. These definitions differ according to their perspective. For example, the definition from the bio-geophysical perspective states that “*the environmental sustainability is the maintaining and improving the integrity of the life supporting systems of the Earth*”. Moldan et al. explain this definition that the environmental sustainability means supporting the biosphere to sustain and increase the future potentials. This is through helping the current and future generations to achieve economic and social development within a cultural diversity framework in the way that attains the safety of the biosphere by proper usage of air, water, and land resources (Moldan et al. 2012, p.6).

This confirms the importance of the efficient usage of renewable and non-renewable resources in supporting the sustainability. Therefore, the successful land-use planning can attain efficient economically and environmental usage of lands, (as an important non-renewable resource). And at the same time, it can attain the social equity in the distribution of the land uses types among different social groups.

(3.3.3) The Contradictions among the Sustainable Development Axes and How the Land-use Planning Process Deal with Them:

Despite that the three axes are interrelated and complementary (as previously mentioned) there are contradictions among them:

(3.3.3.1) The Contradictions among the Sustainable Development Axes:

There is a great debate on the contradictions among the axes of sustainable development, and how to balance among them. In order to realize the nature of these contradictions, we should first explain the core of the sustainable development. This is the provision of the opportunity for everybody in everywhere at any time to have a good quality of life in his or her community or society. This is interpreted by Lee and Huang that the sustainable development aims (beside a better quality of life) the social cohesion, full participation, and a healthy environment. (Lee and Huang 2007, p.506).

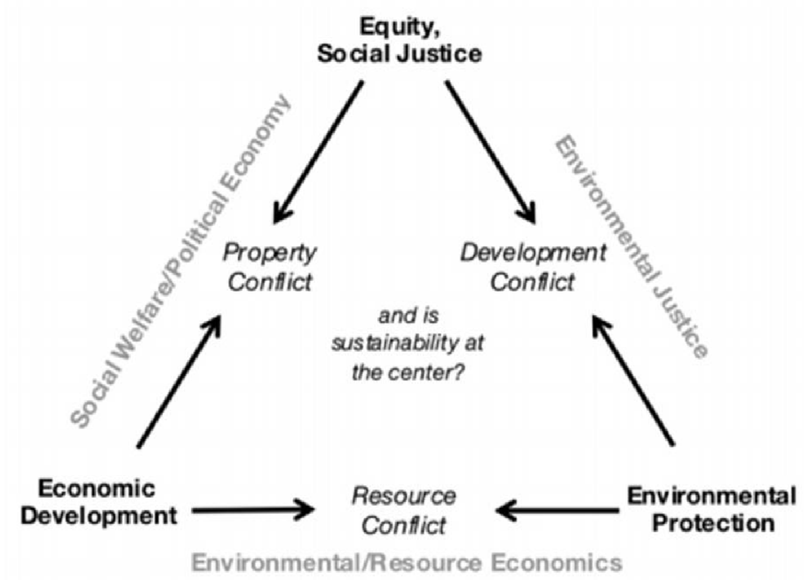
In order to attain the social cohesion and the full participation, there should be social equity among the society classes. And to attain a healthy environment, there should be environmental preservation. For attaining the better quality of life, there should be the two previously mentioned goals in addition to the economic growth. These goals are the three known axes or pillars of the sustainable development. These axes have conflicts or contradictions among each other. These conflicts are: (Godschalk 2004, p.6)

- The “property conflict”: This conflict is between economic growth and social equity. Sharing of opportunities may cause a conflict between the improvement of the private resources and the attitude towards attaining the public good or the equity among different social groups.

- The “resource conflict”: This conflict is between economic growth and environmental preservation. It results from the consumption of natural resources to attain economic growth and the importance of the preservation of their ability to reproduce.

- The “development conflict”: This conflict is between social equity and environmental preservation. It results from the need to help the poor people through economic growth and the importance of protecting the environment through growth management. The next figure (presented by Campbell) shows these conflicts within what he calls “the planner’s triangle”:

Fig. (3.1) The three conflicts within the planner’s triangle



Source: Campbell 2013, p.83

(3.3.3.2) How the Land-use Planning Process Can Deal with the Contradictions among the Sustainable Development Axes:

The geographical scale of the land-use planning application affects the way, by which the land-use planning deals with the conflicts among sustainability axes because as this scale changes, the planning tools change. For instance, the public participation processes on the regional scale are more common than those on the city and neighborhood scales in some countries[2]. The land-use and infrastructure planning should depend on negotiations to deal with the multijurisdictional decision-making processes. As the negotiations within these public participation processes can solve each of the property and development conflicts. Because the negotiations help to attain the balance from the social perspective from one side, and each of the economic and environmental perspectives from the other side. (Godschalk 2004, p.8).

However, in most times the social perspective always has the least priority in planning considerations (Wang et al. 2014, p.45). The focus in the land-use planning is on resolving the resource conflict between economic and environmental perspectives. (Godschalk 2004, p.8).

In general, the sustainable development focus (in solving problems using the land-use planning as a tool) differs according to the type of problem. For example, regarding the urban sprawl, the sustainable development mainly concentrates on the environment because it is threatened by sprawl, which resulted from economic growth. And so, the planning orientation

[2] The case in Egypt is the contrast, as public participation processes on the city scale are more common than those on the region scale.

focuses on the governmental intervention that protects ecological systems more than any other issue. (Godschalk 2004, p.8).

(3.3.4) Mixed Land-use Development Policy as a Way to Sustainability Attainment and the Optimal Approach for Applying it:

The type of development policy directly affects the sustainability attainment. This point discusses the mixed land-use development policy as a way to the sustainability attainment in the land-use planning process and development approaches or models to apply it.

(3.3.4.1) Mixed Land-use Development Policy as a Way to Sustainability Attainment:

Kong et al. confirm the importance of using the mixed land-use development policy. They argue that it is one of the essential elements in the modern urban theories and planning practice because it can support the sustainability attainment of cities. (Kong et al. 2015, p.95). Kong et al. are not the first researchers, who present this idea. According to Han et al., the first researcher, who presented this idea was Jane Jacobs (1961). She believed that the functional diversity has positive effects within the land-use structure of the cities. As mixing of various land-uses types does not necessarily result in conflict and negative effects. However, it may result as synergy and be a catalyst for attaining sustainable land-use planning in case that this mixing is scientifically studied to perform an integrated land-uses structure without land-uses conflicts[3]. (Han et al. 2013, p.2).

The main advantages of the mixed land-use policy are supporting the balance between the job locations and houses locations, which is called "job-housing balance". The increase of sense of community for the residents is another advantage for this policy in addition to the vitality of cities, which is resulted from the activities variety within spaces. (Kong et al. 2015, p.102).

There is an indicator called "Land Use Frequency-LUF", which monitors the number of land-uses located in the same neighborhood or city. The increase in the value of this indicator raises the value of an index called "Land Use Management-LUM" index (especially in cities suffering from the rapid growth problem) as long as the land-uses mixing is well studied. Musakwa and Niekerk present the added values of the mixed land-uses on the three sustainability axes in the following table. (Musakwa and Niekerk 2013, p.148).

Table (3.1) The added values of the mixed land-uses on the three sustainability axes:

Sustainability axes	Added values	Reference
Economical	- Increasing the property values: For example, the mixture between the residential and commercial uses is connected with the high land prices. - The mixing between some definite types of land uses (e.g. residential, administrative services, and commercial) has the advantage that these land-uses are complement to each other - Saving in fuel and energy	Musakwa and Niekerk 2013, p.148
	- Decreasing trips lengths: due to the increase of accessibility to various uses, and so transport costs. - The employment mix increases job opportunity.	Musakwa and Niekerk 2013, (Fig. 3. in p.146)

[3] This is also mentioned in the Netherlands' example, which is illustrated in chapter 5.

Sustainability axes	Added values	Reference
Social	- Decreasing the social distances between the classes: because this mixing supports the spatial integration and the interaction within the community or the society, which can encourage many physical activities like pavement cafes[4].	Musakwa and Niekerk 2013, p.148
Environmental	- Reducing the environmental costs: because the mixed land-use structure supports the non-motorised transport, and so reducing the polluting emissions from the motorised transport, which leads to the efficient usage of space and resources.	Musakwa and Niekerk 2013, p.148

Source: own design, according to the stated references.

(3.3.4.2) The Optimal Approach for Applying the Mixed Land-use Development Policy:

Kong et al. found that the success of the mixed land-use development policy in attaining sustainability is mainly based on the development approach adopted within the city. Many experiences for various cities (in different locations in the world) adopt the compact mixed land-uses policy. These cities have an urban form of compact mixed land-use structure. However, their experiences show that they have different performances even with this resembling urban form. As evidence, most of Chinese cities adopt the mixed-use development policy through just mixing different functions in one space without considering the appropriate mechanism or development approach to apply this policy. This has resulted into different levels of performances among these cities. This means that the successful urban performance is not all about applying successful urban policy, (like the compact mixed land-uses policy), but the more important is the adoption of the most appropriate development approach for applying this policy (Kong et al. 2015, p.102).

There are three known urban development approaches or models, which are used by various countries in the urban land-use planning processes. These models are the ‘‘top-down centrally-controlled development model”, ‘‘bottom-up individual-dominant development model”, and ‘‘bottom-up collective-dominant development model”. (Kong et al. 2015, p.94)

The top-down centrally-controlled development model means that the governmental authority represents the main actor or the dominating actor in the decision-making process. The citizens and other parties are just inactively involved in the development process (Kong et al. 2015, p.96).

The bottom-up individual-dominant development model is a kind of discursive process, (i.e. reaching decision using the arguments and analyzing reasons rather than intuition). The actors in this model should be characterized by the self-awareness. These actors can be the citizens, private sectors, and organizations. They should present their own principles, and perform their own development plan without being restricted by solid goals (Kong et al. 2015, p.96).

Kong et al. found that the third model ‘‘the bottom-up collective-dominant development model’’ is the most efficient model for attaining the proposed benefits from the mixed-use policy for sustainability according to the practical experience in China. (Kong et al. 2015, p.94).

[4] As stated by the Macmillan Dictionary, the pavement cafe is a restaurant, which its tables and seats are placed outdoors on a pavement or streets, where there are no vehicles allowed.(Macmillan Dictionary website, the pavement cafe, 2017)

The collective-dominant development model is based on the idea of the collective entities. These entities are actors that coordinate to perform decisions. This is through connecting the central master plan of the city with the individual interests. So, this approach is considered the result of collective and interactive communications among various interests (Kong et al. 2015, p.96)

This approach can motivate all stakeholders to positively interact in the community development, which supports attaining the balance among various interests and concerns of the social groups. As all stakeholders should be involved directly or indirectly in the development process. (Kong et al. 2015, p.101).

However, the bottom-up collective-dominant development is dependent on the success in collecting the entities of the community. This means that in case of running out of the resources of these entities, the development process will stop, on the contrary from the top-down planning that is dependent on definite governmental entities or authorities. The collective-dominant development approach also requires efficiency in the resources collection and efficient coordination among all stakeholders with various concerns to cooperate in the development process. (Kong et al. 2015, p.102).

Therefore, Kong et al. conclude that there is no definite development model or approach that can be considered the most optimal solution to attain an efficient land-use planning process for all countries. However, the combination between the top-down and the two bottom-up development models may be the optimal solution, which is characterized by having the advantages of these three models or approaches. (Kong et al. 2015, p.102)

The suggested administrative framework for applying the assessment process performed by the proposed system in this research joins between the governmental and non-governmental institutions, as well as the representatives for the citizens. Many actors or entities are involved in the sustainability assessment process as illustrated in details in chapter 7. This is to compensate the gaps resulted from the way of managing the planning process in Egypt through the assessment process of the produced land-use plans.

(3.3.5) Sustainability in Urban Land-use Planning of the Existing Areas and Challenges Facing it:

As mentioned in chapter 1, the focus in this dissertation is on the existing Egyptian cities. So, it is important to illustrate the concept of the sustainability attainment in the re-planning or the renewal of the existing areas and the challenges facing the sustainable land-use planning (or re-planning) of the existing areas.

(3.3.5.1) Factors Affecting Sustainability in Urban Land-use Planning of the Existing Areas:

The land-use planning or the land development in the existing areas is considered a type of re-using for the resources, which mainly reflects the attitude towards the sustainable development. Due to the urgent need to attain a better living environment, the main goal for the re-planning of the existing areas is beyond just upgrading slums areas, but it is more the improvement of the old existing areas (Wang et al. 2014, p.45).

Wang et al. illustrate the factors and principles for each sustainability aspect, which should be considered in the urban land use planning of existing areas:

1.The Economic Aspects:

The land-use allocation in existing areas should consider the economic state of these areas. This is through considering each of the volume of the demand on housing or other uses and the volume of the supply that can be available after the re-planning or the development of the existing area. The economic aspects of the buildings and the duration for their redevelopment should be also studied with the prices of urban vacant and abandoned lands and the costs of the urban upgrading process. (Wang et al. 2014, p.45). The local gross domestic product- GDP and the values ranges for properties and rents should be considered as well. (Wang et al. 2014, p.47.)

There are six economic principles should be attained in the urban land-use planning for the existing urban areas, (especially in the high-density cities). These are the quality of the provided welfare, the conservation and preservation of the valuable sites and buildings, the utilization of land in a strategic way, the community sharing in the planning, the integration of the site design, as well as the efficient arrangement of the transport (Wang et al. 2014, p.45).

2. The Social Aspects:

Upgrading of the living environment of the existing areas (especially the densely populated urban areas) directly impacts the living conditions of their residents. Therefore, the residents should be considered as main part within urban upgrading projects of the existing areas and the outputs of these projects. So, the land-use planning process of the existing areas should study some factors regarding the residents. These are the population trends, family structures, the changes in the society, the social needs of the margin groups (e.g. women, minority races and the elderly), the daily living supplies, and the recreational areas existence. (Wang et al. 2014, p.45). The types of local employment and the area’s social identity should also be considered. (Wang et al. 2014, p.47).

There are six social principles should be also attained in the urban land-use planning for the existing urban areas. These are the satisfaction of residents with the welfare costs, the preservation of the resources and surroundings, the generation of harmonious living environment, the availability of the daily life facilities, the development style, as well as open space for improving social integration among the society classes (Wang et al. 2014, p.46).

3. The Environmental Aspects:

The land-use allocation in existing areas should consider the environmental state of these areas by considering the environmental regulations to guarantee a more liveable and ecological urban space (Wang et al. 2014, p.46). The vegetation rate, local air quality, local water quality, noise pollution, and what is called “light pollution[5]” should be also considered. (Wang et al. 2014, p.47).

4. The Location or Urban Aspects:

The land-use allocation in existing areas should consider each of the aesthetically appearance of the areas and the efficiency of the infrastructure networks. (Wang et al. 2014, p. 46). These are in addition to the details of the land-uses structure, which include the former,

[5] Light pollution is an undesired result of outdoor lighting. (The lightening research centre website, What is light pollution, 2017)

current, and neighboring land-uses, as well as the transportation issue including the road network, traffic volume and internal circulation. The service facilities issue should be also considered, which includes the accessibility to essential services and utilities of housing buildings like water and electricity. (Wang et al. 2014, p.47)

The physical planning principles of the urban land-use planning projects for the existing urban areas include two issues. These are how the urban area appears regarding its aesthetically pleasing and how efficient is its infrastructure. (Wang et al. 2014, p.46).

There are other factors (beside the sustainability factors), which should be considered in re-planning any existing urban site or area. These are (Wang et al. 2014, p.47):

- Political and legal factors: including properties legality and planning regulations.
- Cultural and historical factors: including the satisfaction feelings of the residents with each of the aesthetics features, visibility, visual quality, odours, and the historical features (in case of presence of heritage landmarks), as well as the local built environment, which means architectural and landscape uniqueness, as well as the buildings appearance.
- Physical or natural factors: including the topography (e.g. elevation and slope), the climate aspects (e.g. solar access and wind direction), and the geology nature (e.g. terrain).

(3.3.5.2) Challenges Facing Sustainability in Urban Land-use Planning of the Existing Areas:

A study was performed in China for analyzing the sustainability attainment in three upgrading or re-planning projects for three existing urban areas in 2014. According to the results of this study, Wang et al. see that the re-zoning or the re-development of the lands in these areas not only has effects on residents of these lands, but also has effects on the surrounding environment. So, these effects should be taken into consideration, which makes the decision-making process in the land-use plans of the existing urban areas more difficult and complicated than the land-use planning of the new urban areas (Wang et al. 2014, p.44).

The results of this analyzing study for these three re-zoning (re-development/re-planning) projects show that many important factors (affecting the sustainability) were not taken into account in the planning process. These are environmental factors (like air and water quality), social or cultural factors (like the community identity and accessibility of service facilities), and spatial factors (like slope gradient and relative elevation). (Wang et al. 2014, p.54).

This is because of the huge gap between theory and practice. The planning practitioners saw that these factors are not significant to be considered in the planning process. Also the urban renewal authority[6] does not have enough potentials to study all factors affecting the sustainability in a comprehensive way. This is because of the shortage time and financial or human resources, who are qualified to perform that. (Wang et al. 2014, p.54).

Therefore, the main challenges facing the sustainable land use planning for the existing urban areas are:

- Gaps between theory and practice.

[6] The governmental authority concerns with these re-planning projects.

- Lack of information and data-bases.
- Shortage in time, financial resources, and human resources.

These challenges are not only in China, but in many developing countries including Egypt as illustrated in details in chapter 7.

(3.4) Problems Facing the Urban Sustainability Attainment in the Developing Countries:

According to Zhang et al., there is a must that the land-use changes activities within the cities of the developing countries seriously consider the needs of the future generation and each of the environmental, social, and economic problems (Zhang et al. 2011, p.141). Despite "the sustainable cities" has become a priority in the development agendas of many countries, the developing countries now encounter high rates of urbanization. This causes the urban sprawl, which decreases the land resources of the future generations, the public services overloading, the random development, the brown-fields, pollution, and other consequences. (Musakwa and Niekerk 2013, p.143).

Musakwa and Niekerk see that the main cause of the rapid urbanization is that many developing countries have no efficient land-use management processes despite many serious attempts. These have been done by their governments to attain a balance among the socio-economic development and environmental parameters, but they did not succeed (Musakwa and Niekerk 2013, p.143). The inefficient land-use management is mainly represented in inefficient land-use planning accompanied by the insecure land tenure. (Zhang et al. 2011, p. 142).

Beside high rates of urbanization, there is another challenging problem facing the sustainability in the developing countries. This problem is the urban governance deficiency despite the decentralization attitude adopted in the last five decades by many developing countries to attain good governance. The problem is in the nature of the institutional structures of the local authorities in these countries that are not ready to manage the urban structures. As these authorities were established during the colonial times, when there were predominantly rural communities. (Musakwa and Niekerk 2013, p.143).

Also many local planning authorities still use the master-planning approach, which is ineffective in dealing with the economic, social, and environmental sustainability dimensions of urban areas. This is in addition to the shortage in the financial resources to perform an efficient land-use process, the weak availability of spatial data, and corruption. There is no sufficient qualified people, who can perform the required tasks for successful land-use planning like forecasting, modeling, and monitoring land-use change, and other causes. (Musakwa and Niekerk 2013, p.143).

(3.5) The Assessment Tools of Sustainability:

This section covers the assessment tools of sustainability. This is through presenting the sustainability assessment concept, approaches to it, the required conditions in the sustainability assessment tools, the difference between the sustainability assessment tools and data provision tools and the types of sustainability assessment tools.

(3.5.1) What is the Sustainability Assessment :

The way of defining the sustainability impacts the way of the sustainability assessment process, which identifies whether the applied assessment tools are either strong or weak . This means that the attitude of conceptualizing the sustainability as a way, in which the artificial resources are considered the substitution for the natural ones leads to define the sustainability assessment in a weak or unbeneficial way. This is the reservation of the natural resources by replacing them with artificial alternatives. And so this leads to depending on weak assessment tools like the index of sustainable economic welfare - ISEW and indicators of adjusted net savings. The other stronger attitude of conceptualizing the sustainability as a way, in which the natural resources should be preserved leads to define the sustainability assessment in a beneficial way. And so, this leads to depend on strong assessment tools like the ecological footprint indicators. (Ness et al. 2007, p.506).

The sustainability assessment is the process that can help the planning activities and the decision-making process to move in the direction of attaining sustainability. As the sustainability assessment process can identify the opportunities and problems in any plan or policy and compare between various alternatives regarding the identified opportunities and problems through what is called “sustainability criteria”. (Raphael 2011, p.16) .

Another definition for the sustainability assessment is that it is the process through which the impacts of any action affecting the sustainability are assessed. This action can be the result of a suggested or current policy, plan, program, project, modification in the legislations, activities, and others. (Pope et al. 2004, p. 595).

One of the popular definitions for the sustainability assessment process is according to Devuyst stating that it is the tool, which supports the decision-makers and policy-makers to choose the most appropriate actions to attain a sustainable society. (Ness et al. 2007, p.499).

The sustainability assessment process is applicable on all the decision-making levels (the strategic, policy, or plan level of planning) (Raphael 2011, p.16). There are also various categories for the sustainability assessment processes according to the topics and the goals and the hypotheses that these processes based on. (Raphael 2011, p.17).

The origin for the sustainability assessment processes was the Agenda 21 that focuses on the sustainability, its principles, and its importance in the development processes. The assessment processes play a significant role to attain integration among policies and make the development process sustainable. (Raphael 2011, p.17).

(3.5.2) Approaches to Sustainability Assessment:

It is very important for any successful sustainability assessment process that its approach should be comprehensive, foreseeing, critical or decisive, and integrated. This is to help in the decision-making process regarding significant policies, plans, programs, and projects, and so, attain sustainability. (Raphael 2011, p.18).

(3.5.2.1) Parameters of Selecting the Sustainability Assessment Approach:

According to Raphael (2011), the approaches to the sustainability assessment are various to the degree that presenting a literature to cover them may cause confusion. (Raphael 2011, p.21). However, the variation in these approaches are based on the following parameters (Raphael 2011, p.21,22):

- The objectives of the sustainability assessment approach.
- The adopted sustainability concept.

- The application field.
- The selected criteria of assessment.
- Methods for the assessment and methods for the aggregation of the results of assessing various sustainability aspects.
- The rules used in managing conflicting objectives and attain intermediate solutions among various interests.
- The structure of the assessment process structure and its procedure.
- The timing of the assessment process with regards to the issue under assessment, in order to identify the approach of the assessment process, (i.e. before, or parallel, or after).

(3.5.2.2) The Popular Sustainability Assessment Approaches:

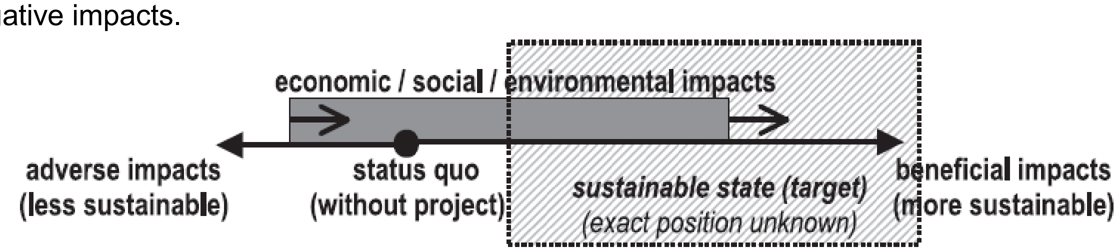
1.Environmental Impact Assessment-EIA (Driven Integrated Assessment or the TBL[7]) Approach:

The purpose from this sustainability assessment approach is to check and confirm that the effects of the issue under assessment (e.g. plan, policy, etc.) are not overall negative, (i.e. it assesses the sustainability as one package). In other words, the used criteria aim to avoid the outputs with less sustainability rather than to support the attainment of more sustainability. (Pope et al. 2004, p. 602) .

The issue under assessment may have positive effects in some sustainability aspects and also negative ones in others, but at the same time, the overall output may be positive. This means that the assessment process will show the final overall output as acceptable (Pope et al. 2004, p.602). As the focus of this approach is on alleviation the negative overall TBL impacts, as far as it is possible. Consequently, the focus of the decision-makers is whether the overall TBL impacts are acceptable, or not. (Pope et al. 2004, p. 606).

The interrelations between the three sustainability axes should be studied. However, the simple combination between the positive and negative effects will not give accurate results like considering these interrelations with all their synergistic impacts on sustainability (Pope et al. 2004, p. 602). The next figure illustrates the EIA-driven integrated assessment approach in performing sustainability assessment.

Fig. (3.2) EIA-driven integrated assessment approach for sustainability assessment for reducing negative impacts.



Source: Pope et al. 2004, p. 602 (reprinted with permission from Elsevier)

Advantages of EIA (driven integrated assessment or the TBL) Approach:

The main advantage of this approach is the ability to distinguish which axe(s) of the three sustainability axes cause(s) has (have) the negative effect on the sustainability as whole. (Pope et al. 2004, p. 608).

[7] As mentioned before the TBL is Triple Bottom Line (economic- social- environmental)

Disadvantages of EIA (driven integrated assessment or the TBL) Approach:

The main disadvantage of this approach is the trade-offs between the economy and the environment, which leads to the prioritizing of the economic concerns rather than each of the environmental and social concerns in the sustainability assessment process. This is the main cause for the domination of the economic agenda and the weak consideration for the environmental concerns for 30 years (Pope et al. 2004, p. 603). Moreover, the main focus in this approach is on the conflicts or the competition among various interests rather than concentrating on the interrelations and integration among them. (Pope et al. 2004, p. 610).

This approach is also criticized for being “a reductionist approach to sustainability” because it causes the division of the comprehensive sustainability concept into three axes. This leads to the disadvantage that the summation of the sustainability axes’ values is less than the value of the sustainability as a whole. This is in case that the interrelations among those three axes are not accurately studied because the sustainability assessment process is limited with just assessing various factors (environmental, social, and economic). And even if these axes or pillars are accurately interconnected, still this approach is considered traditional. And there is the need for an improvement in this traditional way in conceptualizing and applying the sustainability. (Pope et al. 2004, p. 610).

2.The Objectives-led Integrated Assessment Approach (by origin it was named the objectives-led Strategic Environmental Assessment -SEA[8] Approach):

This approach is based on the vision of making each of the environmental, social, and economic objectives integrated. The sustainability assessment process through this approach evaluates to what extent any proposal (or issue under assessment) can attain this vision. On the contrary, the previously mentioned approach just aims to confirm the acceptability of the TBL impacts with regards to definite baseline standards (Pope et al. 2004, p.604). Therefore, the objectives-led integrated assessment approach is considered more appropriate and beneficial for the sustainability concept. (Pope et al. 2004, p.613).

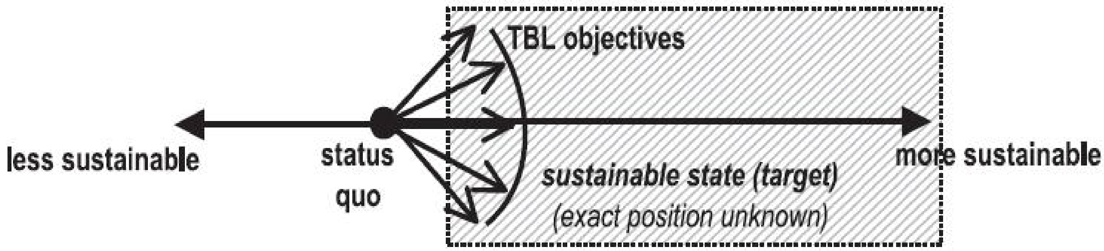
It is considered “a proactive approach”, which means it is a target oriented approach. (Pope et al. 2004, p.604). The objectives-led integrated assessment approach puts the question of whether the proposal under the assessment will make a positive effect to the sustainable development in front of the decision-makers, or not. (Pope et al. 2004, p.606).

Therefore, the main requirement in the objectives-led integrated assessment approach is to identify each of the environmental, social, and economic objectives for performing the assessment process. As this approach aims ‘win–win-win’ outputs among the three sustainability axes and decreasing the competitions or the trade-offs among them, as far as it is possible. This is under the consideration of all the stakeholders needs in this process. Because identifying these objectives from the beginning increases the chance for attaining the ‘win–win-win’ outputs from the proposal under the assessment rather than just depending on assessing the impacts on sustainability resulted from this proposal, (after it is already executed). This is considered a

[8] There are two main differences between SEA and EIA processes. SEA is performed in a stage earlier than the stages, in which the EIA is performed. So, SEA requires less information, and is mainly used in political decisions, whereas EIA requires more definite information, and is mainly used for assessing particular project. (Ness et al. 2007, p.504)

weakness in the EIA driven integrated assessment approach. (Pope et al. 2004, p. 605). The next figure illustrates objectives-led integrated assessment approach to sustainability assessment.

Fig. (3.3) Objectives-led integrated assessment approach to sustainability assessment for maximizing the aimed objectives



Source: Pope et al. 2004, p. 605 (reprinted with permission from Elsevier)

Advantages of Objectives-led Integrated Assessment Approach:

The objectives-led integrated assessment approach has the advantage that the stakeholders can be involved in the assessment process in the earlier steps of the decision-making process concerning any proposal (Pope et al., 2004, p.605). This means that this approach assesses the sustainability in the design stage to identify the optimal alternative for each of the environmental, social, and economic goals. And so, the sustainability criteria are identified based on these goals (Pope et al. 2004, p.608). As each of environmental, social, and economic objectives that connect to various issues (like services, housing, transports, etc.) should affect the planning process from the beginning rather than just be involved in the sustainability assessment process. (Pope et al. 2004, p.606).

The objectives-led integrated assessment approach positively deals with sustainability by aiming at maximizing the 'win–win-win' outputs rather than just minimizing the probable negative effects (Pope et al. 2004, p. 605). In other words, it investigates the possibility of improving the sustainability state rather than the possibility of preventing this state to get worse. (Pope et al. 2004, p.608).

Disadvantage of Objectives-led Integrated Assessment Approach:

Despite all the aforementioned advantages, there is a challenge facing the objectives-led integrated assessment approach. This is the importance of the consistency of objectives with each other, which is a difficult condition because the normal case for strategic objectives is to be contradictive. (Pope et al. 2004, p.606).

Also according to Ness et al., the SEA is performed in stages, which are earlier than stages, in which the EIA is performed. Therefore, the SEA requires less information, and is characterized by higher uncertainty and less concreteness than EIA. This is because SEA is mainly used in political decisions. (Ness et al. 2007, p.504).

3. A New Approach suggested by Pope et al. called "Assessment for Sustainability Approach":

The EIA-driven integrated assessment approach concentrates on trade-offs among various impacts, and the objectives-led integrated assessment approach confirms whether the three sustainability objectives actually reflect sustainability, or not. So, these two approaches are categorized as "direction to target" approaches, which means that there is no definite proposed sustainable state. Therefore, there is a need for an approach supports the measurement of the “distance from target”. This means that the evaluation of the target itself is represented in evaluating the sustainability of the proposals themselves before evaluating to what extent they represent a progress towards sustainability. This is not fulfilled by these two previously illustrated approaches, as they cannot identify definite requirements in any proposal to make it attain the sustainability. (Pope et al. 2004, p. 607,608) .

So, Pope et al. suggest an idea of a new approach called “Assessment for Sustainability Approach”. They believe that it can avoid the aforementioned disadvantages in the two approaches. Their suggested approach aims at investigating whether any proposal is sustainable, or not. This approach is based on the idea that the sustainability assessment can be applied in advance during the decision-making process, so that it assesses the sustainability of the various alternatives using sustainability criteria. The main difference in this approach is in assessing the purpose of the development process (Pope et al. 2004, p.607). This requires having a definite vision on the sustainability meaning. Moreover, it needs a clear interpretation for this meaning in the form of sustainability criteria. This is to have the ability to distinguish the sustainable outputs from the unsustainable outputs for performing an effective sustainability assessment process based on these criteria. (Pope et al. 2004, p.609).

The main advantage in this suggested approach is that it helps the society to identify what “sustainability” means. And so, the society can make comparisons among various initiatives according to this meaning. Worth to be mentioned is that this new approach can be applied on either assessing existing and suggested land-uses planning. (Pope et al. 2004, p. 608).

(3.5.3) The Conditions of the Sustainability Assessment Tools:

The conditions that should be fulfilled in the sustainability assessment process in general and for the sustainability assessment tools in particular include:

- The application of the sustainability assessment tools should be within an organized framework. (Pope et al. 2004, p. 609)
- The sustainability assessment tools can assess the current policies and legislations. (Pope et al. 2004, p. 609).
- These tools should fit all the society’s sectors. (Pope et al. 2004, p. 609).
- Each assessment tool should be appropriate for characteristics of the environment and the society (Ness et al. 2007, p.505). So, the design process of the sustainability assessment tools should be according to the priorities and circumstances of the countries and regions, on which these tools are applied. For example, the weighting process[9] within the sustainability assessment process should be identified according to the nature of the region or the area that is assessed (Sharifi and Murayama 2013, p.79). The weighting procedure should be also characterized by objectivity not subjectivity. (Sharifi and Murayama 2013, p.81).
- The spatial factors in the assessment process should be considered, which means that the sustainability assessment tool can fit on various geographical levels. (Ness et al. 2007, p.505).

[9] The weighting process is for identifying the relative importance of the parameters of any aspect regarding other aspects.

- The ability of these tools to deal with various temporal states, (i.e. they can assess both short term or long term issues or proposals under assessment) (Ness et al. 2007, p.505).
- There should be a balance in the integration process among various sustainability aspects. (Sharifi and Murayama 2013, p.79).
- The institutional or the governance efficiency should be considered in assessing the development processes. As the institutional efficiency especially in fields like planning or financial management directly impacts the sustainable development of any society. (Sharifi and Murayama 2013, p.78,79).
- The range of the minimum and maximum values for any criterion should be identified by assigning scoring levels for the results’ values to be like a benchmarking for each criterion. (Sharifi and Murayama 2013, p.80).
- The participation process is very important for the assessment process in its various steps for avoiding the subjectivity in this process (Sharifi and Murayama 2013, p.81).
- The sharing and presenting the outputs of the sustainability assessment process with stakeholders is important. The shared outputs should be categorized according to the sustainability dimension measured, (e.g. such as economic, social, environmental, and institutional). It is also recommended to grade these outputs according to their values in supporting the sustainability (e.g. good, moderate, and bad) to be easily understood by the stakeholders by using easy representation ways like a graph or chart. (Sharifi and Murayama 2013, p.82).
- The design of the sustainability assessment tools should be applicable by selecting relevant criteria that require available data. And the outputs should be beneficial for the stakeholders. (Sharifi and Murayama 2013, p.84).
- The improvements in the techniques used in the sustainability assessment process should cope with the improvements in the sustainable development concept itself. This means that there should be an interconnection between the techniques used in establishing the sustainability assessment tools and the issues or themes measured by these tools. (Hacking and Guthrie 2008, p.78).

(3.5.4) The Assisting Tools for the Sustainability Assessment Tools:

It is important to differentiate between each of the sustainability assessment tools and the other assisting tools. The assessment tools are tools supporting the assessment process of the sustainability in a direct way, whereas the assisting tools provide the data required for the assessment process. As, the data should be manipulated to be ready to use by the assessment tools. Examples for the assisting tools:

- The earth observation is one of the most popular assisting tools, which is used as a data source in many sustainability studies. It is beneficial for planners and social scientists. As using other tools for collecting data for them (like field surveys) may be difficult and consume a lot of time and costs a lot. The earth observation is defined as the process of extracting information about bodies or objects located on the earth surface using images. The earth observation is considered an important source for spatial data, which is characterized by potentials of providing comprehensive views. So, it can support the following up of the development and changes happened in an updated way (Musakwa and Niekerk 2013, p.144).

- The monetary valuation helps the sustainability assessment tools in the situations that require a monetary assessment. This monetary valuation is appropriate for all temporal types of the sustainability assessment tools. One of the methods used in the monetary valuation is “the travel cost” method, which is the cost required for travelling from one location to another. There are also other methods like “the factor income”, “the avoided cost”, and “the replacement cost”. (Ness et al. 2007, p.505).

(3.5.5) Types of Sustainability Assessment Tools:

(3.5.5.1) Ways for Classifying the Sustainability Assessment Tools:

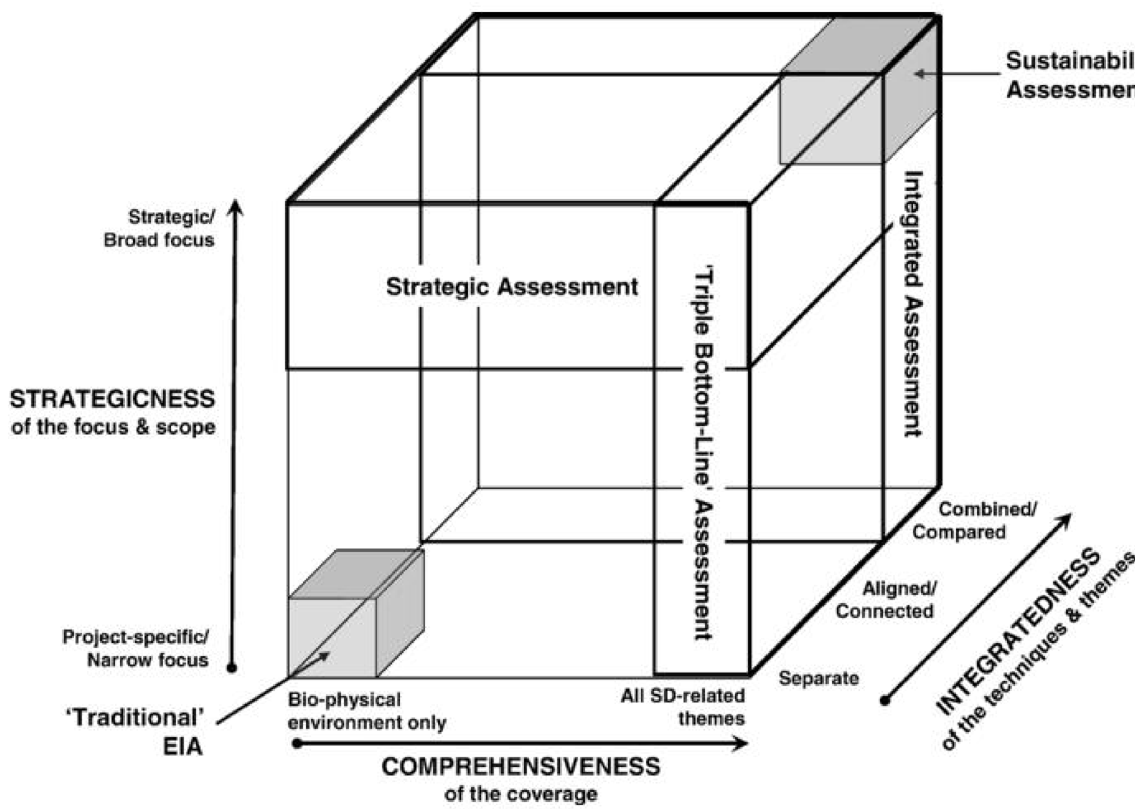
Hacking and Guthrie present three dimensions for classifying the sustainability assessment tools as shown in the next figure (Hacking and Guthrie 2008, p.75):

-The first dimension is the “comprehensiveness” dimension: It identifies how comprehensive the sustainability assessment tool is, which means how many sustainability aspects or themes are assessed using each sustainability assessment tool.

-The second dimension is the “integratedness” dimension: It identifies to what extent an integration happens among various themes or sustainability aspects within the sustainability assessment tool. It also identifies to what extent an integration happens among various techniques used within this sustainability assessment tool.

- The third dimension is the “strategicness” dimension: It identifies how wide the focus or the scope of the sustainability assessment tool is, which can vary from a narrow focus of small specific projects to a broad strategic focus.

Fig. (3.4) The dimensions for classifying the sustainability assessment tools



Source: Hacking and Guthrie 2008, p.75 (reprinted with permission from Elsevier)

Ness et al. introduce other three dimensions for classifying the sustainability assessment tools (Ness et al. 2007, p.499):

- The first is according to the temporal characteristics of the assessment tool, which means the time interval on which the assessment tool focuses, (past[10], current, and future[11] development).

- The second is according to the focus of the assessment tool itself, i.e. whether this focus is on the outcomes of the development processes, or on formulation of changes in the development policies.

- The third is according to what extent the assessment tool is integrated with nature–society systems, which includes environmental, social, and economic aspects.

(3.5.5.2) Classification of the Sustainability Assessment Tools:

Ness et al. classify the sustainability assessment tools into three main categories, which are the indicators and indices, product-related assessment, and integrated assessment tools. These categories are mainly concerned with understanding the sustainability concept, which can vary from the environmental aspect of sustainability to the wide comprehensive concept of sustainability. (Ness et al. 2007, p.499). This means that the sustainability assessment tools may vary from specified assessment tools in definite aspect to comprehensive tools. However, there is still a strong focus on environmental aspects of the sustainability within various sustainability assessment tools (especially in the second type "the product-related assessment tools") with some exceptions. According to Ness et al., the sustainability assessment tools neglect the social and/or economic aspects in most cases. (Ness et al. 2007, p.505).

The next table presents various sustainability assessment tools types according to each of the time interval of the assessment tool's focus, the tasks achieved by each type, and example for each one. These types were collected from five different studies on sustainability assessment tools, two of them are review articles.

[10] The tools for assessing the past development are called "retrospective/ ex-post or descriptive". However, they can be functioned also for assessing future development, but they are not suitable for analyzing the long-term sustainability development. (Ness et al. 2007, p.499,506)

[11] The tools for forecasting or assessing the future development are called "prospective / ex-ante or change-oriented". They mainly aim at alleviating negative expected impacts, and increase positive ones. However, (on the contrary from the retrospective tools) these forecasting tools are characterized by being more subjective, which leads that these tools are sometimes seen as unreliable tools by the decision-makers. (Ness et al. 2007, p.499,506).

Table (3.2) Various sustainability assessment tools types, time interval, the tasks performed by each, and examples for them:[12]

Assessment tool		Time interval (current/retrospective/ prospective)	Tasks	Example	Ref.
1.Indicators and indices	1.1.Non-integrated indicators[13]	Assessing the past development (retrospective assessment) for supporting the decision-making process.	Assessing definite aspect of sustainability	Environmental Pressure Indicators (EPIs)	Ness et al. 2007, p.501
	1.2.Regional flow indicators		Analysis of material and energy flows, and the related harms to the environment among regions or countries.	Input-output energy analysis	
	1.3.Integrated indicators and indices		Assessing the sustainability in a comprehensive way	Sustainable National Income (SNI) index of the Netherlands	Ness et al. 2007, p.502
2.Product-related assessment[14]	2.1.Life cycle assessment	Supporting the decision-making process through assessing the usage of the resources and the impacts on the environment impacts within the period of the production process of a definite product for identifying its probable negative impacts[15] These are considered both retrospective and prospective assessments	Assessing the impacts on the environment of any product or activity within its life cycle.	Life cycle assessment (the waste and energy field).	Ness et al. 2007 p.503
	2.2.Life cycle costing		Assessing the total costs of a product or activity, within its life time.	Life cycle cost assessment and full cost environmental accounting.	
	2.3.Product material flow analysis		Analyzing the flows of the material of the production process.	The product Material Intensity Analysis (MIPS) index	
	2.4.Product energy analysis		Evaluating the energy flow for producing a product or a service, (either direct or indirect[16] energy)	Process Energy Analysis	

[12] There are other types of sustainability assessment tools. However this table states the most popular types for sustainability assessment tools.
[13] These indicators can be aggregated to form indices.
[14] These tools resemble the regional flow indicators, but they concentrate on the products and production process.
[15] These tools mainly concentrate on environmental aspects of the sustainability with exception of the life cycle costing tools, which focus on environmental and economic dimensions.
[16] Indirect energy is the energy that is used in producing the inputs for producing products, e.g. energy for producing metal for the car industry.

Assessment tool		Time interval (current/retrospective/ prospective)	Tasks	Example	Ref.
3.Integrated assessment	3.1. Conceptual modelling and systems dynamics	Dealing with complex themes with various aspects (economic, social, etc.) in an integrated way for supporting the decisions-making process of policies on the local to global scale or projects on the local level, and so supporting the assessing and foreseeing or scenarios formulation for the future development (prospective assessment).	-The Conceptual modelling is the process of performing the qualitative analysis or studying the causative relations among complex themes using the stock and flow charts, or causal loop diagrams to identify which improvements should be happened to attain sustainability. - The systems dynamics are the processes of establishing computational models for dealing with complex themes.	A system dynamics model for the sustainable land-use and urban development in Hong Kong.	Shen et al. 2009, p.503.
	3.2.Multi-criteria analysis		Assessing the issues, in which there are competing or contradictive assessment criteria by defining the goals, and then performing a trade-offs process among them for identifying the most appropriate policy.	Policies for controlling flood in the Netherlands.	Ness et al.,2007, p.504
	3.3.Risk analysis and uncertainty analysis		Evaluating the probability for damages by identifying these probable damages, then qualitatively and/or quantitatively measuring these damages for identifying definite actions to alleviate them.	Societal and environmental risk analyses.	Ness et al. 2007, p.504
	3.4. Vulnerability analysis		Assessing the probability of interaction between the human and environment systems to determine how sensitive and flexible these systems are to any changes and their ability to deal with these changes.	Climate change	Ness et al.,2007, p.504
	3.5.Cost benefit analysis		Assessing the investment proposals for both the public and private sectors by comparing the costs of these proposals with their estimated gains with regards to the sustainability principles.	Energy and transports	Ness et al.,2007, p.504
	3.6.Impact assessment		Foreseeing the probable positive or negative impacts from policies or projects for supporting the policy-making process by improving the adopted policies.	Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and Sustainability Impact Assessment (SIA)	Ness et al.2007, p.504-505

Assessment tool		Time interval (current/retrospective/ prospective)	Tasks	Example	Ref.
4.Decision Consequence Analysis- DCA (this requires the assistance of other tools like indicators and earth observation)		Supporting decisions according to the theory of “decision, probability, and statistics” by considering the unaccepted current state and the proposed future state: First, the determination of the possible ways to transfer from the unaccepted to the proposed state, then the assessment process for the progression rate between them (prospective).	Breaking down the complex issues or objectives like sustainable development and sustainable land-use planning into definite smaller points or themes till obtaining definite measureable points that can be precisely analyzed and assessed within the context of the comprehensive complex issue or objective. (DCA is mainly used in the local planning activities)	A study of “Stellenbosch” town, South Africa that was done on the land use change in this town (including the land cover, the local land use mix index LLUM, and land-use frequency- LUF) for attaining the proposed sustainable land-use structure in this town.	Musakwa and Niekerk 2013, p.144-145
5.The Neighborhood Sustainability Assessment[17] (NSA) tools[18]	5.1. Spin-off tools	Assessing the performance of a neighborhood[19] in the current development processes with regards to definite criteria and themes in order to know where is the neighborhood under assessment from the sustainability and identifying to what extent this neighborhood may attain the objective of the sustainability.	Evaluating the sustainability attainment in the single building sites.	The LEED-ND for assessing sustainability of new construction buildings and existing buildings maintenance, as well as assessing the sustainability of neighbourhood development in five aspects, (smart location and linkage, neighbourhood pattern and design, green infrastructure and buildings, innovation and design process, as well as regional priority credit).	-Sharifi and Murayama 2013, p.73-75 -Wang, et al. 2014, p. 46.
	5.2.Plan embedded tools[20]		Evaluating the sustainability attainment in the plans on the neighborhood-scale.	HQE^{2}R (a project for sustainable renewal of the built environment and the urban neighborhoods).	

Source: own design according to the stated references

[17] There are other terms for the NSA tools, which are district sustainability assessment tool, neighborhood sustainability rating tool, and sustainable community rating tool. (Sharifi and Murayama 2013, p.74)

[18] NSA tools are known as the recent generation or version from the impact assessment tools, which are applied on the project scale. As the previously mentioned, EIA is considered the first generation from the impact assessment tools. (Sharifi and Murayama 2013, p.73)

[19] A neighborhood is defined as a building block of a city. It is considered the base for attaining sustainable community. Some countries begin by concentrating on the neighborhood scale by developing the assessing tools for the sustainability in the neighborhoods' plans as the units for achieving sustainability. (Sharifi and Murayama 2013, p.74).

[20] The plan-embedded tools are the more successful type of the NSA tools. These tools support the integration of the assessment process with the planning process, which can also help to build links between assessment systems in various geographic scales. The interactions between the neighborhood and its surroundings should be taken into account in the assessment process by these tools. Because the inter-relations either among neighborhoods or between neighborhoods with the larger geographical scales show to what extent the sustainability vision is considered in the planning process. (Sharifi and Murayama 2013, p.86)

(3.6) The Importance of Assessment of Sustainability Attainment in Urban Land-use Planning and the Challenges Facing this Process:

In general, there is no successful development process without assessment and following up. Therefore, on the way forward to sustainability, the sustainability goals should be evaluated, which makes the sustainability assessment an important branch in the research field of the sustainability. (Ness et al. 2007, p.498-499). In this section, the importance of sustainability assessment and challenges facing it are illustrated:

(3.6.1) The Importance of Assessing the Sustainability Attainment in Urban Land-use Planning:

The aim of sustainability assessment process is to perform evaluations from the global to local levels for the integrated nature–society systems on the short or long terms. This is to support the decision-makers by identifying the most appropriate actions to attain a sustainable society. (Ness et al. 2007, p.499). Raphael confirms that the sustainability assessment can help to avoid many deficiencies of traditional decision-making processes. This is through supporting the decision-makers to take the actions that attain a more sustainable society, and to examine whether the sustainability vision is really taken as a priority, or not. (Raphael 2011, p.18).

Moreover, the sustainability assessment provides the decision-makers with sustainability criteria to base their decisions on. This is not only to determine the right actions, but also to identify the objectives that support the sustainability in any development process. As defining these criteria for the decision-makers avoids any probability that the decisions is based on guesswork, and confirms that the criteria formulated by specialists are according to scientific studies (Raphael 2011, p.18).

Raphael listed some of the “sustainability assessment qualities”, which are aspects of the sustainability assessment importance (Raphael 2011, p.66-67):

- The sustainability assessment affects the outcomes of the land-use planning process. As the assessment for the land-use plans helps in deciding the feasibility of the plans to avoid spending efforts, time, and resources in executing inefficient plans.
- The participation of the stakeholders in the assessment process can help to perform an assessment process that considers all the points of views, (technical, financial, etc.). This leads to a comprehensive coverage of all the perspectives in the land-use plans.
- The assessment process can include all the sustainability aspects (the environmental, social, cultural, and economic) in an integrative way.
- The efficient assessment processes can analyse all the issues, problems, opportunities, and alternatives in the plans or policies.
- The assessment process is based on a comprehensive knowledge base from various information sources, and can guarantee the accurate analysis of all the impacts of the assessed plan or policy.
- The assessment process can guarantee the execution of the assessed plans provided that this process should involve the institutions that can effectively share in the plan execution, and are directly affected by the assessed plan.

Applying an environmental impact assessment on the land-use plans can greatly minimize the negative impacts that may be resulted from changes in the land-uses. This is conditioned that the assessment should be based on a studied methodology (Nuissl et al. 2009, p.415). This is because the environmental impact assessment of land-use changes identifies the consequences of each alternative for the land-use planning decisions. And so, it can direct the urban development to the right way. Therefore, Nuissl et al. see the environmental impact assessment is very significant for orienting or controlling the urban growth especially in case this growth is declining. As the comprehensive framework of the environmental impact assessment covers the socio-economic aspects of the urban growth. (Nuissl et al. 2009, p.422).

The impact assessment is not only important for the growth management, but also for managing lands in the inner cities. This is through a conceptual assessment framework that involves experts from various disciplines. This framework includes studying the impacts of applying new strategies, the effects of land-use changes, the probabilities of the land-use patterns that may happen in the future, and their impacts on the ecosystem services. And so, it can identify the most beneficial land-use pattern. (Nuissl et al. 2009, p.422).

Also the sustainability assessment frameworks can help in the integration of the sustainability in the form of definite decisions executed by the planning sector on the small level of the neighborhood in particular (Raphael 2011, p.22). This is already experienced in Western Australia, as the sustainability assessment process is applied to perform integration of the sustainability in the land-use planning and development practices. (Raphael 2011, p.67).

Musakwa and Niekerk confirm the importance of the sustainability assessment for the urban land-use planning. As previously mentioned, the sustainable land-use plan is the plan that fulfills each of the current and the future residents‘ needs. This means that the current changes in the land-uses should not harm the future residents. In order to solve the difficult equation of performing the sustainable land-use planning, a comprehensive decision framework is required to manage the daily, personal, and business or policy decisions. The problem is how to monitor the sustainability in these decisions, which are in many aspects immeasurable, and how to guide the stakeholders to attain sustainability in land-use planning. Musakwa and Niekerk consider the Decision Consequence Analysis- DCA[21] the best solution for simplifying and activating the sustainable land-use management. (Musakwa and Niekerk 2013,p.144).

Zhang et al. show how the policymakers need to measure the sustainability in the urban land-use planning. So that, they can determine the weak points in the planning that may cause problems, and identify the effective strategies to solve these problems for performing efficient urban land-use management. This is to attain the sustainable development for cities on the long run. (Zhang et al. 2011,p.142)

<u>(3.6.2) The Challenges Facing the Sustainability Assessment in Urban Land-use Planning:</u>

The main challenges face the efficiency of the sustainability assessment include:

<u>First: the data unavailability on the required geographical level / time intervals / form</u>:

Not all the required data for the sustainability assessment process is always available on all the geographical levels. For example, on the local level, it is very difficult to measure social issues like the local employment demand and the environmental parameters like the local air quality. (Wang et al. 2014, p.46).

[21] DCA is one of the sustainability assessment tools types, as previously mentioned in the assessment tools of sustainability.

Also sometimes, the required data is not available in several time intervals. Some assessment tools (like the systems dynamics for assessing the sustainability of the land-use planning through the simulation of the future) require data on previous time intervals. This may not be available. (Shen et al. 2009, p.20,21).

Some required data is not available in the required form of some analyses (Allen 2008, p.165). For example, the individual income or consumption may be practically only available as family income or consumption rather than individual income or consumption.

Second: the inapplicability in performing some assessments:

The most known example for the inapplicability in performing some assessments is the difficulty to practically assessing the effects of land-use changes on the ecosystem like lands fragmentation and air pollution in the field of spatial planning. These studies are considered highly sophisticated, and they require complicated methodologies. These cannot be applied like other individual aspects within the assessment process of the land-use changes in spatial planning. (Nuissl et al. 2009, p.415).

Third: the difficulty in attaining a balance or integration:

It is difficult to attain a balance or integration for various sustainability axes (social, environmental, and economic) in the assessment process of sustainability (Sharifi and Murayama 2013, p.79). Despite methods, such as weighting methods are used for performing the balance or integration among various criteria. However, the obtained weights from these methods may be not totally accurate or misleading due to the subjectivity in the weighting system in sometimes. (Sharifi and Murayama 2013, p.81).

Fourth: the lack of measureable quantitative indicators:

There is a lack of measureable quantitative indicators in the sustainability assessment of urban land use planning (Zhang et al. 2011, p.143). As there is a need to formulate the mathematical equations for these indicators. These equations should be easily applied within the assessment tools in a way that definite numerical measurements can be obtained rather than the qualitative indicators that present only qualitative results.

Fifth: the lack in the financial, technical, and human resources required for the assessment process:

The data collection task within the assessment process requires a lot of financial resources, which represent a great challenge, especially for the developing countries.

As aforementioned, the development of the assessing techniques should cope with the development in the sustainability concept or theories, which is considered a technical challenge (Hacking and Guthrie 2008, p.78). Also sometimes there is a lack in the software or hardware, which are required for the sustainability assessment in the land-use planning process. (Allen 2008, p. 165).

With regards to the human resources, many planning organizations suffer from the lack in the qualified staff, who can deal with the recent updates in the sustainability assessment applications. (Allen 2008, p.164).

Sixth: the institutional challenges:

There are institutional challenges facing the efficiency of the sustainability assessment process for the land-use planning. For example, the institutional system of some organization does not allow the continuous updating in applying highly technical assessment tools. (Allen 2008, p.164).

Also the complications and bureaucracy in some organizations that leads to lack in performing cooperation among various institutions influencing the urban development process like the cooperation between planning and transportation organizations (Allen 2008, p. 165). This is illustrated in details in the Egyptian case in chapter 7.

Finally, there is a lack of the political support for applying the sustainability assessment process within the land-use planning, which is resulted from the unawareness of the sustainability concept. (Allen 2008, p.165).

(3.7) The Importance of Participation in the Sustainability Assessment :

According to Raphael, both the theoretical and practical studies show how effective the participation process is in all the main stages of the sustainability assessment in the land-use planning field. As recently the most dominant attitude in the sustainability assessment experiences is the involvement of the broader public in the assessment process. Because the participation process is seen as a kind of equity and democracy. The participation is also considered as a priority element of the assessment tools in the political and public commitments in the third millennium agreement or Agenda 21. (Raphael 2011, p. 60)

The following points are listed by Raphael to emphasize on the importance of the participation in the sustainability assessment process (Raphael 2011, p. 61):

- The government institutions have become aware of the communities expectations from any development process.
- The trust of the public in their governments can be reinforced.
- The satisfaction of the public with the development processes’ results will increase, as they share in the decision-making.
- The participation may cause a positive change in public attitudes and values.
- The enriching and variety in the decision making processes are resulted from the involvement of various concerning groups with several backgrounds and professions, especially the well educated people .
- Two-direction communications between the broader public or the community and the decision-makers are established.

However, there is a problem that the assessment reports may be too specific or technical to be understood by the broader public in the participation process. This should be taken into consideration in the formulation of these reports, so that the used language and expressions in these reports should be simple enough for the broader public. (Raphael 2011, p. 62-63).

(3.8) Reflections:

The focus of this chapter is on the sustainability in the urban land-use planning and the assessment process for it. The significance of using efficient assessment tools for evaluating the sustainability attainment in the land-use plans is clarified. So, this leads us to chapter 4 (Planning Support Systems) that illustrates the concept and role of these systems in supporting the urban land-use planning. Then, chapter 5 browses ten previous experiences in assessing sustainability in the land-use planning to be the guides for establishing the proposed system in this research.

Chapter 4
Planning Support Systems
(4.1) Introduction on Planning Support Science:

There are many challenges that face the planners nowadays for applying the recent planning concepts like the resilience cities, smart cities, and sustainable cities. These challenges are more complex than the available planning research or information. The matter needs the technology aid because technology is the backbone in managing cities. (Pelzer 2015, p.14). This led to the emergence of a new research field called “Planning Support Science”. The amount of data is increasing in a very quick manner through various channels including the social media. Therefore, the main task of the planning support science is to offer frameworks that can accommodate new data with its new types and new methods of connecting data from various sources to support planning, analysis, and decision-making processes.(Geertman et al. 2017, p.5,6).

Planning Support Systems (PSSs) have become the corner stone in planning activities in developed countries. (Kim et al. 2012, p. 1112). And it is also expected that in a short time PSSs will find their way to developing countries as there are already some successful experiences in these countries, (e.g. Uganda, Sri Lanka, and Iran).

Kim et al. suggest that PSSs can decrease the probability of inconvenient or wrong planning decisions, which may occur due to planners' weak experiences and knowledge. They mention that the vision from applying PSS in spatial planning practice in South Korea is to perform two main tasks for supporting the sustainable urban planning. The first task is to increase the efficiency of the decision making process in the planning practice by improving the provision of spatial information. The second task is to activate of public participation and involvement in the planning decision making and to motivate the cooperation between decision makers and stakeholders. This is to attain more transparency. (Kim et al. 2012, p. 1112).

However, according to Pelzer, PSSs still have not made the expected revolution in planning in the most optimal way, as they perform a modest role in planning activities. This is because the usage of PSSs in practice does not represent the actual potentials in PSSs as it is aimed by PSS developers. (Pelzer, 2015, p.14).

This chapter presents PSSs as an effective tool in planning. In the beginning, it gives a historical background for the concept of PSSs. Then, the Spatial Planning Support System (SPSS) is defined, and the differences between SPSS, Spatial Decision Support System (SDSS), and GIS are explained. After that, this chapter illustrates each of the challenges facing the development and application of PSSs and how to overcome them. The types of modeling techniques, technologies used in developing PSSs, and the types of PSSs and their components are also illustrated. Then, it presents the role of artificial intelligence in developing PSSs. Also the criteria of efficient PSSs are investigated. Finally, the contribution of PSSs to planning is discussed by illustrating the added value of the PSSs to planning on various levels. The planning approaches supported by PSSs and the role of PSSs in supporting sustainability attainment in urban land-use planning (that is the focus of this dissertation) are also discussed.

(4.2) Historical Background and the Evolution in the PSSs’ Concept:

PSSs were first introduced by “Britten Harris” in mid 80s. (Geertman et al. 2013, p.1). The PSSs initially emerged in the form of a group of computer methods and models using GIS to support definite planning tasks. (Li and Jiao 2013, p.3). By mid 90s, some PSSs have been already established in the form we have now. This means that PSSs began to have Graphical User Interfaces (GUIs), in which planners adjust some parameters and visualize the probable impacts due to changes in parameters in the form of maps or charts. (Geertman et al. 2017, p.3). Nowadays, PSSs have recently become the main focus in researches, studies, and conferences due to their widespread in various fields of applications and their benefits for the planning and development process. (Geertman and Stillwell 2009, p.3).

The concept of PSS changed several times since its emergence according to the main focus for planning issues and the computer technology improvements from time to time. The next table presents some concepts for PSSs from 1989 till 2017, who introduced each, and when.

Table (4.1) The evolution in PSSs’ concept since 1989 till 2017:

The PSS concept	Introduced by	When	Reference
PSS is formulated from a group of computer-based methods and models to support definite planning tasks by using the system interface.	Harris	1989	Li and Jiao 2013, p.3
PSS is composed from some computer-based methods and models forming an integrated system to perform a definite planning task. A PSS is a framework is based on three components: 1. The type of the planning tasks and problems and data related to them. 2. The system models and methods that support the planning process by analysis, forecasting, and prescription. 3. The way to manipulate raw data into information.	Harris and Batty	1993	Geertman and Stillwell 2009, p.3
PSS is a kind of geo-information technology that is adopted to assist people working in planning by browsing, analyzing, visualizing, forecasting, prescribing, designing, executing, and evaluating.	Batty	1995	Li and Jiao 2013, p.3
PSS is a framework for integrated systems of information and software. It consists of three components: information, models, and visualization of results for public.	Klosterman Brail and Klosterman	1997 and 1999 2001	Geertman and Stillwell 2009, p.3
PSS is a geo-information technology, which include theories, data, information, knowledge, methods, tools, and meta-information. These together are used to support a professional planning task.	Geertman and Stillwell	2003	Geertman and Stillwell 2009, p.3
PSS is used to predict or forecast the future impact of any kind of development.	Brail	2005[1]	Geertman and Stillwell 2009, p.3
PSS includes models and knowledge from various disciplines (i.e. can deal with interdisciplinary issues) like transport planning, environmental analysis, and land use planning.	Brail	2008	Pelzer 2015, p.91
PSS is a geo-information technology that is used to support sustainable urban development. It is different from DSS in the sense that the latter deals with operational decision and solving problems, while PSS deals with long term strategic activities.	Geertman et al.	2013	Geertman et al. 2013, p.1
PSSs are group of tools, models, and techniques that can attain smart cities.	Geertman et al.	2015	Geertman et al. 2015, p.3

[1] Batty stated this definition for PSS in 2005 according to Brail.

The PSS concept	Introduced by	When	Reference
PSS are a group of modest tools, models, and techniques that can support the attainment of more resilient and smarter urban futures.	Geertman et al.	2017	Geertman et al. 2017, p.5

Source: own design according to the stated references

The previous table shows the changes in the PSS concept with time. However, it seems that the concept is almost the same, but with a thorough look at these previous concepts, we can find some differences that happened due to the computational technology improvements, and in order to cope with the planning concepts development. First, Harris’ concept was a bit tight on just a PSS is a group of computer methods and models for supporting definite planning tasks (1989). Then, the PSS concept has improved by Harris and Batty to be an integrated system composed from three types of components, which are the planning tasks and problems, models and methods, as well as the manipulation of raw data into information (1993).

By 1995, Batty has seen that a PSS is more than an integrated system, but it is a kind of geo-information technology. After that, Klosterman in 1997 and 1999 then Brail and Klosterman in 2001 have confirmed that a PSS is not just an integrated system based on geo-information technologies, but the mature form of PSS should be a framework for integrated systems of information and software. (Geertman and Stillwell 2009, p.3).

In 2003, Geertman and Stillwell in their book " Planning Support Systems in Practice " have defined a PSS as a geo-information technology that includes different types of actors (theories, data, information, knowledge, methods, tools, meta-information, etc.). All of them support the planning process through the framework of PSS. This means that a PSS is not only a type of software or models or systems, it can be a combination of hardware and software.

For example, consider the “Map-Table” which is a digital, touch-enabled screen (46 inches), and is fixed in a moveable table; This screen, which is a hardware part of “Map-table”, has the ability to handle many types of software packages. In the Netherlands, for instance, it works with each of ESRI’s ArcGIS environment, CommunityViz, Scenario 360 software, and web viewers, which are developed by governmental organizations for presenting various map layers. In other cases, the MapTable is combined with different software like Sketchbook Pro or Google Streetview. The MapTable is considered a PSS that is used to support policy and planning processes. Moreover, one can see in the following figure it also supports the collaboration among stakeholders in these processes as it is illustrated in the section concerning the added value of PSS.(Pelzer 2015,p.47).

Fig. (4.1) An example of a PSS that is formed from a combination between software and hardware[2]

Source: Pelzer 2015, p.51

Brail in 2005 (according to Batty) has mentioned that a PSS is beyond supporting the planning tasks or process, but it should be used to predict or forecast the future impact of any kind of development. Then, Brail has referred to the inter-disciplinary potential in PSS in 2008. (Pelzer 2015, p.91).

Some lecture notes in geoinformation and cartography are presented in a book under the title “Planning Support Systems for the Sustainable Urban Development”, (that was edited by Geertman et al.). These lecture notes have presented the role of PSSs in the attainment of the sustainable development within the 13th international conference on Computers in Urban Planning and Urban Management (CUPUM) in 2013. This is one of the important pioneering conferences in the planning support field that focuses on the role of computational applications in the planning and development processes. This conference takes places every two years since 1989. In 2015, the same conference (the 14th CUPUM) has focused on the role of PSSs in the attainment of smart cities in the book “Planning Support Systems and Smart Cities”. Recently, the 15th CUPUM has focused on the role of PSSs in the attainment of more resilient and smarter urban futures (2017).

Worth to be mentioned that some planners have been skeptical about PSS, and they see that PSS are infeasible. Klosterman in 1998 saw that for 10 years the planning support tools have not attained any contribution for supporting planning process. And also Harris in 1999 has spoken about how planners are doubtful regarding with those tools. However, by the beginning of the 21st century, this issue has totally changed and PSSs have returned to be the focus of planning studies. Planners changed their minds and they started to pursue PSSs as efficient tools for time and resources. (Geertman et al. 2013, p.2)

(4.3) What is a Spatial Planning Support System (S)PSS:

[2] The MapTable is applied here to explore the options in a plan area using CommuntiyViz software in the Netherlands.

We can conclude from all the previous that there is no definite definition of PSS. However, it is confirmed that PSSs in most cases depend on geo-information technologies[3]. These are adopted to assist people working in planning by browsing, analyzing, visualizing, forecasting, prescribing, designing, executing, evaluating, and discussing any aspect in the planning process. (Li and Jiao 2013, p.3).

SPSSs are systems related to geo-information technology that are established to support planning processes, e.g. problem identification, data analysis, data modeling, results visualization, scenario-generating, monitoring, assessment, report preparation, and support participation or collaborative decision making. (Sudhira and Ramachandra 2009, p. 178-179).

It seems that PSS and SPSS are the same. Some researchers use the term “PSS” and other use the term “SPSS”. However, the main characteristic of the SPSS is that it should be based on GIS. Moreover, some SPSSs mainly aim at making the planning process more interactive and participatory. One of the famous examples of these systems is "What-If?", which is considered an interactive GIS-based PSS that supports the comprehensive land-use plans making.(Sudhira and Ramachandra 2009, p. 179).

(4.4) The Differences between SPSS, SDSS and GIS:

There are three different terms that are well known these days in the planning scene: Spatial Planning Support system (SPSS), Spatial Decision Support System (SDSS), and the Geographic Information Systems (GIS). So it is important to discern between these three terms and to identify why the proposed system in this study is named as a "Spatial Planning Support system".

GIS is a special type of information systems that not only deal with items, or activities, or events, but also deal with their geographical location. (Longley et al. 2005, p.4). The users of the GIS are the analysts (Li and Jiao 2013, p.2), who use GIS mainly in storing, managing, analyzing, and displaying spatial data. (Geertman et al. 2013, p.1). This means that GIS is a tool used within systems such SPSS and SDSS.

A SPSS is defined as a computer assistant system for the planning process which includes GIS, urban models, visualization tools, and other components that have been the focus of many studies and already have been used to support planning process in many developed countries. In addition, PSS is based on visualization technologies and support the participation process in the planning activities. (Kim et al. 2012, p. 1112).

A DSS or Decision Making Support System (DMSS) is defined as information system designed to support or assist in all the stages of decision making in an interactive way. A SDSS is a special category of DSS or DMSS, which is characterized by the ability to store and analyze data based on its spatial or geographical location. (Mora et al. 2003, p. ix, x). In most cases, DSS are used in a GIS environment. (Keenan 2003, p.30).

Therefore, SPSSs deal with planning issues, whereas SDSSs support the decision making process in spatial planning issues or problems, unlike DSS that can be used in supporting decision making process in other fields like law, medicine, etc.

[3] The next chapter presents an example for a PSS that is not based on GIS (the Netherlands' Example).

We can conclude from all the above that GIS are considered a kind of tools, whereas SPSS and SDSS are considered independent systems that are composed of several tools including GIS. Geertman et al. consider GIS as a general-purpose tool, as it can be used in various spatial problems, whereas SPSS and SDSS have specialized functions for supporting planning tasks. (Geertman et al. 2015, p.3).The next table shows a detailed comparison between SPSSs and SDSSs:

Table (4.2) A comparison between SPSSs and SDSS:

Point of comparison	SPSSs	SDSS
Defination	SPSS are systems relating to geo-information technology that have been basically established to support planning processes within a collaborative decision making way. (Sudhira and Ramachandra 2009, p. 178-179)	SDSS are interactive computer systems supporting a user or a group of users in making highly effective decisions and dealing with semi-structured spatial decision problems. (Flacke 2012, p.5)
Supporting	Professional planning activities by providing integrated environments based on multiple technologies (Li and Jiao 2013, p.2)	Executive decision making. (Li and Jiao 2013, p.2)
Design to	Facilitates group interaction and discussion. (Li and Jiao 2013, p.2)	Supports decision making. (Li and Jiao 2013, p.2)
Focus on	The analysis of a variety of possibilities on the major issues and future development strategies to compare, interactively discuss, communicate, and to finally reach an agreement.(Geertman and Stillwell 2004, p.292,293)	Specific issues and goals to achieve decision making.(Geertman and Stillwell 2004, p.292,293)
Role in planning process	Support the whole or some parts of the professional planning activity. (Li and Jiao 2013, p.2)	Support a decision research process for complex spatial problems. (Li and Jiao 2013, p.2)
Deal with	Uncertainty and scenario planning. (Geertman and Stillwell 2004, p.292,293)	Spatial problem solving. (Geertman and Stillwell 2004, p.292,293)
Period covered	Long range strategies and issues. (Li and Jiao 2013, p.2)	Short range policy making. (Li and Jiao 2013, p.2)
Oriented to serve	Planners and stakeholders. (Li and Jiao 2013, p.2)	Decision makers. (Li and Jiao 2013, p.2)
Users	Planners. (Li and Jiao 2013, p.2)	Domain Experts. (Li and Jiao 2013, p.2)
Data type	Spatial and non-spatial data. (Geertman and Stillwell 2004, p.292,293)	Spatial and non-spatial data. (Geertman and Stillwell 2004, p.292,293)
Type of Models within the system	Urban planning models. (Geertman and Stillwell 2004, p.292,293)	Decision support models. (Geertman and Stillwell 2004, p.292,293)
Platform	Public participation platform. (Geertman and Stillwell 2004, p.292,293)	Domain oriented platform. (Geertman and Stillwell 2004, p.292,293)

Source: own design, according to the stated references

<u>(4.5) Challenges Facing the Development and Application of PSSs, and How to Overcome them:</u>

Some planners see that new computer-based support systems like (S)PSS (that were developed by researchers) are not beneficial in planning practice, or policy making, and hence not extensively used. In fact, many systems were not expected to sell quickly in the market unless there are reasonable financial resources. (Geertman and Stillwell 2009, p.1). This shows that there are many challenges or problems facing both the PSSs development and their active application in the planning practice.

(4.5.1) The Challenges Facing the PSSs Development and How to Overcome them:

The challenges facing the PSSs development are divided into three categories:

(4.5.1.1) Problems in the PSSs Technology:

Three interesting surveys were done by Vonk in 2006 investigating problems facing the PSS application in the field of spatial planning in the Netherlands. The first survey was done among 43 employees from 12 significant Dutch regional spatial planning organizations. These employees are geo-information specialists, planners, and managers. The second survey was among PSS developers concerning a number of 58 PSSs. The third survey was among experts in PSS. The surveys results show that the PSS technology was still at an early stage of development. This led to complicated PSSs, whereas a mature technology leads to simple or straightforward PSSs. Most of PSSs that have been already developed to deal with analytical tasks (like modeling and simulation) have not matched the actual demands of planning practice due to the immature technology used in their development. Therefore, as the technology becomes mature, it produces simple and easy-to-use systems. (Geertman and Stillwell 2009, p.4, 6).

(4.5.1.2) Problems in the Information Provision: (Geertman and Stillwell 2009, p.11 ,12)

Information is considered the backbone of any planning organization, (either quantitative or qualitative information). Large organizations in the planning field believe so, and have recently began to take a transparent attitude with their information by exchanging information with other organizations. This is to increase the benefit through what is called "data integration" on both micro and macro levels in spite of all the obstacles resulting from information confidentiality issues.

The information problem is not limited by the shortage in information provision (data fragmentation problem), but it is represented also in the lack of the harmonization among different kinds of information (e.g. at various geographical scales) and the duplication or gaps in the collected information.

Therefore, many serious attempts were done to deal with information problems all over the world at national and international levels. For instance, the Infrastructure for Spatial Information in Europe (INSPIRE) initiative (that is a geo-portal at international level) aims at providing users (like policy makers, planners, managers, individuals, and organizations) with spatial or geographical information from many sources and on several levels in an interactive manner.

The information problem facing the PSSs development can be solved in a reversible manner. This means that the provision and harmonization of information support the efficiency of the PSS, and at the same time, PSSs can help in handling the information to be the proper format.

(4.5.1.3) Problems in the Design of PSSs:

To obtain reliable results from a PSS or a SPSS, the programmed (modeled) methodology should be carefully studied to perform successful information analysis to reach the most fruitful planning decisions. For example, Sudhira and Ramachandra conclude that the main problem facing any SPSS is how to manipulate the spatial information in the system's models to perform policy or scenario analysis to evaluate the planning options and visualize the evaluation results. This is mainly a design problem. (Sudhira and Ramachandra 2009, p. 176).

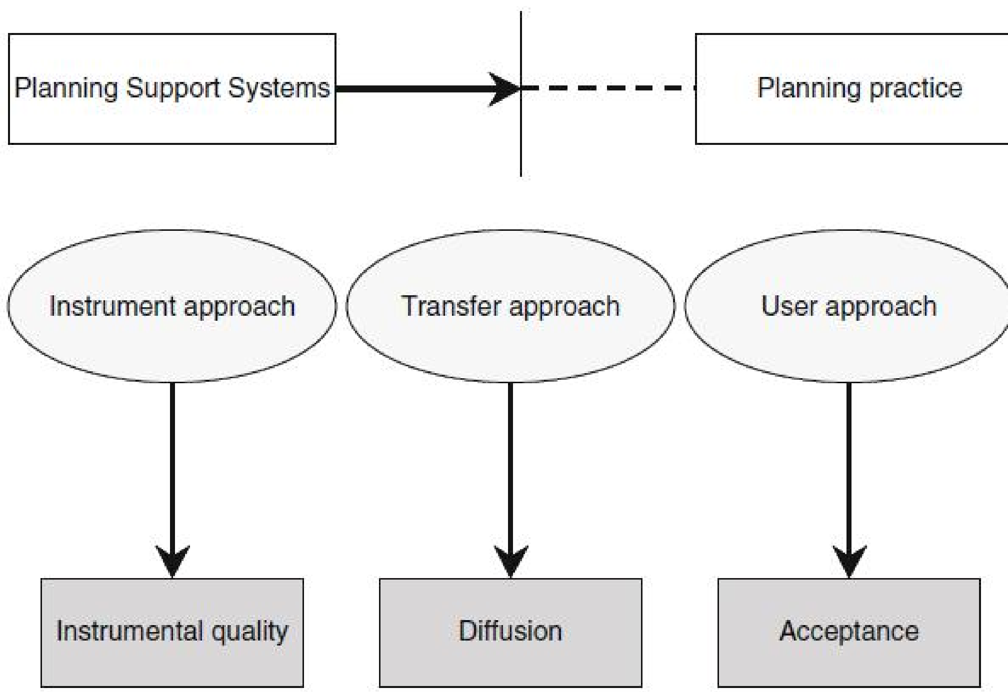
This means that design problems of any PSS can be overcome by studying the methodology or procedure programmed in it. This studying should include several aspects like to which extent and how efficient the methodology solves the planning problem or performs the proposed task.

Also the simplicity of the modeling process of a PSS leads to much success of this PSS. Klosterman argues that complex models like the Cellular Automate- CA models[4] are not considered more beneficial in practice than simple[5] models in all cases. Klosterman uses the PSS “What if?” as an evidence for this argument. “What if?” was designed using a simple rule-based model to some extent, which encourages the planning practitioners to use it. This is because of its easy methodology in browsing the spatial future of an area with various circumstances. However, Klosterman confirms that using a simple or a complex model mainly depends on the context or the task targeted by each PSS. (Pelzer 2015, p.17)

(4.5.2) Challenges Facing the Active Application of PSSs and How to Overcome them:

Beside the three previously mentioned challenges facing the development of PSSs, there are challenges facing the application of PSSs. These may hinder the PSSs actual application in the planning practice. The reasons for the weak PSSs application can be categorized according to three approaches. (Geertman and Stillwell 2009, p.1). The next figure presents these challenges, which are called by Vonk et al. "the bottlenecks". (Vonk et al. 2006, p.271).

Fig. (4.2) Conceptual framework for the problems facing the feasibility of PSS application in the planning practice with regards to three approaches



Source: Vonk et al. 2006, p.267 (reprinted with permission from Springer)

[4] The “Cellular Automate” meaning is illustrated in the next point in this chapter.
[5] “Simple” does not mean superficial or simplistic. “Simple” means not complicated and not having non-important details.

(4.5.2.1) The Instrument Approach for Challenges Facing the Active Application of PSSs :

The instrument approach presents the reasons related to the quality of the PSS design and its suitability for the actual needs of the planning process. These reasons are considered a common challenge facing each of the PSS development and application.

One of the evidences for the presence of problems within the PSS design is that the actual demand in the market is for simple systems. However, the actual supply is advanced systems. (Geertman and Stillwell 2009, p.1). The main cause for underutilization of the PSSs is the focus on improving their instrumental characteristics instead of improving their utility for planning practitioners. (Pelzer 2015, p.15). Also PSSs sometimes do not fulfill the political visions. (Vonk et al. 2006, p.272).

The studies concerning PSSs have concentrated in the 1990s-2000s on the instrumental characteristics of PSSs. There are huge improvements introduced in the models, software, and hardware; which have flexibly facilitated the connection between PSSs as instruments and the planning activities. For example, software or models like the calculation processes have become faster so that they can provide results for the impact analysis of the focus issue during meetings for this issue. The hardware improvements have also offered many potentials especially in the collaborative planning activities like map-based tables and “theater like” settings. Other new developed models like what are called "microscopic models" have made a tangible improvement in the decision making processes. (Pelzer 2015, p.16).

It is recommended to perform some improvements in the PSS technology based on the active cooperation between the system developers and geoinformation specialists. This is to develop feasible PSSs that are truly beneficial for planners. (Vonk et al. 2006, p. 272).

It is also recommended to develop PSSs that require less number of practitioners, which will facilitate the learning process for these PSSs. This will not avoid the complication in the planning process modeled by these tools, but it aims at making simpler interfaces for these PSSs. (Allen 2008, p. 166). The complexity in planning activities increases by time because many fields should be considered as important factors, and should be integrated in a balanced way in any planning decision. Also, many stakeholders or actors with different backgrounds affect the planning process from its early stages. This should be carefully considered in the PSS design to facilitate the complicated planning process. (Geertman and Stillwell 2009, p.4).

(4.5.2.2) The Transfer Approach for Challenges Facing the Active Application of PSSs :

The transfer approach presents the reasons related to the shortage in the mechanisms for transferring the PSSs to the target users. For example, some PSSs do not encourage the bottom-top management of the planning process. These PSSs can be easily used by the specialized people rather than public or normal users. (Geertman and Stillwell 2009, p.1). And at the same time, some of the top-down strategies do not support the usage of the PSSs. These reasons also include the lack of collaboration among the GIS experts and planners and lack of execution of decisions provided by PSSs. (Vonk et al. 2006, p.272).

Therefore, the planning community awareness should be raised to enhance the demand on PSSs. This can be achieved by re-applying best practices or experiences in PSSs in other cities or regions to increase chances that planners know about these PSSs, so that the planners may begin to adopt them in their planning activities. (Vonk et al. 2006, p. 272). Also, comparative assessment for various PSSs can be performed for tracking best practices to extract learned lessons from them. (Allen 2008, p. 166).

(4.5.2.3) The User Approach for Challenges Facing the Active Application of PSSs :

The problems related to the user approach are considered the result of the transfer approach problems. It presents the reasons why target users abstain from using the developed PSSs. This is due to the lack in experience and awareness of these users regarding the importance of PSSs. (Geertman and Stillwell 2009, p.1). These reasons also include the lack of organizational facilities to adopt PSSs in their work, lack of the required funding to apply PSSs, some negative social power, and unavailability of the required data for PSSs. (Vonk et al. 2006, p.272).

Therefore, the geo-information specialists should take up the role as initiators of diffusion of PSSs by trying to persuade managers of organizations with the advantages and benefits of new developments in geo-information technology. Also, these managers should begin to put PSSs as a main learning or training material in the plans to improve their employers' knowledge in their organizations; especially the planning research organizations. (Vonk et al. 2006, p. 271, 272).

It is also recommended to support the real time interactive process between stakeholders using PSS like the digital charrette in INDEX, (illustrated in details in chapter 5). This encourages the involvement of stakeholders in the planning process, and hence producing outcomes that fulfill the society expectations and needs. The data standards should be also identified to be taken in consideration in data gathering processes to fulfill the requirements of these PSSs. (Allen 2008, p. 166).

A recent research project was performed in Melbourne, Australia for developing a framework for assessing the usability of the PSSs and to what extent the PSSs can achieve a positive user experience. This research project concentrated on three PSSs that are specified in Land Suitability Analysis-LSA (Russo et al. 2015, p.337). The project evaluated the user interfaces of these PSSs, and how these interfaces support the efficient achievement of the specific tasks in a way that the users see that these PSSs performing an added value to the Land Suitability Analysis process (Russo et al. 2015, p.339).

An evaluating framework is named "DECIDE[6]" that targeted various participants in the evaluation process of this research. These participants are PSS designers, developers, potential users, and training instructors. (Russo et al. 2015, p.338).

The results of the evaluation process showed that there are weak points in the interfaces of these PSSs despite their strengths. The main recommendation is to design PSSs with simple user-friendly interface, so that this can facilitate the user-interaction with the system. However, this evaluation process was applied on individual users, i.e. PSSs that need individual users. So it was

[6] This name is based on six activities or steps that were performed by that framework:
D:Determine the evaluation goals, E: Explore the questions that should be asked to the participants in the evaluation process, C: Choose the evaluation and data collection methods, I: Identify the practical issues, D: Decide how to deal with the ethical issues, and E: Evaluate, analyze, interpret and present the data (results of the evaluation process) (Russo et al. 2015, p.340-343).

recommended that an evaluation process should be applied on PSSs with group users (Russo et al., 2015, p.352). And this is what Pelzer tried to make in assessing the usefulness of planning support system, as it is illustrated latter in the point of the added value of PSSs. (Pelzer 2015).

In general the main recommendation suggested by Vonk et al. for overcoming the weak points in PSSs application is that PSSs should be made transparent and understandable, e.g. which PSS kinds should be applied for which planning tasks, by which users, in which institutions, and under which external circumstances.(Vonk et al. 2006, p. 271,272).

However, there are many PSSs already in their way from the scientific laboratories to the marketplace in a progressive way. These PSSs are successful or "off-the-shelf" products as they are sold in the market at an acceptable price. (Geertman and Stillwell 2009, p.4).

(4.6) The PSSs Modeling Techniques and Technologies:

As previously mentioned, the problems in PSS technology are challenges facing the PSSs development. The corner stone in making any PSS feasible is the technology used in it. Many PSSs are considered unsuccessful to a great extent, in contrast to a small number of successful PSSs either free or "commercial-off-the-shelf (COTS) packages", (e.g. CommunityViz, SLEUTH, INDEX, UrbanSim, What if?). The main cause for the success or the failure of any PSS is the technology. (Klosterman and Pettit 2005, p.477)

The PSSs modeling techniques are approaches that are used to design and establish PSSs (Klosterman and Pettit 2005, p.478), whereas the PSSs technologies are the technical capabilities, methods, and processes that are used for developing PSSs.

(4.6.1) PSSs Modeling Techniques:

The PSSs’ modeling techniques used in establishing PSSs can be classified[7] as follows: (Klosterman and Pettit 2005, p.477- 479)

(4.6.1.1) Large-scale Urban Models:

Large scale models are applied on a large geographical scale (e.g. regions). There are three well known (or widely used) and mature models in this type. These are METROPILUS, SPARTACUS, and TRANUS. They are also considered the first three models that have been developed as large scale urban models. Later, “UrbanSim” appeared in the research field.

(4.6.1.2) Rule-based Models:

This type has begun to be known by the introduction of California Urban Futures (CUF) model in 1994, which is considered the first GIS-based urban development model. These models are based on definite rules that identify the behavior of the model to perform definite function. For example, the two models CUF and “What if”? are based on rules aiming at evaluating the relative suitability of different locations, rules for projecting future land-use demands, and rules for identifying the most suitable land-use type for any location.

Other examples for rule based models are CommunityViz, INDEX, and Place3S, which aim at identifying the impact of future development patterns on transportation facilities, public infrastructure, etc.

[7] The four modeling techniques are mentioned by a historical order, in which they were used for the first time in supporting planning activities. (Klosterman and Pettit 2005, p.478).

(4.6.1.3) State-change Models:

The second version from CUF is the CUF II model", (the previously mentioned model as a rule based model). The CUF II model was developed in 1998 and is considered the first example of a state-change model.

The state-change models are used like the rule based models to project the future land-use change or future urban growth. However, the state change models do not make simulations for the demography and economy as factors impacting urban growth. The state change models are mainly based on land-use data at definite two points in time. These models focus on a group of independent variables that are connected to the land-use change, so that the current and the projected values of these variables can help in the projection of changes in future land-use.

(4.6.1.4) Cellular Automata Models:

This type of PSSs models was the focus of researches for many years. The CA models are mainly concerned with urban growth. The methodology of these models is based on the representation of the urban area on a lattice of cells, each cell in this lattice has a definite number of states (e.g. developed and undeveloped). The sequence of the time is modeled by using definite steps to represent the future patterns by using transition rules, which identify the cells behavior with time, (e.g. whether a cell state will change from undeveloped to developed). This is done while considering some conditions for each cell and its neighboring cells at each time step. SLEUTH and the Dynamic Urban Evolutionary Model (DUEM) are considered among the well known examples of the CA models.

There are PSSs that combine the four previously mentioned modeling techniques. For example, the Land-use Evolution and impact Assessment Model (LEAM) is based on all these four modeling techniques. (Deal and Pallathucheril 2009, p. 31).

(4.6.2) The Technologies used in PSSs Formulation:

Before discussing the PSSs technologies, the planning tasks which are proposed to be supported by the PSSs should be stated. There are three main tasks related to planning: exploration, selection, as well as the negotiation of the ideas, challenges, and alternatives. The first task is exploring scenarios for how the city will be in the future or predictions for the urban growth. The second task is selecting the optimal scenario from what have been explored. Analysis processes may be required within the selection task like deciding the optimal location for commercial uses. The third task is the negotiation, which is essential in case of various and conflicting interests. For example, when there are many official actors involved in the same development project. (Pelzer 2015, p.109).

The PSSs technology can support the three planning tasks through two main capabilities: communication support and analytical support. The communication support is the usage of technology to facilitate the information exchange between the involved actors. The analytical support is the usage of technology to perform the calculations that support the planning processes. (Pelzer 2015, p.109).

However, the efficient composite usage of the communication and analytical capabilities for supporting the planning process can be difficult in some cases for two reasons. The first is that some actors or stakeholders do not want to share all their information. The second is that data quality should be very high (with many up-to-date details) to facilitate the negotiation task. The quality of data cannot be maintained for many types of data, which may negatively affect the support of the two capabilities (Pelzer 2015, P.124). The following table illustrates how are the two PSSs technical capabilities support the three main planning tasks.

Table (4.3) Examples for impacts on the three planning tasks resulted from “the task-technology fit[8]” of the technology capacities:

Technology capabilities / Planning Task	Communication Support (improving knowledge exchange among stakeholders)	Analytical Support (information provision based on calculations)
Exploration	Learning about others and learning about the object	Leaning about the object
Selection	Efficiency	More informed outcome
Negotiation	Consensus	More informed outcome

Source: Pelzer 2015, p.111

The technology used in PSSs is rapidly developing. This affects the PSSs development because as technology gets more sophisticated and mature, it is easier to use it. (Geertman and Stillwell 2009, p.12). For example, Information and Communications Technology (ICT) and geo-technology have affected the methods of visualization of spatial data in a noteworthy way. Moreover, grid technology, web mapping, interactive web services, Google Earth, and Google Maps services have been introduced and become applicable in the planning practices. The emergence of new languages such as Hypertext Markup Language (HTML)[9] and the Extensible Markup Language (XML) have facilitated new developments in technologies. (Geertman and Stillwell 2009, p.12).

The following are the most significant technologies used in PSSs development: (Geertman and Stillwell 2009, p.12-16)

(4.6.2.1) Grid Technology:

The evolution of the grid technology (or as it is called "e-Infrastructure") is considered one of the significant recent technological development. The grid technology includes computational tools that are characterized by being networked, inter-operable, and scalable tools. In addition, it includes services that facilitate the processes of locating, accessing, sharing, aggregating, and manipulation the digital data in a flexible manner via the internet.

The computing processes in the grid technology include various computer resources (e.g. platforms, computer languages, hardware and software architectures). These resources can deal with large tasks that need a lot of time. However, there are also computing processes in the grid technology that can perform intensive operations in a short time.

Grid technology has the ability to convert the companies’ activities to be a public utility on a global scale through using computational connecting items like processors, storage systems, and software.

[8] “Task-technology fit” means that a PSS may have positive and negative impacts on performing a definite task. (Pelzer 2015, p.125).

[9] The HTML is the main language for web pages making that can help to describe the structure of any text-based information in a document to indicate headings, paragraphs, lists, etc. Also this language can provide texts with interactive forms, embedded images, and other items.

Grid technology also provides a multi-user environment, so it can support any collaborative PSS. That is why the grid infrastructure can perform video-conferencing and other collaborative or participative planning activities.

One of the successful application of grid technology is a research program done by the National Centre for e-Social Science (NCeSS) in the United Kingdom. This program is named Geographic Virtual Urban Environments (GeoVUE), and aims at introducing new solutions to social science research problems. It was created by grid-enabled virtual environments, which link spatial data about cities to GIS software.

GeoVUE supports decision making process by connecting the academics and professionals in planning with planners and urban designers in the preparation process of plans. GeoVUE also makes the geographic information available for a more general audience or the stakeholders of the planning process to be aware of problems and policies affecting their cities.

Another grid technology application called MapTube was implemented by NCeSS. MapTube is a system that links maps with socio-economic attributes data in an open source spatial analysis software linked to GIS. This system aims at a better scientific understanding for some issues like spatial patterns, income distribution, and demography.

(4.6.2.2) Web Technology:

The Web Technology makes data available through a common framework in the web. The web technology has been established by many researchers and industrial partners in a participative process. The Web Ontology Language (WOL) is used for integrating and combining data taken from various sources.

The main challenge facing information sharing between two applications in two different domains via this web technology is trust, especially if the information exchange is done in machine-to-machine environments. This requires a client application in first domain, which can request information from a web service of a different domain. The client application should present a proof that is known and trusted by the web service.

(4.6.2.3) Analysis and Modeling Technology:

The analysis and modeling technology is used mainly for simulation and prediction purposes. Spatial planning is considered an important field of application of the analysis and modeling techniques; especially the spatial micro simulation.

(4.7) Types of PSSs and their Components:

In this section, types and components of PSSs are illustrated:

(4.7.1) Types of PSSs:

The most known classification of PSSs types among researchers is classification with respect to the purpose for which these PSSs have been developed. Geertman and Stillwell (2003) have classified PSSs regarding their purpose as follows: (Geertman and Stillwell 2004, p. 295)

- PSSs that are developed to support stakeholders participation in the planning process.
- PSSs that are developed to perform specific tasks in planning processes, e.g. analysis.
- PSSs that are developed to work as information transfer for residents about different planning and policy actions and issues in their region.

- PSSs that are developed to support specific type of planning, (like strategic planning, environmental planning, land-use and infrastructure planning).

Klosterman and Pettit (2005) have presented three classifications for PSSs. These are classification according to the nature of the PSSs role in the planning process, classification according to PSSs purposes, and classification according to the modeling techniques of the PSSs, which is illustrated in the previous section.

The classification according to the nature of the PSSs role in the planning process is as follows: (Klosterman and Pettit 2005, p.477-478)

- PSSs that are used for analysis, forecast, or prediction, and design activities.
- PSSs that are used to improve the communication and expression processes in the planning activities.

The classification according to the purpose of the PSSs by Klosterman and Pettit is different than the aforementioned classification by Geertman and Stillwell as follows: (Klosterman and Pettit 2005, p.479-480)

- PSSs that perform projection of future change in land-use or land cover. These systems aim at projecting future changes in land-use, or land cover in any area. They are used and matched with all kinds of modeling techniques to project future land-use patterns. The number of land-use categories that can be projected and the geographical scale of application may differ from example to another. One of the known examples of these land-use change PSSs is "What if?".
- PSSs that perform comprehensive forecasting. These systems can perform the function of the land-use change models and they can deal with other variables, (e.g. transportation flows, population, employment, environmental impacts, etc.). METROPILUS, SPARTACUS, TRANUS, and UrbanSim are examples for this PSSs type. "What if?" is also considered an example of this type beside being an example for land-use change models. However, "What if?" can perform projection regarding the two variables: population and employment patterns for small scale areas only.
- PSSs that perform three-dimensional visualization. The visualization process has become the focus in the last period to the extent that it is supposed that almost all PSSs can perform the 3D visualization of any alternative. This is to present information concerning the implications of this alternative to the PSS users in a more clear and comprehensible way. CommunityViz is the known example for PSSs which independently perform the 3D visualization. Other PSSs need assisting 3D visualization tools like ERDAS's Imagine VirtualGIS, ESRI's 3D Analyst, ArcScene, and ArcGlobe to perform 3D visualization for information or results.
- PSSs that perform the assessment of various alternatives impact. There are many PSSs which can be used to assess the impact of alternative public choices in different ways, but the geographical scale of assessment may differ from one type to another. For example, CommunityViz, INDEX, and Place3S are characterized by their ability to assess the impact at a neighborhood or community scale.

(4.7.2) PSSs Components:

Typical or traditional PSSs consist of main or basic items, (like any decision support system or any computational system), as follows: (Geertman 2002 , p.1)

- Items concerning information: These are the input items to the system. The information includes data, theories, meta-information, etc.
- Models and algorisms: These are the processing items of the system. These perform the tasks (like analysis, forecasting, etc.) based on the information entered or the system inputs.
- Visualizing tools: These are the output items from the system. These items transfer the results in many forms (reports, maps, statistics, etc.) to the public or stakeholders or PSS users in general. The type of the visualizing method depends on the target user of the system.

(4.8) Artificial Intelligence and PSSs:

(4.8.1) The Artificial Intelligence Definition:

The most widely spread definition of artificial intelligence- AI (as a computer science field) is that it aims at developing computational systems that are able to realize, analyze, and act like the human brain. (The website of technical term, artificial intelligence, 2017).

In 2003, Kalogirou has defined the AI as the usage of complex programming techniques for formulation of the computer systems and programs. These techniques are able to execute more complex tasks than programs, which are executed by using straightforward or simple programming. (Wu and Silva 2010, p.247).

There is still a debate whether it is possible to totally emulate the potentials of the human brain through the AI. For example, Kalogirou thinks that these complex programming techniques are still far from the potentials of the actual thought. (Wu and Silva 2010, p.247).

(4.8.2) The Emergence of the Need for Artificial Intelligence in Urban Development:

The urbanization and urban growth of the cities lead to physical, social, and environmental changes in the land. These changes result from the combination between spatial and non-spatial factors which trigger the dynamic process of land change due to the interaction between these factors. The urban land-use dynamics or changes are defined as the direct results of actions of individuals, public, and private corporations by time in the urban space.(Wu and Silva 2010, p.246).

Many researchers have tried to study the dynamics of land change by using several tools and methodologies. In the beginning there was a great dependency on the static and top-down approaches of traditional modeling (e.g. linear and mathematics modeling). However, the complexity of the dynamic changes in urban land did not work with these traditional computer techniques. This means that computer techniques had to improve by becoming more dynamic rather than static through the use of complex analyses and AI in the spatial analysis since the 1970s. AI is now applicable and extensively used in many scientific fields including PSSs because it provides and facilitates the consideration of high levels of complexity in the modeling process, which could not be provided by simple models. (Wu and Silva 2010, p.246).

(4.8.3) Artificial Intelligence Approaches used in Supporting the Urban Development:

Wu and Silva (2010) present AI approaches used in urban studies in general in their review article "Artificial Intelligence Solutions for Urban Land Dynamics: A Review". They classify the AI approaches into five categories according to their applications and characteristics. These are artificial life, intelligent stochastic simulation models, evolutionary computing and spatial DNA, knowledge-based intelligent systems, and a category for the underdeveloped AI approaches (Wu and Silva 2010, p.247). In the following table, we briefly present these categories, their sub-categories, and their applications in supporting the urban development.

Table (4.4) The categories of AI approaches used in urban planning and urban studies and their applications or roles in supporting the urban development:

AI approach		Applications in supporting the urban development
Artificial Life	Cellular Automata- CA	Modeling the urban growth process. (Wu and Silva 2010, p.248)
	Agent-Based Model- ABM	Modeling the non-spatial dynamics, (e.g. social parameters[10])- Connecting the dynamic socioeconomic with the environmental factors - Simulating the social-economic interactions in urban systems (Wu and Silva 2010, p.248-249)
	Swarm Intelligence- SI	Transportation and urban traffic problems (Wu and Silva 2010, p.249)
Intelligent Stochastic Optimization Processes	Genetic Algorithm- GA	Land change studies (Wu and Silva 2010, p.249)
	Simulated Annealing - SA	Urban road network design- Optimizing traffic signals- Location and allocation problems of land use- Household data synthesis. (Wu and Silva 2010, p.250)
	Others like: Hill Climbing Algorithm	The calibration procedures for modeling solutions of shopping center locations problems. (Wu and Silva 2010, p.250)
Evolution Computing and Spatial DNA	Artificial Neural Network. (ANN)	Land cover classification- Land pattern learning- Finding suitable parameters for other models, (e.g. preparing the parameter values for a CA model for land use change of a cluster of cities in southern China)- Modeling multiple regional land use - Simulations for alternative development scenarios. (Wu and Silva 2010, p.251)
	Spatial DNA	Regional planning through the combination between Spatial DNA and CA models. (Wu and Silva 2010, p.251)
	Others like: Shuffled Complex Evolution (SCE) algorithm.	The design of a cost-effective water distribution networks. (Wu and Silva 2010, p.251)
Knowledge-Based Intelligent Systems	Fuzzy Logic	Evaluating the urban residential environment- Analysis of problems related to land classification- Multistage classifier for land cover classification- Some urban studies like traffic flow and urban growth modeling. (Wu and Silva 2010, p.252)
	Expert system (ES) [11]	Urban planning in general and site selection- Land evaluation- Land use allocation and classification- Integration with GIS technologies for general application. (Wu and Silva 2010, p.252)
	Heuristics	The generation of land use plans- Evaluation of the macro strategy and suitability of land uses. (Wu and Silva 2010, p.253)
	Reasoning Systems (two types)	<u>Rule-based system (RBS):</u> Urban land planning studies like the landscape change modeling-based scenarios. (Wu and Silva 2010, p.253)
		<u>Case-based reasoning (CBR)</u>: Environmental problems like management of waste water treatment, monitoring air quality and other- Urban planning. (Wu and Silva 2010, p.253)
Under-developed AI Approaches	<u>Example</u>: Reinforced Learning (RL) and Analytical Learning (AL) (subareas of machine learning)	Traffic control through the simulation of the route choice behaviors within transport networks- Control and optimize traffic signals-Simulation of the dynamic change of multiple land uses. (Wu and Silva 2010, p.253)

Source: by own according to the stated references.

[10] Unlike CA’s abilities in modeling the spatial dynamics of land change.
[11] This AI technique is suggested in the design of proposed SPSS in the dissertation.

(4.8.4) The Role of Artificial Intelligence in Developing PSSs:

Many examples for PSSs are based on one or more from the previously mentioned AI techniques. For example, the PSS "Land use and land cover change (LUCC)" performs predication of the transition probability of land parcels. The land transition probability means the conversion within lands like land uses changes, changes in the buildings by demolition or reconstruction, and sub-division in land parcels. The LUCC is based on the coupling between multi agent systems and CA techniques. (Osaragi and Nishimatsu 2013, p.33).

AI has many potentials that are not available in the traditional static techniques. The most prominent potentials are the ability to emulate humans; the machine learning, which is the ability of the techniques to learn new information for the input data and the interactivity with the user.

We can deduce from the previous table, the benefits of AI techniques in developing PSSs as follows:

- There is a big variety of the AI techniques applications within the urban development field. They almost cover all these fields, (e.g. the land-use planning, land cover studies, air quality, traffic, transportation, roads, and infrastructure networks).
- The applications of AI techniques can deal with definite urban cases like residential areas and cities centers.
- The applications of AI techniques are on various geographical scales regional, local, and sites.
- These techniques perform various processes, (e.g. land evaluation, land allocation, alternatives scenarios, land suitability, and strategies evaluation).
- These techniques deal with spatial parameters and non-spatial parameters (social, economic, and environmental).
- The AI techniques are able to integrate with GIS.

(4.9) Criteria of Efficient PSS:

In order to develop an efficient and feasible PSS in any country, it is important to consider the current demands and needs as well as the characteristics of the planning process in this country. (Pelzer 2015, p.106). Pelzer classifies the criteria of an efficient PSS into three categories: usability, the support potentials of the PSS, and suitability for the planning system of the country in case that the evaluated PSS was developed to deal with definite planning issue or case. (Pelzer 2015, p.66).

First: the PSS Usability Criteria: Pelzer presents ten criteria for assessing the usability of PSS for the planning process in the next table:

Table (4.5) Criteria for assessing the PSS usability for the planning process:

Usability Creterion	Meaning
Trancparent	The PSS models and parameters can be accessed and understood by users.
Communicative	The spatial information is capably provided
User friendly	The users can easily use the PSS themselves.
Interactivie	The PSS interacts with the users by providing feedbacks.
Flexible	The PSS can be used in various planning purposes.

Usability Creterion	Meaning
Short calculation time	The waiting time for analysis results, is short.
Appropriate data quality	The input data to the PSS is valid and appropriate
Suitable Level of detail	The required level of detail of the PSS is suitable to the users perspective.
Comprehensive	The PSS considers all the respective aspects.
Reliable	The PSS outputs are reliable

Source: Pelzer 2015, p.70

Second: the support potentials of the PSS: these potentials are assessed according to the tasks that can be accomplished by PSS. Some PSSs can perform more than one tasks. These tasks are: (Pelzer 2015, p.71)

- Informing task: the ability of PSS to transfer the required information to the user.
- Communication task: the ability of PSS to make an improvement on the knowledge exchange process among several users.
- Analysis task: the ability of PSS to provide answers to the users' questions especially through performing quantitative modeling and analysis.

Third: the suitability of PSS to the planning characteristics of the country: these potentials can differ according to the planning system of the country in which the PSS is applied. The planning system varies according to some parameters like the type of the users involved in the planning process, the characteristics of this process itself, and the content of the planning issue or problem. (Pelzer 2015, p.71).

Note: These criteria can help in assessing the proposed system in this research regarding its usability and efficiency.

(4.10) The Contribution of PSSs to Planning:

This section focuses on the importance of the PSSs for planning in general. PSSs are considered the knowledge technologies, by which the planning practitioners can present their inputs in a collaborative process rather than just the PSSs perform complicated planning tasks. (Pelzer 2015, p.18).

The concept of added value or contribution of the PSSs is considered a central concept in planning support science.(Pelzer 2015, p.62). The added value of the PSSs is beyond assisting the planning process. Pelzer defines the added value of a PSS as the case of improving the planning practice when PSS is used in comparison with the case when PSS is not applied, so that the PSS can lead to better outcome of the planning process. This definition is based on the assumption that the type of inputs to the analysis process using PSS can produce better planning decisions.(Pelzer 2015, p.43).

For example, Al-Ahmadi et al. (2009) see PSSs as a significant tool for realizing and assessing the consequences of past, current, and future planning policies using the urban simulations processes especially using AI techniques. The consequences of urban strategies, plans, or policies need time to be clear. And the simulations processes through PSSs give the opportunity to deal with all time states (past, present or future). Therefore, the simulations using PSSs represent essential assistance for planning, which help planners and other policy makers to expect and consider many various probable outcomes. (Al-Ahmadi et al. 2009, p.88).

(4.10.1) The Added Values of PSSs to Planning Regarding Various Levels:

Pelzer presented an evaluation process to measure the added value of the PSS from the practitioners’ perspective. This process was a qualitative research in which two methods were applied: fifteen semi-structured interviews and a Group Decision Room (GDR) workshop. The main target of these interviews was to collect information about the added value of PSSs to realize how the practitioners see PSSs as a beneficial tool. The GDR workshop aimed at structuring and prioritizing the findings of the interviews. (Pelzer 2015, p.48,50).

The target participants that are GIS advisors, spatial planners, and environmental advisors were from 15 different organizations that use the MapTable[12] for supporting the policy making process for planning purposes. While excluding the organizations that use this tool for educational purposes or other purposes (Pelzer 2015, p.48,50), the results presents the added value at three levels or aspects:

1. Individual level: The main added value of PSS on the individual level is the learning process. This includes learning about objects of planning like the type of problem, its causes, and the planning process to deal with it. (Pelzer 2015, p.45). For example, the PSS “Land Use Scanner” helps users to know more about the flood risk in the Netherlands. (Pelzer et al. 2014, p.17).

The learning is also about the perspective of other stakeholders or partners in planning process. For instance, the planner can know the residents’ expectations or perspective (Pelzer 2015, p.45) or other experts’ perspectives (e.g. the transport experts) .(Pelzer et al. 2014, p. 17).

The results of another study by Pelzer that aimed at comparing between four PSSs[13] using a questionnaire have confirmed that the learning is the most important added value for PSS. (Pelzer 2015, p.66).

2. Group level: PSSs can positively impact the planning process on the group level at the following sides: communication, collaboration, consensus, and efficiency. (Pelzer 2015, p.45). Communication and collaboration depend mainly on the perspective of the practitioners on the group level (Pelzer 2015, p.58). PSSs can increase the collaboration process in the planning activities due to the interactions and the sharing potentials in the PSSs. This supports the communication process between stakeholders involved in the planning process by sharing knowledge among them. The collaboration and the communication lead to consensus in the planning process in defining problems and taking decisions. All of these eventually increase the efficiency of the planning process by saving resources, time, and effort. (Pelzer et al. 2014, p.17,18). This shows that the collaboration and communication are the cornerstone of planning process. (Pelzer 2015, p.61).

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[12] MapTable is illustrated before in this chapter.

[13] These four PSSs are SprintStad, Map Table, CommunityViz, and Urban Strategy

3. Outcome level: The PSSs’ components like models, visualizations tools, and other, can enhance the planning process outcomes (plans). The PSSs facilitate the studying of the relations between different factors affecting and affected by the planning process, as the analysis potential of the PSSs helps in more effective usage for information. (Pelzer et al. 2014, p. 18). Therefore, PSSs can lead to perform much better plans and decisions as an added value for the planning process on the outcome level. (Pelzer 2015, p.46). However, there should be precise information with the efficient consideration for this information through the applied methodology for obtaining feasible outcomes. (Pelzer 2015, p.49).

Worth to be mentioned that Pelzer referred to some negative effects of PSSs like impeding the urban designer creativity in some cases. Also sometimes PSSs may disturb the communication process rather than supporting it. So, he confirms that PSSs alone cannot be the magic solution for all the planning problems. Yet, PSSs are useful in definite tasks for specific purposes.(Pelzer 2015, p.161).

(4.10.2) Planning Approaches Supported by PSSs:

As previously mentioned in chapter 2, there are three main planning approaches. The first approach is the system analysis and procedural planning approach, or what is called the modernism that includes the rational planning, physical planning, and comprehensive planning (Pallagst 2007, p.41- 46). The second approach is the postmodernism (Pallagst 2007, p. 46-49). The third approach is the collaborative approach (Innes 1995, p.3). According to Pelzer et al., the PSSs represent an added value for each of the system analysis and procedural planning approach and the collaborative approach. (Pelzer et al. 2014, p.16,17).

Regarding the system analysis and procedural planning approach, PSSs have proved themselves to be able to improve the planning process outcomes as they support the professional planning tasks, and hence support this approach. (Pelzer et al. 2014, p.16,17).

Regarding the collaborative approach, many examples of PSSs (e.g. Community Viz) greatly support the communication process, which is the pillar of the collaborative approach in planning. This is due to the potentials offered by PSS like collective design, social interaction, interpersonal communication, and community debate. These can help making collective goals based on shared interests. (Pelzer et al. 2014, p.17). The main vision of PSSs is to support stakeholders of the planning process to improve their knowledge to achieve good governance for the urban development process and to solve conflicts of interest. (Geertman et al. 2013, p.4).

(4.10.3) The Role of PSSs in Sustainability Attainment in Urban Land-use Planning:

Chapter 3 clarifies how important is the sustainability in the land-use planning process and the challenges facing the sustainability attainment in this process. Therefore, it is important to use efficient assessment tools for evaluating the sustainability of land use plans.

However, as previously mentioned, the problems facing the sustainable development are multi-dimensional: social, economical, spatial, and environmental. This shows that this process is not only complex, but also the urban development process is characterized by being a complex dynamic process (Koomen and Rijken 2013, p.1). Therefore, to deal with this dynamic complexity in realizing sustainability in the urban development, there is a need for supporting instruments such as PSSs.

Although there is no strong evidence that PSSs are essential for the sustainability of the urban development process, there are successful experiences that show and prove the importance of PSSs in sustainability attainment in the urban development process. (Geertman et al. 2013, p.4). As previously mentioned (in this chapter) the book titled "*Planning Support Systems for Sustainable Urban Development*" (2013) is dedicated for collecting researches concerning the importance of PSSs for the sustainable urban development. It shows that the PSSs can support some fields in the sustainable urban development. These fields include the urban land use planning process as the main process affecting the urban development.

Not only this book, but also many writings confirm the importance of PSSs for sustainable urban development. For example, Pettit presents “What if?” as a collaborative GIS-based PSS that assists the formulation of a sustainable land-use strategy for Hervey Bay, Australia. Pettit confirms that “What if?” can provide a way to integrate the previously mentioned dimensions of the sustainable urban development process. (Pettit 2005, p. 523).

Some PSSs that perform the land-use change modeling, help analyzing the impact of land-use change on sustainability[14]. These PSSs support the spatial planning in the formulation of the spatial policies through the simulation of the expected spatial developments to show the possible consequences of various alternatives for land-use change policies. This eventually help the policy makers to decide which policies will be adopted. (Koomen and Rijken 2013, p.3,4).

The next chapter illustrates in details examples for PSSs that support the sustainability attainment and assessment in land-use planning to demonstrate in a tangible way how PSSs support the sustainability attainment in this process.

(4.11) Reflection:

This chapter focuses on PSSs as planning tools by illustrating many aspects of PSSs. First, an introduction on the planning support science and a historical background for the concept of PSSs are presented. Then, the SPSS definition and the differences between SPSS, SDSS, and GIS are clarified. After that, the challenges facing the development and application of PSSs and how to overcome them are discussed. Then, the types of modeling techniques and technologies used in developing PSSs and the types of PSSs and their components are illustrated. The artificial intelligence concept and its role in developing PSSs are stated. Then, the criteria of efficient PSSs are presented.

Finally, the contribution of PSSs to planning is discussed by illustrating the added value of PSSs to planning regarding each of the individual, group, and outcome levels. Then, the planning approaches, which are supported by PSSs, are mentioned. At the end, the role of PSSs in sustainability attainment in urban land-use planning is explained. It becomes clear that PSSs represent an added value in planning activities in general, and specifically in the sustainability attainment in urban land use planning. Chapters 6 and 7 present the technical and administrative

[14] E.g. decreasing open spaces or exposing urban areas to flooding.

frameworks for the proposed SPSS that can be applied in supporting planners and decision-makers in the assessment of the sustainability attainment in plans in the existing Egyptian Cities.

Chapter 5
Previous Examples in the Field of Sustainability Assessment using Various Tools Types

(5.1) Introduction:

This chapter is considered the most important chapter in the theoretical section of the thesis. It illustrates selected previous examples or studies in the assessment of definite aspect(s) or all sustainability aspects. These selected examples have used various assessment tools from various countries (developed and developing countries). However, all of these experiences can be guides for the proposed system, as there are many extracted learned lessons from them because of their diversity.

The assessment tools used in these examples include urban indicators, (S)PSS, and a prototype for a (S)PSS. It is worth mentioning that as this chapter presents these selected previous examples or experiences, there may be only one available reference for some of the illustrated examples due to the specificity of these assessment tools within each example.

The previous examples have been chosen according to two classifications:

First. according to the purpose of the example, which include three types:

It was intended that the three categories in this classification are decided according to the degree of the sophistication of the tool used to fulfill the purpose of each example. This means that the tool that can fulfill the purpose of the third category in this classification is more sophisticated than the second, and the second is more sophisticated than the first.

The proposed system from the research is belonged to the second type, which is considered to be a moderate degree of sophistication. As PSSs are new for the Egyptian planning system, and it is reasonable to not use the highest sophisticated tools. The three categories in this classification are:

a. Examples that aim at assessing the sustainability (or definite aspect(s) from it) within the current state only of the land use planning (Taiwan’s example, China’s example 1, and Iran’s example).

b. Examples that either aim at assessing the sustainability (or definite aspect(s) from it) within current state for choosing the best alternative for the suggested state of land use planning (China’s example 2). Or, they aim at assessing the sustainability (or definite aspect(s) from it) in current state for forecasting the future changes, which affect sustainability (or definite aspect(s) from it) (Australia's example).

c. Examples that aim at assessing the sustainability (or definite aspect(s) from it) within current state. And so, either they generate alternatives for land use planning or identifying policies for attaining sustainability (or definite aspect(s) from it) in the future. (The Netherlands’ example, Cyprus’ example, INDEX, USA’s example, and India’s example).

Second. according to the nature of the assessment tool used in the example, which includes three types:

a. Examples that perform the assessment process by using urban Indicators only[1] (China’s example 1, and Taiwan’s example).

[1] The urban indicators are considered one of the recent tools for the urban management. The urban indicators are tools for analyzing and making policies. The urban indicators’ idea has emerged since the

b. Examples that perform the assessment process by using PSSs or SPSSs, which are classified into two categories:

- The first category is SPSSs, which are based on a GIS software, which can be in the form of an extension within a GIS software or through integration of the GIS software in the assessment steps of the (S)PSS. This category is also divided into two types:
  - The first type is PSSs or SPSSs designed especially for definite cases or study areas. This type includes:
    - PSSs or SPSSs, which are applied on urban land (Iran’s example, Australia's example, and China’s Example 2).
    - PSSs or SPSSs, which are applied on rural land (Cyprus’ example).
  - The second type is PSSs or SPSSs, which can be applied in various cases. This type includes:
    - PSSs or SPSSs, which are commercial software (non-open source) (INDEX).
    - PSSs or SPSSs, which are open source software (USA’s example).
- The second category is PSSs, which are not based on a GIS software (the Netherlands’ example).

c. Examples perform the assessment process by using a prototype for a PSS or SPSS (India’s example).

Each example will be studied with regards to the following points:

- Objective/s.
- Research problem.
- Focus/ major Issues.
- Methodology/ approach.
- The developed or used tools (techniques / model / system / methods).
- Scale of application or study.
- Tasks achieved (evaluate definite state / forecast future scenarios / identify directions or alternatives for future).
- The state on which the assessment process is done (current state/suggested or planned state).
- The learned lessons from the example to be guides in the field of sustainability assessment.
- Discussion for identifying the strengths and weaknesses in the example

The next figure shows the chosen guide examples and their classifications with regards to the two previously mentioned classifications.

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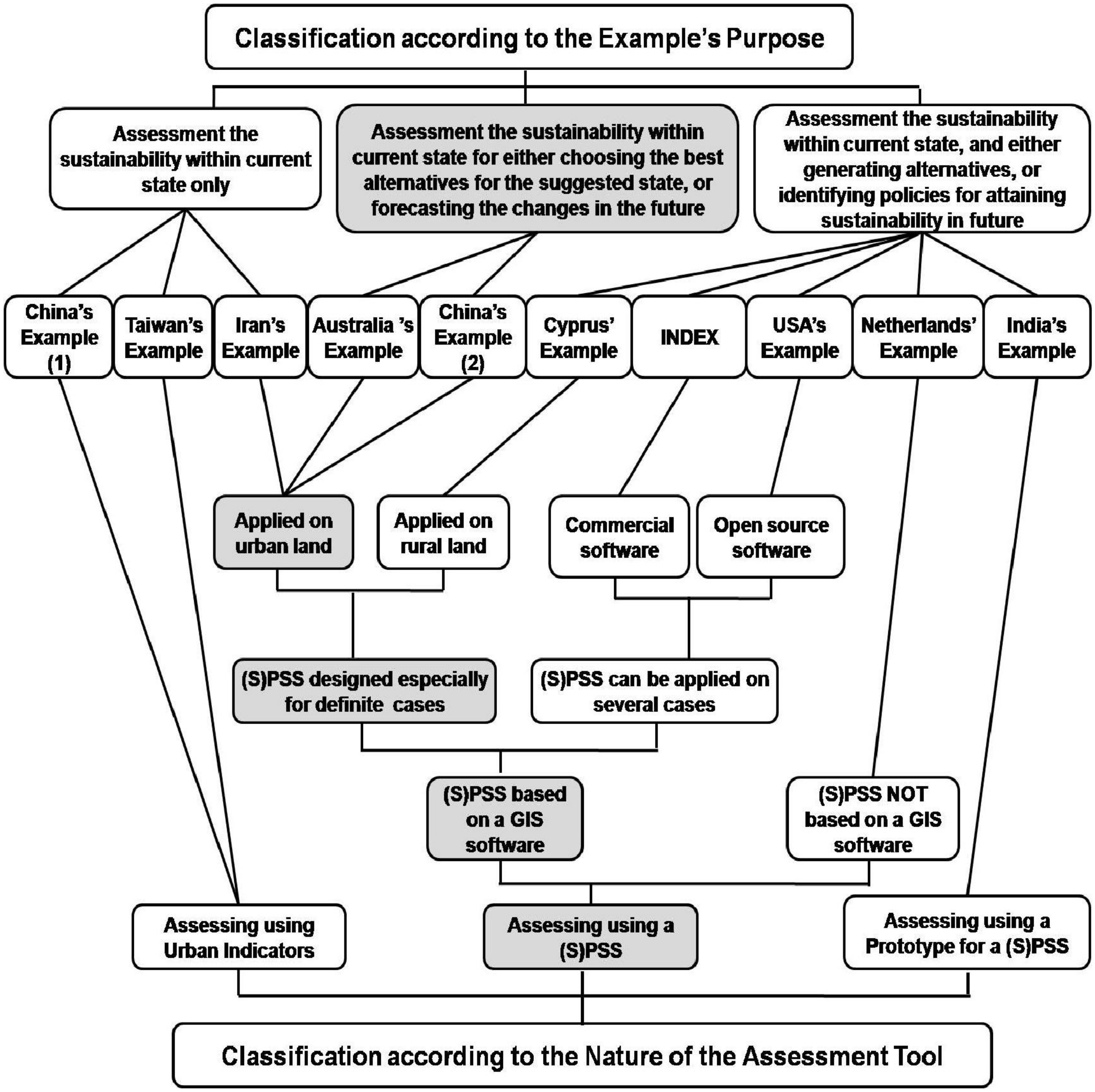
late 1960s in Europe in the form of economic and social indicators. Since then, it has significantly developed, and so the usage of the indicators has been widened to include many fields, so that urban indicators are now applied in many fields and on various urban levels. (Ghattas 2010, p.43).

Fig. (5.1) The chosen guide examples and their classifications according to each of the purpose of the example and the nature of the assessment tool used in the example[2]



Source: by own

(5.2) China's Example (1):

This example has been chosen not only as an example for using urban indicators in assessing sustainability attainment in urban land-use planning. But also in this example, the urban indicators were used in assessing the current state of sustainability attainment on the local level of cities. And this is the proposed goal from this dissertation (assessing sustainability in the land-use planning in the Egyptian cities). Moreover, this example has worked on the existing Chinese cities (old cities) like the existing Egyptian cities, which are the target of this dissertation.

2 N.b: The grey shapes are types of tools within the focus of this dissertation (the proposed SPSS).

(5.2.1) Objectives of China's Example(1):

The main objective is to establish an approach for urban land-use assessment to improve the efficiency of the land use management (Zhang et al. 2011, p.141). This is through establishing what is called Evaluating Sustainability in Urban Land Use- ESULU and Sustainable Urban Land Use Evaluating System-SULUES. These can support the decision makers with information concerning the state of the sustainability attainment in urban land-use. They also identify directions for policies and actions required to attain sustainability in the land-use planning process through the obtained assessment results (Zhang et al. 2011, p.147).

(5.2.2) Research Problem of China's Example(1):

The research problem is the rapid urbanization that leads to the continuous loss of agricultural land to satisfy the urban requirements from these lands. The natural and agricultural landscapes have been converted to urban landscapes, which is one of the most pressing problems facing cities, according to the Habitat II Agenda. As this leads to many consequences like inappropriate land-uses, informal tenure, and urban congestion. (Zhang et al. 2011, p.142).

As in case that the rapid urbanization continues, this will lead to serious environmental, social, and economic problems. At the same time, any shortage in the monitoring and evaluating processes for the sustainability of urban land use will increase these problems. (Zhang et al. 2011, p.141).

Due to the rapid urbanization in China that has happened in the 1990s-2000s, the landscape has totally converted (Zhang et al. 2011, p.142). The absence of the quantitatively measuring indicators has been a real obstacle in front of the sustainability assessment process for urban land use. (Zhang et al. 2011, p.143).

(5.2.3) Focus/Major Issues of China's Example(1):

The main issue in this example is the policymakers' need for a quantitative measurement way for the sustainability of urban land-uses. This is to determine each of problems facing sustainability of urban land-uses and the effective strategies to deal with these problems. Therefore, an indicator framework was applied for this purpose. The indicators can measure the sustainability and the regional differences in attaining it within the urban land-use management among various Chinese cases (Chinese capital cities and municipalities). (Zhang et al. 2011, p.142).

(5.2.4) Methodology/ Approach of China's Example(1):

The framework for the sustainability indicators in the SULUES is based on 13 indicators, which are divided into 4 groups. These were extracted through literatures in the field of assessing sustainability and consulting with a group of experts in this field. As the Principal Component Analysis-PCA was applied to help in identifying the main factors affecting the process of evaluating the sustainability of urban land-use planning. (Zhang et al. 2011, p.141). The methodology includes the following stages:

First stage: the sustainability indicators selection and data collection: (Zhang et al. 2011, p.143)

In this stage the indicators that can demonstrate the effects of urban land-use planning on sustainability were identified according to the previous literatures through a coherent conceptual and analytical framework, which covers various sustainability aspects. This is to give the needed understanding for the sustainability of urban land-use as theory or concept. This framework is called Framework for Evaluation Sustainable Land Management-FESLM, (which has been already used in various experiences before).

FESLM is based on 5-axis assessment guidelines for the sustainable land use management field, which include sustainable land use issues. However, the unique circumstances of China have been considered in applying these guidelines in selecting the appropriate indicators for measuring sustainability of urban land-use. The team members have cooperated with 15 practitioners and academics in the field of land use management, in order to perform the pilot study for the SULUES. These practitioners and academics have evaluated (in their interview with the team work of this pilot study) the appropriateness of the selected indictors. This is in order to comprehensively cover the four main issues of sustainability of urban land-use planning of the Chinese cities. These are the economic, social, environmental, and urban land-use structure issues. This is with the special focus on the target of attaining the rational distribution of urban land-use structure in China.

Then the data is collected, and so structuring these indicators according to definite criteria (or selection principles), e.g. easiness in applying these indicators and their cost efficacy of the data provision process for them.

<u>Second stage: the Principal Component Analysis-PCA and the Indicators Calculation:</u>

In this stage, the PCA method was applied through experts consultation. This method aims at finally obtaining a small number of comprehensive variables (components) that will replace the large number for the original variables affecting sustainability in urban land-use. And so, the data-structure is simplified without losing much of the original data information. (Zhang et al. 2011, p.144).

It is known that the indicators values are aggregated to form indices, but in this example the indicators values have been aggregated through definite equations using weights to form three factors to calculate the comprehensive value for the sustainability assessment for each city. The three factors (or what are called principal components) have taken three definite eigen-values[3] through experts consultation. These factors are the urban land-use social-economic potential factor, the urban land-use structure factor, and the urban land-use ecological environment constraints factor. (Zhang et al. 2011, p. 144-145).

<u>Third stage: the ESULU (SULUES) grouping analysis:</u>

After the identification of the principal components or the factors and the indicators included in each, the last stage began. This was intended to execute the group analysis or group classification for identifying the sustainability level of urban land-use planning of the cases. This is based on the results of the calculated indicators and factors for each city. So, the Chinese cites were classified into four classes according to definite criteria or what are called "the loading of three principal factors".

For example, the first class includes two probabilities. In the first probability, the loading of three principal factors are: Factor 1> 0, Factor 2> 0, and Factor 3 >0. This means that the three

3 <u>Eigen-values</u>: are a special group of scalars (or graded values) connected with a linear equations system (a matrix equation). The Eigen-values are also called characteristic roots, or characteristic values, or proper values, or latent roots. (Welfarm- Math World website, 2017)

factors results are more than zero, i.e. the three factors have a high probability towards sustainability. So, the loadings of the principal components or factors are (H,H,H). In the second probability, the loading of three principal factors are: Factor 1> 0, Factor 2> 0, while Factor 3 <0. So, the loadings of the principal components or factors are (H,H,L), and so on, the other three classes include the other possible probabilities for the three factors. (Zhang et al. 2011, p.145).

(5.2.5) Developed or Used Tools in China’s Example(1):

A number of 13 sustainability indicators embedded in the SULUES are the used tools, which are developed with the principal component analysis for obtaining comprehensive variables (components).

(5.2.6) Scale of Application of China’s Example(1):

The scale of application is the city level for the capital cities and municipalities in China.

(5.2.7) Tasks Achieved in China’s Example(1):

The main task is to evaluate the current state for sustainability attainment in the land-use structure in the Chinese cities.

(5.2.8) The State on which the Assessment Process is Done within China’s Example(1):

The SULUES has dealt with the current state for the land-use structure in the Chinese capital cities and municipalities.

(5.2.9) The Learned Lessons from China’s Example(1):

1.The cooperation with those local practitioners and academics gives the opportunity to benefit from the assessment results. As they help in identifying the appropriate recommendations to attain the sustainable urban land use development according to their experiences with the Chinese cites. (Zhang et al. 2011, p. 143).

2.Using the indicator approach is significant in identifying the directions of the development goals, evaluating the development performance, and allowing contact among each of the policymakers, experts, and public. This is to reach an understanding of the sustainability of land-use concept. This approach has been successfully adopted in the process of city management, land-use planning, and the environmental issues in various cities and regions with different needs and goals. (Zhang et al. 2011, p. 142).

3. Some of indicators used in this example can be beneficial by applying from them in the application of assessing the sustainability in the urban land-use in the Egyptian cities according to their appropriateness for the Egyptian circumstances. (Zhang et al. 2011, p. 147).

4. The grouping analysis of the factors results is a feasible method.

5.The FESLM (indicator framework) that was used in ESULU is comprehensive for all aspects required for assessing sustainability of urban land-use. It includes social, economic, and environmental aspects[4]. The procedure of using the PCA with the indicators group is considered rational. As the PCA identifies the three principal components, which are embedded in the comprehensive sustainability concept. Therefore, assessment of these components reflects to what extent the sustainability is attained in the process of the urban land-use planning in the

4 However, not all the environmental parameters were covered.

Chinese cities. Then, the grouping analysis classifies these cities into four categories for the degree of sustainability attainment in urban land-use. (Zhang et al. 2011, p. 147).

Therefore, ESULU can be considered a good theoretical basis for formulating efficient policies for managing the urban land-use process in a way that attains sustainability in urban land-use planning.

(5.2.10) Discussion on China's Example(1):

(5.2.10.1) Strengths of China's Example(1):

- The integrated land-use planning that can thoroughly assess the three axis of sustainability and the rationality of land use skeleton is beneficial for the local governments for formulating the zoning strategies. These are seen as very important for the local government for managing the urban land use development in order to design all the land resource types. And at the same time, these strategies can support the preservation of the open areas and prevent the loss of agricultural land resources. (Zhang et al. 2011, p. 147).
- The indicator approach is efficient in assessing the sustainability state in urban land use, and so supports the efficiency of land use management process. The assessment results have provided the central and local government in the Chinese cities with recommendations. These results have also supported the identification of the appropriate policies for attaining the sustainable development in the urban land use and planning process. (Zhang et al. 2011, p. 141).
- Many previous experiences have mainly concentrated on assessing sustainability of land-use in agricultural areas. And even experiences, (which have dealt with the urban areas), have established definite assessment frameworks that can only address the issues of the three sustainability aspects as a whole on the national level only. A few experiences have dealt with the urban areas by using a comprehensive tailored assessment framework that easily assesses the sustainability of urban land-use on the urban city level. This Chinese study is considered one of these few experiences. (Zhang et al. 2011, p. 142).
- The PCA method has allowed the combination between indicators with different units. For example, there is an indicator for "per capita cultivated land" with measuring unit "hectare", and another indicator for "total land area" with unit "sq. km".

(5.2.10.2) Weaknesses of China's Example(1):

- There is no equivalent balance among the three factors. The first factor "urban land use social-economic potential factor" has the greatest influence with respect to the other two factors "urban land use structure factor" and "urban land use ecological environment constraints factor". The cities with a higher score in the first factor have been considered as having more sustainable land-use. (Zhang et al. 2011, p. 145). This reflects that the focusing was on the economic and social issues, while the urban land-use structure and the environmental issues were not priorities in assessing the sustainability in urban land-use planning.
- The environmental indicators have not covered all the environmental issues (only the solid wastes and environmental pollution treatment). And there were no indicators

measuring the noise levels, the water pollution, the air pollutants, and other environmental parameters.

(5.3) Taiwan's Example:

This is another example for using urban indicators in assessing sustainability. This example has been chosen not only as an example for using urban indicators in assessing sustainability attainment, but also these indicators were used in assessing the current state of the city level. Also the methodology used in this example is simple and easily programmed in the frame of a system.

(5.3.1) Objectives of Taiwan’s Example:

The main objective is to establish a system for “Taipei” sustainability indicators, which consists of 51 sustainability indicators. This is in order to evaluate the environmental, social, economic, and institutional conditions in Taipei, as well as determining the trend of sustainable development from 1994 to 2004 (Lee and Huang 2007, p.505). It also aimed at supporting the decision makers with thorough information concerning each of the environment preservation and welfare restoration of population. (Lee and Huang 2007, p.519).

(5.3.2) Research Problem of Taiwan’s Example:

Taiwan is considered an area of natural disasters, and is affected by many negative effects caused from continuous environmental changes due to globalization, international economic growth, and the climate change. This opposes the attainment of the sustainable development because the rapid economic growth leads to the consumption of the earth's resource capacity. So, the concept of sustainable development should include the target of maximizing economic growth, at the same time accompanying with the assessment of the ecological or environmental impacts of this economic growth. All the previous show the need for the assessing and determining of the sustainable development trend in Taiwan in general and in Taipei in particular. (Lee and Huang 2007, p.506).

(5.3.3) Focus/Major Issues of Taiwan’s Example:

The main issues that structure the framework in this example are: (Lee and Huang 2007, p.508)

- “What will happen without sustainable development?”
- “What is sustainability?”
- “How to assess sustainability?”
- “What are the influences on sustainability?”

(5.3.4) Methodology/ Approach of Taiwan’s Example: (Lee and Huang 2007, p.510-518.)

The framework for the sustainability indicators' system for Taipei is represented in the “3E1I” framework. As the "3E" represents the three axis of sustainability, which are "Economic efficiency", "Equity", and "Environmental preservation".

The sustainability index is formed from the composite indicator values of sustainable development, which are calculated for the four sustainability dimensions (economic, social, environmental, and institutional dimensions). A set of 51 indicators forming the composite indicator values of sustainable development. This approach helps in assessing the trend towards sustainability as a whole. At the same time, it helps to determine which dimension affects the sustainability positively and which affects it negatively. Therefore, this approach supports the decision making process, and gives the citizens the opportunity to easily understand the progress within sustainable development in a tangible and quantitative way.

There are three main stages for establishing the Taipei sustainability index. These are the simplification of indicators' results, the calculation of the four dimensions of the sustainability index, and the calculation of the overall sustainability index, as follows:

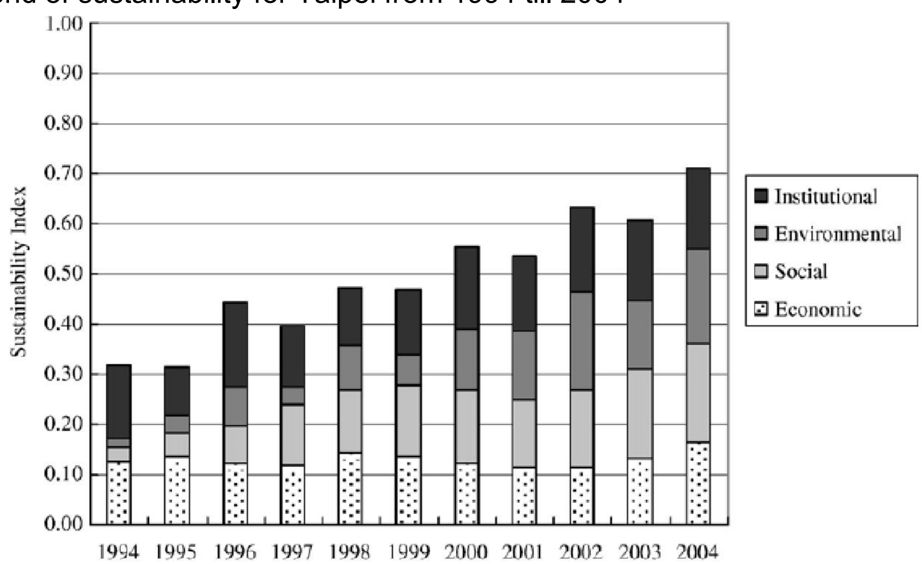
First the Simplification of Indicators' Results: The simplification of indicators means the standardization of different indicator values[5] to express the sustainability of individual indicators with definite and simple numbers. As the indicators' values have various units, and so unifying these values through simplification allows comparisons between indicators.

Second the Calculation of the Four Dimensions of the Sustainability Index: In order to calculate each of the four dimensions forming the sustainability index, a weighting process[6] was applied on the results from the first stage to perform an initial integration and analysis for the overall sustainability trend. There are two methods for applying any weighting process. The first is the non-equal weights method. And the second is an equal weights method. So, each dimension of the four dimensions has been calculated through just taking the average of all the standardized values of the indicators within this dimension.

Third the Calculation of the Overall Sustainability Index: In which the overall sustainability index is calculated through the values of the four dimensions forming the sustainability index.

The analysis of the results has revealed that the sustainability index for Taipei has gradually increased year by year. This indicates that the urban construction that has been performed during these years has helped in attaining a move towards sustainable development as shown in the next figure.

Fig. (5.2) Trend of sustainability for Taipei from 1994 till 2004



Source: Lee and Huang 2007, p.518 (reprinted with permission from Elsevier)

5 The standardization of indicators values are making these values lie between 0 and 1.

6 There are many available methods for calculating composite index weighting, and every method produces different results, (e.g. the Delphi Technique, Analytical Hierarchy Process-AHP, and Multivariate Analysis and Grey Theory).

In the analysis of the results, it was interesting to see that the social and environmental dimensions are moving towards sustainable development, whereas the economic and institutional dimensions have produced relatively poor results. It is worth mentioning that the economic sustainability index has gradually moved towards sustainable development since 2002, but the overall sustainability index shows a gradual trend towards sustainable development during the 11 years from 1994 to 2004.

(5.3.5) Developed or Used Tools in Taiwan’s Example:

A set of 51 indicators forming the composite indicator values of sustainable development are the developed tools. The standard deviation method has been applied as the basic method for calculating the sustainability index in this study and a weighting method for calculating the sustainability index (equal weights for all indicators).

(5.3.6) Scale of Application of Taiwan’s Example:

The scale of application is the city level.

(5.3.7) Tasks Achieved in Taiwan’s Example:

The main task is to evaluate the trend towards attaining sustainability over a period of 11 years, in order to evaluate the current progress towards sustainability.

(5.3.8) The State on which the Assessment Process is Done within Taiwan’s Example:

The current state for sectors affecting the four dimensions of sustainability in Taipei. (Lee and Huang 2007, p.519).

(5.3.9) The Learned Lessons from Taiwan’s Example:

1. Some of the indicators can be used as a guide for identifications of urban indicators for assessing sustainability in the land-use planning process in the Egyptian cities.

2.The methodology is beneficial as a guide for the proposed system in this research.

3. How to determine which dimension is moving towards sustainability, and which is moving away, and which aspects within each dimension should be focused on.

4. Within the methodology of this example, the trend of each factor assessed by each indicator (either towards or away from sustainability) is analyzed. This helps in adjusting the values of the indicators in the calculation of the sustainability index by reversing the values of the indicators, which their factors’ are moving away from sustainability, and so obtaining accurate results.

5. The idea of the simplification of the indicators values through the standardization of different indicator values allows the sustainability in each factor to be assessed by each indicator with a definite and simple number. Also, the simplification of indicators (with various units) allows unification of these values, and so provides more logical comparisons between factors affecting sustainability.

(5.3.10) Discussion on Taiwan’s Example:

(5.3.10.1) Strengths of Taiwan’s Example:

- Simple methodology used in calculating the sustainability index.
- The preparation of the sustainability index helps in attaining the balance between the environment and the human inhabitance. (Lee and Huang 2007, p.519).

- The sustainability index supports decision makers with a kind of comprehensive information regarding the preservation of the environment and humanity or social affairs for the residents of the study area. (Lee and Huang 2007, p.519)
- The methodology used in the sustainability evaluation (through assessing the four dimensions that affect it over a period of time) helps in deducing which dimension is moving towards sustainability and which is moving away. So, the decision maker can know the point of concentration in the development plans beginning with the dimensions moving away from sustainability especially the factors or aspects within these dimensions. As these aspects had bad results in the indicators measuring them. Also, the decision maker can deduce which dimension is improving by time and which is static. For example, the results of the sustainability assessment of Taipei have shown that the economic and environmental dimensions have gradually shifted towards sustainable development, whereas each of the social and institutional dimensions have remained relatively static. However, since 2002, the social dimension has also shifted towards sustainable development. (Lee and Huang 2007, p.519).

<u>(5.3.10.2) Weaknesses of Taiwan's Example:</u>

- This study has not covered all service types in the social dimension assessment. For example the medical, commercial, and administrative services. The infrastructure networks (like communication and the roads network) and accessibility to services have not been assessed in this study.
- This study has not assessed to what extent the sensitive uses (like residential and medical uses) are isolated from the industrial areas.
- The usage of a weighting method for calculating the sustainability index that depends on equal weights for all indicators is sometimes misleading. As not all the aspects have the same degree of significance with regards to the sustainability attainment.
- Some weak points are mentioned according to Lee and Huang: Lee and Huang 2007, p.519

  1.This study lacks the long-term indicators mechanism in assessing the sustainability. As the changes in time and space are essential in achieving sustainability goals from the urban development perspective. Also, the sustainability indicators should be dynamic, in order to cope with changes in policies actions. This means that these indicators ought to be revised every three to five year intervals, in order to re-evaluate their suitability. And so, these indicators can be adjusted to reflect changes in policy actions related to urban development and government strategy.

  2.This study did not allow comparisons of sustainability indicators with other countries, as the comparisons are important for providing the citizens with a global perspective on their city. Commonly used calculation methods by other countries had to be considered in this study to allow comparisons of sustainability indicators. However, this may represent a difficulty for the local citizens, who may have difficulty in interpreting the type and degree of the importance of some kinds of data. So, it was recommended to apply the commonly used calculation methods by other countries in case of the accessibility or the availability of the required data for these calculations.

3.The sustainability index developed in this study has not given an absolute and precise evaluation for the performance of Taipei towards sustainable development. It has not precisely indicated the point at which Taipei has actually attained goals of sustainable development. This study has only provided an indication for whether Taipei has attained any progress towards sustainable development during the past 11 years, or not. However, this study has succeeded in identifying which indicators (from the 51 sustainability indicators in the four sustainability dimensions) indicate possibilities for moving towards or away from sustainability. This can be the base for concrete policies that focus on aspects, where the progress towards sustainability is not realized.

4.The sustainability indicators and index ought to be published for public and citizens through an open and real time information system. This is to enable citizens to know about the progress towards sustainable development at anytime, so that they can intake an active role in helping the city administration achieve the sustainable development. As each of the good governance, transparency, reliability, as well as submissiveness to the agreements, requirements, and rules are significantly important for developing the projects of sustainable development. This is along with formulation of environmental policies and strategies for resource management.

(5.4) Iran's Example:

(5.4.1) Objectives of Iran's Example:

The general objective was the attainment of the spatial equity to support the sustainable urban planning. This is through assessing the spatial equity and balance between the demands of the residents in the residential areas and the supply provided by different types of services on one geographical scale. The balance between the same type of services on different geographical scales is also assessed. So, in order to attain this general objective, a multifunctional or multi-scale equity evaluation framework has been established to obtain an absolute measure of spatial equity at parcel level. (Taleai et al. 2014, p.56)

(5.4.2) Research Problem of Iran's Example:

The rapid urban growth in the cities of the developing countries has put a strain on the recourses of the local authorities, who cannot cope with this rapid growth providing the essential infrastructure and social facilities for the residents in these cities. The problem is not only the insufficiency of the infrastructure and social facilities but also the unsuitability of their spatial distribution or what is called "the inadequacy of supply". So, the spatial equity problem consists of two aspects, the first is the spatial distribution of facilities with regards to the spatial distribution of demand. And the second is the inadequacy of supply in an aggregated way, (i.e. the total supply with respect to total demand). As it can happen that the supply is adequate but inequitable or vice versa. (Taleai et al. 2014, p.56).

(5.4.3) Focus/Major Issues of Iran's Example:

The following issues have been discussed in this study (Taleai et al. 2014, p.57):

- The relations between different urban land-uses types (e.g. residential and recreational land uses) and how to model these relations.
- The assessment of minimum service standards as the base for equity modeling.

- The modeling of the trade-offs among different services at various geographical scales (local, district, city, and regional) in the equity evaluation process: As different demands for services emerge on various services' levels. This means that the presence of a definite level of any services may not compensate the absence of another level from the same service. E.g. a single household may need educational services from preschool, primary, and secondary levels, or health services from primary care to the high-cost inpatient care in a general and specialized hospital.

  Thus, although there is an available support from a service in a higher or lower level of this service to some extent, this may or may not compensate the need for other levels from this service. For example, if there is a clinic (as a district-level medical opportunity) that provides primary health services. The shortage in local-level medical services is compensated by district-level medical land uses such as clinics. However, the shortage of local-level education services (primary school) cannot be compensated by higher level educational services like universities. Therefore, the trade-offs among different services on various geographical scales may be suitable for some types of services, which their various levels can compensate each other like health services or commercial services but not for other services like educational services.

<u>(5.4.4) Methodology/ Approach of Iran's Example:</u>

This study is based on the Integrated Spatial Equity Evaluation framework-ISEE, which includes five main stages. These stages are the geo-database establishment, definition of evaluation factors, equity modeling of each opportunity or facility (service), policy development and ISEE, and geo-visualization of equity and policy evaluation.

<u>The First Stage: Establishment of the Geo-database</u>:

This is for the data gathering and entering within the geo-database. This data includes the demographic data (parcel level), the land-use type in each parcel (at least the dominant land-use type), the administrative boundaries (neighborhoods, districts, and municipality regions), the current streets or roads network data, and facilities or services, or what is called "opportunities" parcels. (Taleai et al. 2014, p.58).

<u>The Second Stage: Definition of Evaluation Factors</u>: (Taleai et al. 2014, p.58,59)

In this stage, the factors used to evaluate the spatial equity of services distribution are defined. The first factor concerns the supply from services, or what is called ''service area distance'' or ''catchment distance''. This evaluates to what extent the supply from services is accessible, which is measured in terms of costs required to travel from a facility parcel to a residential parcel. This includes distance, travel time, or travel cost. This factor is called "Cost of Travel" (CoT). The ''deactivate CoT'' is considered the maximum cost (distance / time / money), which is affordable for people to travel to a facility parcel. The ''optimum CoT'' is considered a reference cost to travel to a facility parcel. This means that the residential parcels with a CoT lower than the ''optimum CoT'' are fully accessible. Therefore, there is a reversible relation between the accessibility to any service and the CoT for it, i.e. the accessibility to any service equals zero at the deactivate CoT.

The second factor concerns the demand to any facility or service (opportunity) from the population or the residents of the study city or area. The indicator called ''Land Per Capita''

(LPC) is used for measuring the demand from services. LPC value indicates how much area of land is used for specific land-use type (service) on each geographic scale per capita or person. It is calculated by dividing available land area by the served population, so LPC determines the area shortage in each service type considering minimum service standards. The ‘‘Optimum LPC’’ specifies a LPC value that satisfies the standards, which are identified by planners (after considering the shortage in funding to provide all the services the people need).

CoT and LPC have been used as evaluation factors for ISEE. They have also been identified for the study area based on studies and standards that the urban planners have agreed upon through the top-down approach. This means that the evaluation was not based on a collaborative process with stakeholders.

The Third Stage: Equity Modeling of each Opportunity or Facility (service): (Taleai et al. 2014, p.59,60)

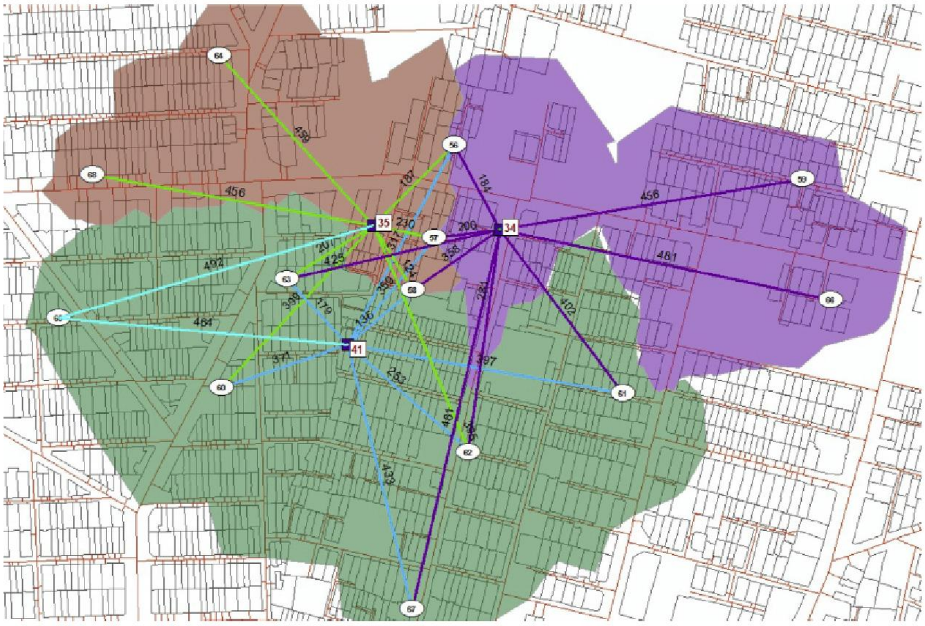
In this stage, the spatial accessibility of each opportunity land-use type is calculated in three steps based on the two previously mentioned evaluation factors (LPC and CoT).

Step1: An opportunity type (e.g. children’s park) is selected. Then, what is called "service area" for the selected opportunity parcel is determined. This is done through the identification of a cut-off value or the deactivate CoT value according to standards determined by planners and the shortest path analysis in the current streets network. As this "service area" is considered the area, in which the selected opportunity parcel is accessible, as the opportunity parcel is in its center (the next figure shows examples for service areas). Then, the LPC is calculated through dividing the area of the selected opportunity parcel by the sum of the population living in the residential parcels located within the service area. Afterwards, the other opportunity parcels of the same type are identified, and the first step for each opportunity parcel is repeated.

As the optimum LPC varies from one opportunity type to another, a normalization process is done to make comparisons among various opportunity types and performing an aggregation of equity values. The normalized LPC is calculated by dividing the LPC value by optimum LPC to obtain NLPC. This is repeated for all available opportunity parcels with the same opportunity land-use type.

Step2: In order to calculate the accessibility for each residential parcel, a residential parcel is selected. Then, all opportunity parcels (with definite land-use type like parks that the selected residential parcel is located within their deactivate CoT) are selected. Next, using network analysis, the CoT between each selected opportunity parcel and the selected residential parcel is calculated. As the deactivate CoT varies from opportunity type to another, the CoT is normalized by dividing it by the "deactivate CoT" of the same type of opportunities to obtain NCoT. The next figure shows the paths between residential parcels to opportunity parcels.

Fig.(5.3) Distribution of selected residential parcels and their links to opportunity parcels within the service areas[7]



Source: Taleai et al. 2014, p. 62 (reprinted with permission from Elsevier)

Then, an aggregation process (using a definite equation) for calculating the accessibility value for the selected residential parcel is done. This is using variables representing each of the supply NCoT (step2) for the opportunity type and the demand NLPC from the opportunity type[8] (step1). Then this process is repeated for all residential parcels.

Notice: There is an equation, which was used for obtaining the accessibility value for any residential parcel placed in a definite location with respect to the selected opportunity parcels that the residential parcel placed within their deactivate CoT. However, this equation can be replaced by a comprehensive accessibility model including multimodal and multidimensional transport issues considering the social, cultural, and gender characteristics in the study area.

Step3: a normalized or absolute value of equity or accessibility ''e'' is calculated for all the accessibility values of all the residential parcels obtained from the second step using another definite equation. This value is used to determine to which extent there is a balance between demand and supply based on the norms and service standards. So, if ''e'' > 1, this means that the residential parcel is oversupplied, 1 means balance of demand and supply and <1 means undersupplied.

Then, all the three steps in the third stage are repeated with all the other opportunity types. The results of the third stage have shown the degree of each of inequity and inadequacy. As some opportunities may be provided in an equity way to the residential parcels, (i.e. the normalized LPC for these opportunity parcels are more than optimum LPC). However, at the

7 The squares are the opportunity parcels and the circles are the residential parcels.

8 N.b.: a lower value of CoT between a residential parcel and opportunities units results in a higher score of accessibility value for the residential parcel. By contrast, a higher NLPC value results in a higher score for the residential parcel.

same time, these opportunities are provided in an inadequate way, (i.e. normalized CoT for these opportunity parcels are more than ‘‘deactivation CoT’’).

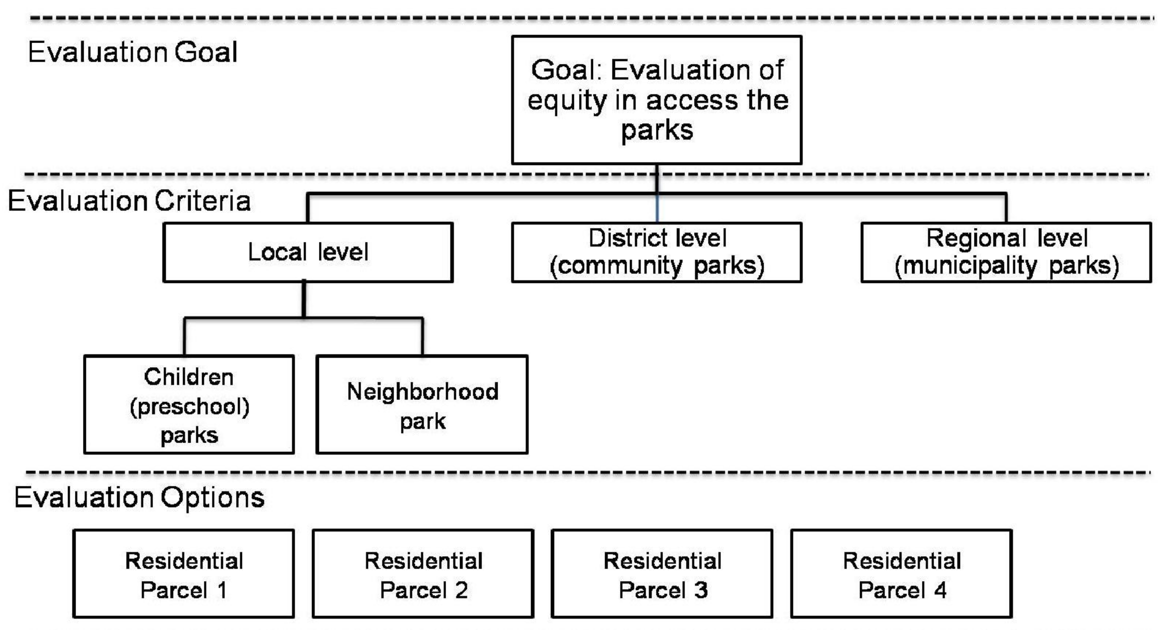
The output of the third stage is represented by a table for each opportunity type. This table consists of several rows, each row is concerned with a residential parcel. It states the CoT and the NCoT for each opportunity parcel with regards to the residential parcel (step 1), the accessibility value for the residential parcel (step 2), and the normalized and absolute measure of equity for the residential parcel (step 3).

The Fourth Stage: Policy Development and ISEE: (Taleai et al. 2014, p.60-63)

In this stage a structured aggregation process is developed using Multi-Criteria Analysis-MCA techniques. This is in order to generate aggregated equity measures for various opportunity types on different geographical scales. The MCA techniques are based on the equity evaluation goal. As this approach supports either equity analysis on different geographical scales for the same opportunity type or for different opportunities on definite geographical scale.

In order to perform what is called the “integrated spatial equity evaluation for opportunities", a hierarchical decision matrix for evaluating the equity and the accessibility of each opportunity type is established. In the matrix, the goal that is “the aggregation of equity values of an opportunity type (e.g. parks) on different geographical scales” is placed at the top. Then, the evaluation criteria for this opportunity type on various geographical scales are in the middle. Lastly, the residential parcels are at the bottom, which are considered as options resulted from evaluating the equity and accessibility to this type. The next figure illustrates the hierarchical decision matrix that aims at evaluating equity in accessibility of children from residential parcels to parks on various geographical scales.

Fig. (5.4) Hierarchical decision matrix for equity evaluation of children's accessibility to parks



Source: Taleai et al. 2014, p. 63 (reprinted with permission from Elsevier)

The geographical levels of this matrix (concerning parks) are (local, district and regional). And according to the minimum standards, the local parks contain two categories, which are the neighborhood parks and children's' parks. So, the three steps of the second stage were done for this opportunity type with regards to the neighborhood, children, district, and regional parks. As each option (residential parcel) in the bottom of this matrix has scored values concerning its accessibility to different levels of this opportunity type.

Moreover, any option (residential parcel) may attain high accessibility values with regards to some opportunities and low values to others. It is known that the degree of importance of each opportunity differs from opportunity type to other according to the degree demand of each opportunity. Therefore, information concerning the preference of each opportunity is required to compare between residential parcels (options) according to the relative importance of the opportunities.

The Analytical Hierarchy Process (AHP) is one of the well known methods that is widely used with the MCA techniques (specifically in GIS). AHP is used in the calculation of the relative preference or importance (weights) among various criteria through pair-wise comparisons of these criteria. The AHP was used in this example to obtain the decision makers' preferences with regards to various opportunities or various geographical scales of the same opportunity. This process is used as a way for compensation for low scores of some criteria by high scores of others providing that the decision makers decide whether trade-offs between different criteria are acceptable, or not. The urban planners have developed a hierarchical structure of the criteria and asked successive questions. This led to the identification of the importance of each criterion with regards to another criterion, so that the weights for the different criteria were calculated according to the results of their pair-wise comparison.

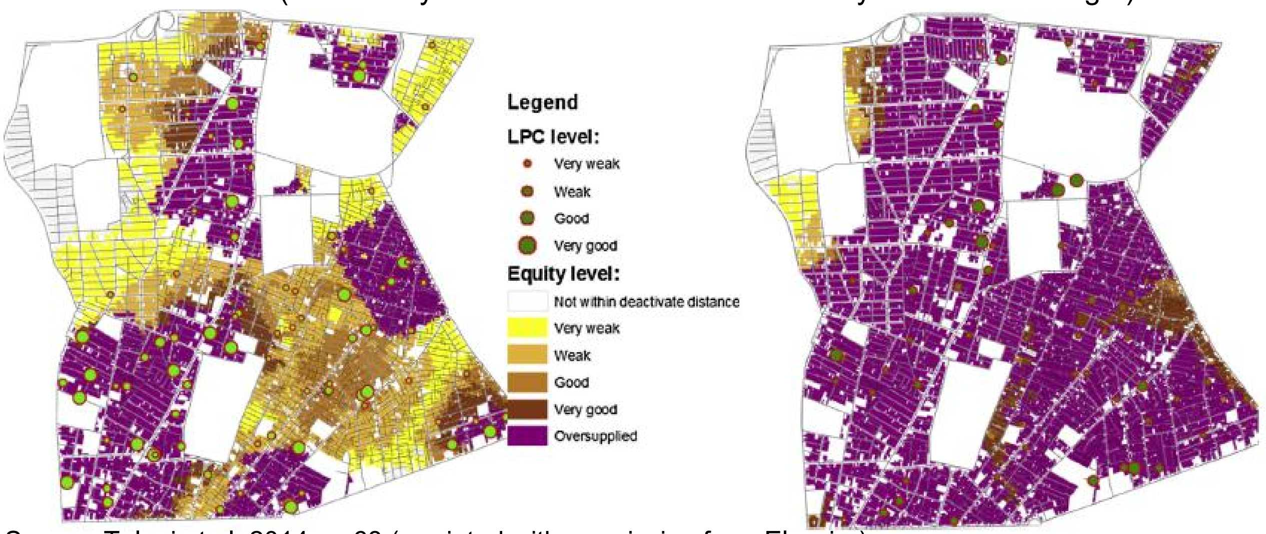
Therefore, the overall or aggregated equity for the first residential parcel "E" with regards to each opportunity type depending on its relative importance on each geographical scale is determined. As this aggregated equity is calculated with regards to the first opportunity type based on decision rules using a general aggregation formula based on weighted linear combination (WLC). This includes the relative weight of this opportunity type and absolute measure of equity for the residential parcel ''e'' resulted from (step 3) in the third stage. Then, repeating that for other residential parcels and with regards to other opportunity types.

<u>The Fifth Stage: Geo-visualization of Equity and Policy Evaluation:</u> (Taleai et al. 2014, p.63-66)

The final stage is the geo-visualization process of the results. This is formulating maps to show the overall or aggregated equity of each residential parcel with regards to each opportunity type resulting from the third stage "e", as well as the overall equity map that is obtained from the fourth stage "E". These maps are visualized to identify various equity aspects for each residential parcel. The overall or aggregated equity "E" is graded into six grades indicating the degree of imbalance between each of the demands on each opportunity and its supply for each residential parcel. The urban planners can then easily determine the parcels with good situations that indicate a sufficient supply offered from opportunities for these parcels, or others with weak situations that indicate a limited supply from opportunities. The six categories are determined based on the overall equity values "E", as follows: <u>Oversupply</u>: E > 1, <u>Very good</u>: 1 ≥ E ≥ 0:75, <u>Good</u>: 0:5 ≤ E < 0:75, <u>Weak</u>: 0:25 ≤ E < 0:5, and <u>No supply</u>: E = 0.

The aim from the resulting maps is that these maps can be easily interpreted by decision makers and planners for checking the spatial equity. For example, the resulted maps show whether there is an oversupply situation of a definite opportunity type on local level or not, and at the same time, if there is undersupply situation of the same opportunity type on district level. Therefore, some of these local level opportunities should be upgraded to fulfill the requirements on district level. Also these maps help the planner to decide which opportunity has the priority to be allocated on definite level or replacing the land-use type of the parcels having an oversupplied opportunity with another opportunity that is undersupplied.

Fig. (5.5) Example for the resulted maps for equity levels of residential parcels to access to educational services (elementary schools at the left and secondary schools at the right)



Source: Taleai et al. 2014, p. 68 (reprinted with permission from Elsevier)

<u>(5.4.5) Developed or Used Tools in Iran’s Example:</u>

The ISEE model (that is based on SMCA technique and GIS) is the main tool in this example. This SMCA includes AHP process.

The inputs of the ISEE model are: (Taleai et al. 2014, p. 58)

- The number of residents in each parcel for identifying the volume of the demand on various facilities types.
- The type of each facility or service, its area, and its spatial or geographical scale for identifying the volume of the supply.
- The minimum service standards for determining the minimum norms for services' supply.

The outputs of the ISEE model are the equity values on parcel level, which are the base for the "thematic parcel based maps". These maps identify the parcels that have problems and determine the under-serviced residents. And so, they help in making recommendations for planning policy. (Taleai et al. 2014, p. 58).

The main characteristics of the ISEE model are: (Taleai et al. 2014, p. 58)

- The accessibility concept is the base for measuring the cost of travel between locations of demands (residential parcels) and the locations for supply (services' parcels).
- Residential parcels are "the subject land-use", and the required services are "the opportunities".
- The spatial scales of services or opportunities are local, district, and regional. The used spatial scales were the local and district scales, which are considered the preferred

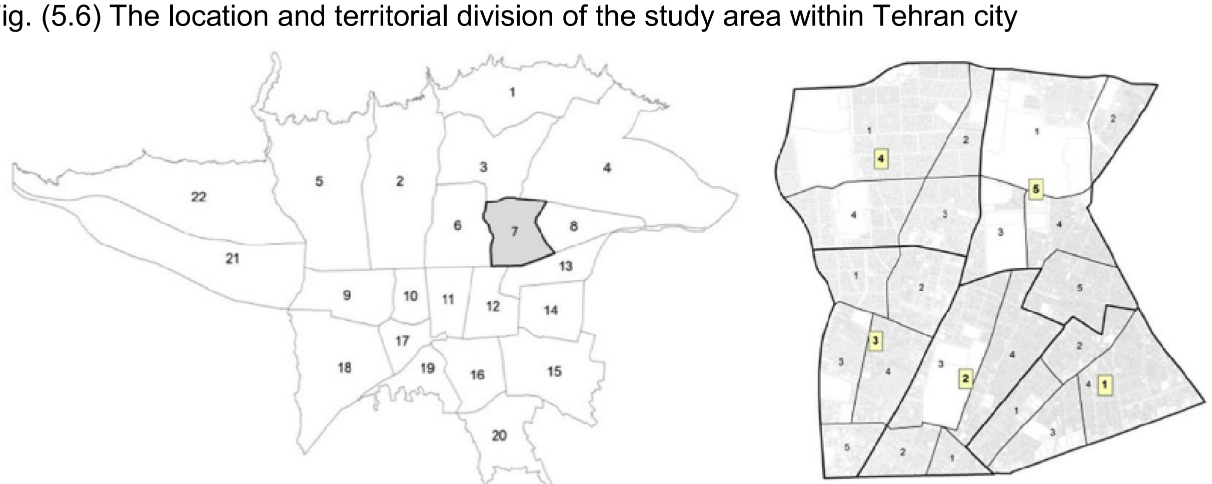
scales for evaluating opportunities for children. The acceptable walking distance was the base for evaluating the accessibility of these opportunities for children. However, other criteria like street design, safety, and terrain that can encourage or discourage the walking activities were not used in the model.

- The trade-offs among various equity values (multi-criteria) for opportunities of various spatial scales were used. However, the results were aggregated to form one indicator to be the base of planning policy formulation.
- The ISEE model is a disaggregated model. The application of the model on the parcel level made it necessary to use the disaggregated accessibility measures. Because these measures are suitable for micro-level spatial planning with small analysis units (like parcel or building) to perform a detailed evaluation of spatial equity. (Taleai et al. 2014, p. 57). The trend towards the disaggregated models has become more popular in many experiences and supported by many researchers like Soora Rasouli and Harry Timmermans, who support the usage of the disaggregated models. (Rasouli and Timmermans 2013).

(5.4.6) Scale of Application of Iran’s Example:

The model has been applied on the 7th metropolitan division, (which contains 5 neighborhoods), as a case study area in Tehran city that contains 22 metropolitan divisions. The next figure shows the location and territorial division of the 7th Metropolitan Division (study area) with regards to Tehran city.

Fig. (5.6) The location and territorial division of the study area within Tehran city



Source: Taleai et al. 2014, p. 64 (reprinted with permission from Elsevier)

(5.4.7) Tasks Achieved in Iran’s Example:

The main task is to evaluate current state for spatial equity of services provision among residential parcels.

(5.4.8) The State on which the Assessment Process is Done within Iran’s Example:

The state of the assessment process is the current state for the services distribution.

(5.4.9) The Learned Lessons from Iran’s Example:

1.The modeling of the spatial equity of services amongst a residential area on the parcel level (detailed land-use planning) using MCA methods based on GIS.

2.How to study the paths between any residential parcel and services parcels using the network analysis.
3.The CoT and the LPC evaluating factors that indicate accessibility and equity among residential parcels in obtaining services.
4.How to identify the locations to allocate the services in the undersupplied areas from these services.
5.AHP for weighting various criteria through consultation with experts.
6.Colored for visualizing results that is easily understood by non-expert people.

(5.4.10) Discussion on Iran’s Example:

(5.4.10.1) Strengths of Iran’s Example:

- The interpretation and visualization potentials in ISEE can support urban planners with information for decisions-making especially decisions concerning the determination of imbalances between the demand and supply of social facilities (Taleai et al. 2014, p.68). There are many benefits that can be gained from this spatial equity investigating like developing two alternative decision matrices for comparing the overall equity values for two definite opportunity types on both district and local scales. The visual comparison of the resulted maps from these two matrices declare which part of the city has the higher priority to be provided by any type of the two opportunity than the other type and on which scale. This visual comparison can also identify the equity values for these two opportunities on the same scale. (Taleai et al. 2014, p. 66).
- The outputs of ISEE can offer a comprehensive and easily interpreted evaluation. ISEE helps users to understand the aspects of the spatial equity issues in either disaggregated or aggregated levels. (Taleai et al. 2014, p. 66).
- The integration among the equity indicators and other parameters such as a mixed use development index provides a rigid base for the evaluation of required social facilities that are proposed through land-use plans. It also provides a base for alternative policies assessments to overcome any shortcomings and imbalances in the social services provision considering the minimum service standards. (Taleai et al. 2014, p. 66).
- There is a potential for establishing equitable policy measures at various geographical scales. (Taleai et al. 2014, p. 66).
- The model is flexible and able to be applied in regional planning with the suitable modifications needed for studying the transport networks and services on this level. (Taleai et al. 2014, p. 66)
- The accessibility of each option (residential parcel) to various opportunities (services) depends on some criteria reflecting the values resulted from the consequences of each option. As there were several values for each residential parcel because of the presence of several probabilities for having several opportunities. This makes the decision problem a multi-criteria analysis problem. As the accessibility of each residential parcel accessibility may be strong to some opportunities and weak for others. Therefore, the usage of a compensatory MCA techniques, such as AHP was successful, as low scores of one criterion can be compensated by high scores of another. However, the decision makers or planners should decide the acceptable trade-offs among various criteria,

which will be aggregated by combining weights and scores for each of the options to obtain an overall equity value at the end. (Taleai et al. 2014, p. 57).

(5.4.10.2) Weaknesses of Iran's Example:

- The usage of the top down approach in identifying the optimum CoT and the LPC for the study area and identifying the relative importance or weights of various services types was not the best approach. The opinions of the residents are beneficial in many cases to show how important each service type represents to them. This can be executed through participatory geographic information systems (PGIS) tools that can detect and deal with conflicts between stakeholders. (Taleai et al. 2014, p. 66).
- As it has been mentioned before, definite criteria, (like street design, safety, terrain, and others, which can support the walking activities, were not used in the model. (Taleai et al. 2014, p. 58).

(5.5)The Example of Australia:

(5.5.1) Objectives of Australia's Example:

The general objective is to provide an integrated sustainability assessment framework by incorporation of all related domains affecting urban sustainability, (i.e. demography, land-use, environment, transport, and infrastructure). This incorporation is done within an assessment method through "SILENT Model", (its name is based on "the Sustainable Infrastructure, Land-use, Environment and Transport Model"). This model supports planning and decision making processes through assessing the current comparative levels of urban sustainability and forecasting future scenarios by using simulation. And so, it can evaluate the effects of these scenarios on sustainability. (Yigitcanlar and Dur 2010, p.333).

(5.5.2) Research Problem of Australia's Example:

The main problem is unsustainable urban development resulted from the unmanaged interrelations between each of the urban form, transportation, and infrastructure and their impacts on the environment (Yigitcanlar and Dur 2010, p.324). There is a need to know how to determine and evaluate the interrelated qualities in the sustainability to identify the interventions needed to attain more sustainable communities (Yigitcanlar and Dur 2010, p.326). As there are few available sustainability assessment methodologies, or models, or tools, and there are almost no integrated approaches including all the sustainability aspects, (the environmental, economic, and social aspects). As in most cases, the focus is on one of the three aspects. So, despite the argument of some researchers that all sustainability aspects work as supplementary to each other, the sustainability is still considered an aggregation of all these aspects. And so, there is an urgent need to study the inter-relations and the dynamics among them. (Yigitcanlar and Dur 2010, p.332).

(5.5.3) Focus/Major Issues of Australia's Example:

The main focus is on the sustainability indexing model based on GIS with regards to the infrastructure, land-use, environment, and transport.

(5.5.4) Methodology/ Approach of Australia's Example:

The SILENT Model was established through the following four logical steps: (Yigitcanlar and Dur 2010, p.325)

1. An appropriate measurement approach for assessing the urban sustainability was chosen, which is an indicator-based sustainability approach. This approach is characterized by its

conceptual consistency and practical simplicity. The performance indicators used in this approach were selected based on the existing planning schemes, so that these indicators could express the local sustainability concerns. These indicators are called "Gold Coast City Planning Scheme's Sustainability Indicators".

2. The parameters affecting sustainability were identified, and so deciding the main indicator categories that include indicators sets. These sets consist of the individual indicators to perform the measurement of the comparative sustainability levels of the urban structure. The analysis process in the model is based on the concept of the composite impacts from the interrelationship of transport and infrastructure on the urban form and the environment.

3. The resulted values of each set of individual indicators were aggregated to form a composite index. This is through determining a weight for each individual indicator in its set based on the relative importance of the parameter measured by the individual indicator. As the determination of the individual indicators' weights was done through a number of statistical procedures, and the analysis (done by the model) is based on a multivariate analysis technique. A stepwise regression method was also performed to identify the most appropriate indicator sets to determine sustainability levels.

4. The model outputs were obtained, which are the spatial sustainability composite index values. These values include the current comparative levels of urban sustainability, so that they were the base for the benchmarking and policy making processes. And so, the effects on sustainability resulted from various alternative development scenarios were forecasted.

The SILENT model is formed from four bases, which are the conceptual base, the indicator base, the indexing base, and the policy support base. The following illustrate how the four bases forming the structure of the SILENT Model were prepared: (Yigitcanlar and Dur 2010, p.328-334)

First: the Preparation of the Conceptual Base of the Model:

As any research project, the establishment of the SILENT model was proceeded by a review for the literature and studies done in the field of urban sustainability, as well as the best practices in establishing models for similar purposes. There are four main indicator categories in the SILENT Model, which are demography, land-use and urban form, transport, as well as environment. Yigitcanlar and Dur have deduced from the sustainability's literature that these categories are representive for all main human activities, (beside the sustainability three main axes that are the social, economic, and environmental factors). However, the individual indicators within these categories were chosen according to their suitability for the circumstances of the target case study area (Gold Coast City, Australia).

Second: the Preparation of the Indicators Base of the Model

As stated before, the selection of the indicators was based on their suitability for the circumstances of the target case study area. This was after considering some main factors, which are the availability of data required for these indicators, the priorities of the institutions and public, and others. However, the main challenge was how to assign a common unit of measurement to be the base for the comparison method.

The team of the SILENT Model have dealt with this challenge by using what is called "ecological foot-printing"[9] as a common unit for the measurement process of each of the sustainability indicators and composite indices-based assessment methods. This unit (ecological foot-printing) was chosen based on conclusions extracted from the literature.

The following illustrate the steps for the preparation of the indicators base, till obtaining the indicators' results:

- As the factors affecting the urban sustainability that would be measured by indicators are objective and independent in various fields. Therefore, an analysis process for these factors was performed to make an initial identification for the indicators measuring these factors.
- Then, by using a set of statistical methods, the most appropriate indicators were selected. The purpose of the statistical analysis in these methods is to determine whether there is a correlation between indicators (proposed to selection) and urban sustainability, or not. This is through a factor analysis technique using a multivariate analysis method.
- A number of 30 indicators (out of more than 600 indicators) were selected as the most appropriate indicators for the circumstance of the study area and the practicality of the required data's collection process for these indicators. These 30 indicators have formed the indicator system in the SILENT model. The indicators selection process was a collaborative selection process, which was performed by a group of dozen experts (five researchers, five practitioners, and two local government policy makers). Each indicator is belonged to a definite indicator set, and each indicator set is related to an indicator category.
- The indicator-based measurement process in the SILENT Model has required selecting appropriate parameters that will form the formula of each indicator, which was a challenging step. In order to determine the parameters of social and value-dependent measures, public or residents participations were required. There were also some immeasurable parameters or parameters that need unavailable data. And so, alternative parameters or variables for replacing these parameters had to be identified. A method called "Delphi method"[10] was used for this purpose. This method needs the participation

9 The ecological footprint is a measuring unit for the volume of people demand from the Earth's natural resources with regards to the earth's capacity for the regeneration of these resources. The ecological footprint reflects the quantity of biologically produced land and sea area, which are required to fulfill the consumption of the populations all over the world through overfishing, overhunting and overharvesting forests, as well as, taking over the resulted wastes from that consumption, (like the percentage of the carbon dioxide resulted from factories that is absorbed by the forests and green areas). The spent Earth's natural resources differ according to the lifestyle, which the people perform. As the Earth suffers from what is called "the global ecological overshoot" because the annual demand from natural resources has exceeded 1.6 times what are regenerated by the Earth since the 1970s. In other words, the Earth now needs a period of time equal to one year and six months to regenerate what are used from the natural resources in one year. (Global Footprint Network website, 2017).

10 The Delphi method is a kind of communication technique used for assigning the most appropriate solutions for a definite issue among various experts' point of views. This method is characterized by being a systematic interactive predicting method that should include a group of experts. These experts have to reply to a group questionnaires through two or more rounds. After each round, a coordinator should

of an expert team within a group of workshops or surveys, in order to identify the most appropriate parameters for each indicator.

- After calculating and obtaining the result of each formula for each indicator, the resulted values were normalized as a preliminary step before the weighting and aggregation processes. So, linear arithmetic normalization procedures, (which have been proven as beneficial in other similar indexing researches), were used by identifying the minimum and maximum values for each indicator. And so, all the indicators were converted into standard scale that has five grades or degrees (Low, Medium-low, Medium, Medium-high, and High).

Third: the Preparation of the Indexing Base of the Model:

Some researchers see that each of "the composite indicators" and "the indices" have the same meaning. However, some studies adopt the term "composite indicators" and other use the term "comparable indices" for expressing of a set of various individual indicators. The only difference between each of "the composite indicators" and "the indices" is that the indices' results have no unit that is considered as an advantage for supporting the comparison processes among several cases, whereas the results of the composite indicators normally have units. These are not suitable for performing the comparison processes.

With regards to assessing sustainability, it is known that groups of individual indicators are collected in the form in three indices (environmental, economic, and social). This is through the assignment of the weight for each individual indicator with regards to its indicators set, in order to be aggregated. As the weighting process helps to avoid the overlap in the information concerning the indicators that have relations between each other to obtain accurate and unbiased results. However, in some cases the weighting methodology using linear aggregation, may cause a problem of bias in the indices' results because of the loss of some critical information during the aggregation process of the indicators to form indices. As the results of some indicators called “positive indicators”, which are measuring parameters supporting sustainability, may act as a compensation role (during the aggregation process) for results of “negative indicators’ that are measuring parameters hindering sustainability[11]. Therefore, unless this problem is avoided, the assessment process will unbeneficial. As it may be difficult to definitely identify the parameters that are needed to focus on within the policies or strategies for attaining sustainability.

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present a conclusion for what the experts have predicted through this round and their reasons for having reached this predication. The points in this conclusion are presented without stating the name of any expert who has adopted any point. Therefore, experts will be motivated to think another time in their previous replies based on the answers of other experts, so that many points will be canceled or neglected through discussions to remain the "right" or the most appropriate answer. These rounds are stopped at the end after attaining some conditions such as the number of rounds, the consensus, the stability of definite answers, and the scores of the mean or median in the final round that identify the final results. (RAND Corporation website, 2017)

11 An example for this problem, an experience was applied on Oregon state, USA, in which the final results have shown higher grades for social and economic indices, and at the same time low grade for the environmental index. However, the overall sustainability results were high after the aggregation process for the three indices to form the overall sustainability index. Despite the fact that the environmental index was low, which are considered misleading results. (Minner , 2015)

So, the weighting process in the SILENT Model was done through the aforementioned Delphi method, as the team of experts have decided the most suitable weight for each indicator. In order to avoid any bias in the indices' results, some "control or critical indicators" were excluded from the aggregation process for other indicators. And these indicators were used in a disaggregated form to work as if they are early alarms indicating such problems or mistakes.

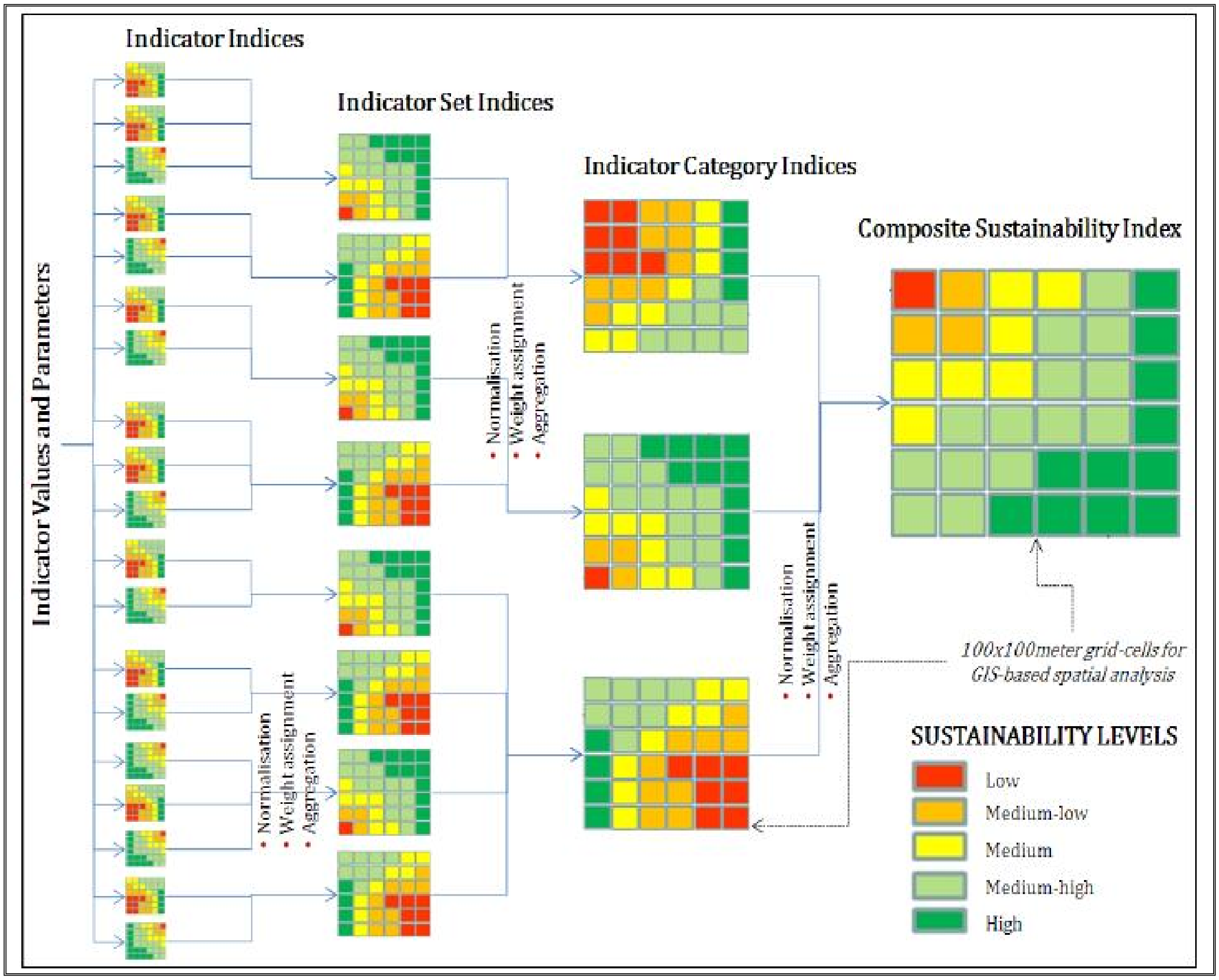
The aggregation process for obtaining the composite index results was performed. As the normalized results for parcels were aggregated into grid cells [12]. The normalized results concerning Census Collection Districts (CCDs), the postcode areas level, or the scale of suburbs were disaggregated into grid cells.

The last step was the visualization of the composite index results’ values in a GIS environment using the software "ArcGIS™". As the SILENT model is a GIS-based model that was based on a grid cell system for performing the sustainability analysis. So first, the assigning of the calculated values for each indicator, which were ranged from the value of 0 to 5, so Low (0.00–1.00), Medium-low (1.01–2.00), Medium (2.01–3.00), Medium-high (3.01–4.00), and High (4.01–5.00). Then the GIS system calculated the values of the indices' sets and the composite sustainability index. After that, these results were graded in five comparative sustainability degrees or grades (Low, Medium-low, Medium, Medium-high, and High).

The GIS system has also offered a tabular report for the exact values of the comparative sustainability level per each grid cell. This report includes a visualization for the sustainability values (per each grid) for each indicator in the 30 indicators (values' range is between 0 and 5), as well as a visualization for each indicator set in nine indicator sets and a visualization for each indicator category from a number of four indicator categories. The visualization of the composite index value was also done per each grid cell as shown in the next figure.

12 Each grid was 100* 100 meters.

Fig. (5.7) The composite sustainability indexing structure of the SILENT Model



Source: Yigitcanlar and Dur 2010, p.332.

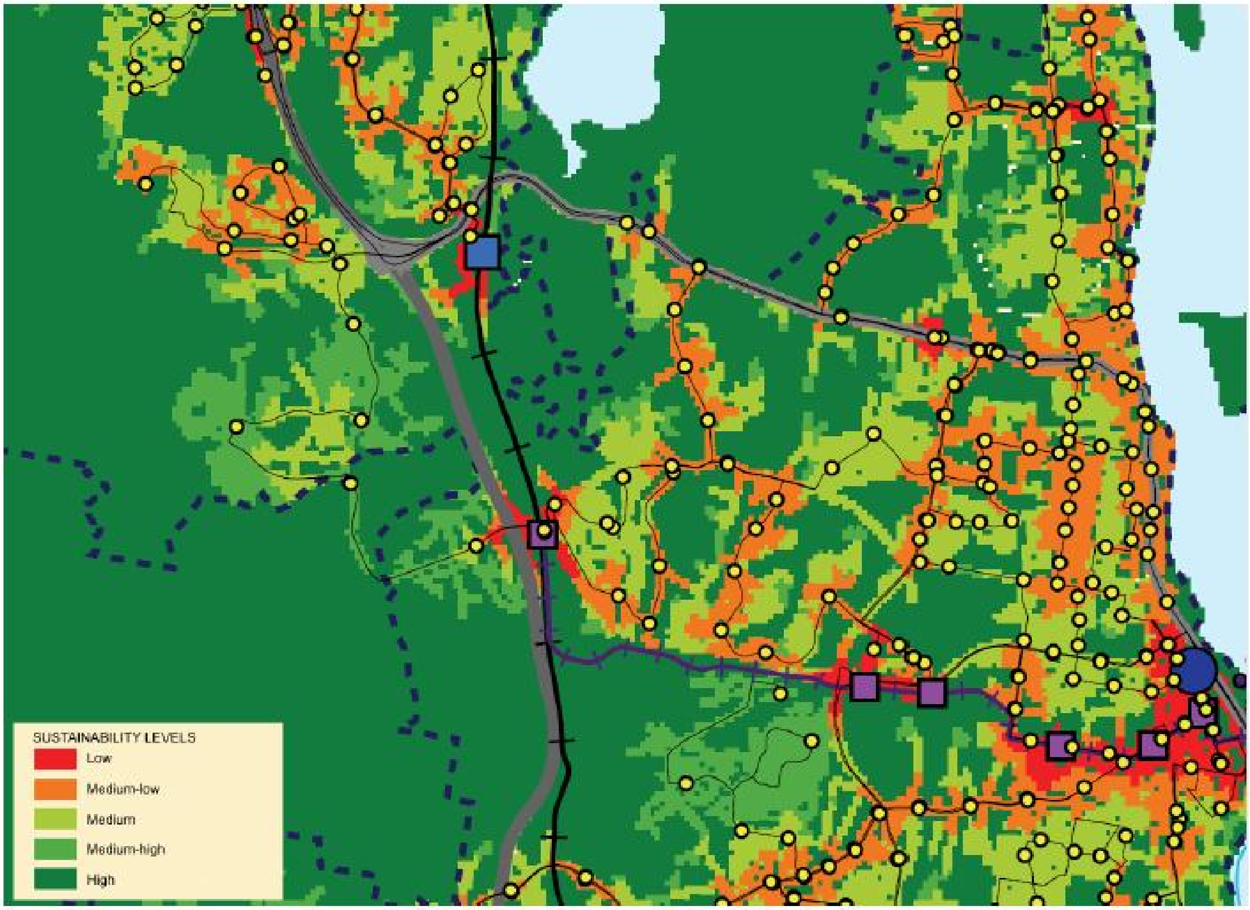
The final outputs were:

-The grid cell values that were placed by using the aggregation method in the form of other spatial scales of analysis in the GIS system, (e.g. street, neighborhood, CCD, suburb, and city). These were to obtain a multi color composite urban sustainability map that shows which areas have low sustainability levels, and which have high sustainability levels, and can be easily interpreted from decision makers and public as shown in the next figure.

- A map for each individual indicator.
- The indicator sets.
- The indicator categories.

The next map shows the sustainability levels within the resulted composite indexing map of the study area.

Fig. (5.8) The composite indexing map obtained by the SILENT Model[13]



Source: Yigitcanlar and Dur 2010, p.333

Fourth: the Preparation of the Policy Support Base of the Model:

As mentioned before, the purpose from the development of the SILENT Model is not only evaluating the current state of comparative urban sustainability levels and performing the benchmarking but also forecasting future scenarios. A simulation process was used for assessing the effects of these scenarios on sustainability. And so, this allowed both current and future comparative sustainability levels to be taken in account in the process of policies and strategies formulation. The model can be used in forming planning policies in many fields, (e.g. sustainable urban development, sustainable transport infrastructure and services, and others). As well as, it can help in supporting the public's awareness towards sustainability through the participatory planning potentials in this model.

(5.5.5) Developed or Used Tools in Australia’s Example:

The tool used in this example is the SILENT Model, which is a comprehensive sustainability assessment model. It is considered an advanced grid-based system and an indicator-based urban sustainability indexing model. The structure of the SILENT Model is composed from four

13 As it is clear here that the areas that are located around the major arterial roads and main activity centers have low sustainability levels in comparison with the areas located near green spaces and natural environment.

parts of the model; the conceptual base, indicator base, urban sustainability indexing base, and the policy and decision support base of the model.

The used techniques was a factor analysis technique for determining whether there are relations between indicators and urban sustainability, or not.

The used methods are:
- The Delphi method for identifying the most appropriate parameters for each indicator and identifying weights of indicators.
- A set of statistical methods for making sure that the most suitable indicators were selected.
- A correlation matrix for analyzing the factors affecting the urban sustainability.

(5.5.6) Scale of Application of Australia’s Example:

The first application of the model was done on a study area of the Gold Coast City as a pilot study. The purpose was to test whether the model works in a proper manner and gives logic results, or not rather than to evaluate sustainability attainment. The application of the model on this study area has confirmed the success of the model. (Yigitcanlar and Dur 2010, p.333).

(5.5.7) Tasks Achieved in Australia’s Example:

The main task is to evaluate the current comparative levels of sustainability by assessing all related domains affecting urban sustainability, (i.e. demography, land-use, environment, transport and infrastructure). This is in terms of 5 comparative sustainability levels: Low, Medium-low, Medium, Medium-high, and High. This evaluation is the base for the benchmarking and policy making processes and the forecasting of the effects on sustainability resulting from various alternative development scenarios. (Yigitcanlar and Dur 2010, p. 332)

(5.5.8) The State on which the Assessment Process is Done within Australia’s Example:

The assessment process was applied on the current state of comparative sustainability levels of urban localities and the forecasting of future scenarios, and so assessing the effects of these future scenarios on sustainability. (Yigitcanlar and Dur 2010, p. 333).

(5.5.9) The Learned Lessons from Australia’s Example:

1. The indicator system used in the SILENT model covers four various fields (demography, land-use and urban form, transport, and environment).
2. Some of the formulas of the individual indicators are applicable for the Egyptian circumstances.
3. The concept of the weighting process using Delphi method (in which a team experts identify the most suitable weight for each indicator) helps to avoid any bias in the indices' results. As some "control or critical indicators" were excluded from the aggregation process for other indicators, and were used in a disaggregated form to be used as early alarms indicating problems or mistakes.
4. The idea of converting all the indicators values into standard scale of five grades or degrees is beneficial in the interpretation of the indicators results in a simple form that is understandable for the public.
5. The usage of the grid-based system is effective in performing the sustainability analysis because of using the same comparable size of grid-units.
6. The grid cell values were calculated by using the aggregation method in the form of various spatial scales of analysis in the GIS system (street, neighborhood, CCD, suburb, and city). As

the obtained map shows which areas have low sustainability levels, and which have high sustainability levels thar is easily interpreted by the decision makers and public.

(5.5.10) Discussion on Australia's Example:

(5.5.10.1) Strengths of Australia's Example:

- Despite the fact that the SILENT model was in its early stages when it was tested on the Gold Coast case study using hypothetical data, this model has proven its feasibility in performing the sustainability indexing and assessment, as well as the estimation of the directions of local sustainability policies. As it can be used practically as a planning decision support system because it is beneficial in studying urban dynamics and determining the relationships of each of the urban form and problems happening in the urban areas, which help in policies' testing. (Yigitcanlar and Dur 2010, p.334).
- The usage of the grid-based analysis has the advantage of performing the analysis by using comparable same size analysis units. As the model assigns indicators' values obtained from various parameters in each grid cell through an indicator-based assessment system. Then, each index is calculated and assigned to each grid cell in the form of both tables and dynamic visual forms (i.e. attribute tables and GIS maps). And the same process was done with regards to the composite index. (Yigitcanlar and Dur 2010, p. 325).
- This indexing model can be used in formation of the planning policies in many fields, (e.g. sustainable urban development, sustainable transport infrastructure and services, etc.). It can support the public's awareness towards sustainability through the participatory planning potentials in it. (Yigitcanlar and Dur 2010, p. 333).
- The repeated usage of the of the SILENT model offers a dynamic sustainability assessment process. (Yigitcanlar and Dur 2010, p. 325).
- The model uses an integrated sustainability assessment framework. As all related domains affecting urban sustainability (i.e., demography, land-use, environment, transport and infrastructure) are assessed through it.
- The spatial indexing process is beneficial for the analysis and the visualization of comparative sustainability levels on the local level. (Yigitcanlar and Dur 2010, p. 325).
- The SILENT model can perform policies and test scenarios beside the assessment function. (Yigitcanlar and Dur 2010, p. 325).
- The model is practical and has many theoretical strengths because it is based on indicators and indices, which enable the comparison among various aspects in the sustainability state. (Yigitcanlar and Dur 2010, p. 326).
- The methodology of establishing this model and the application on the case study is considered flexible methodology. As it can be applied in any urban area conditioning that the indicators are suitable to the circumstances in the area of application. (Yigitcanlar and Dur 2010, p. 328).

- The weighting process in the SILENT Model was done through the Delphi method to assign the most suitable weight for each indicator, and to avoid any bias in the indices' results. (Yigitcanlar and Dur 2010, p. 330).
- The analyzing process for factors affecting sustainability aimed at decreasing the number for these factors. However, the obtained factors were objective, and supported more efficient sustainability assessment results. (Yigitcanlar and Dur 2010, p. 331).
- The conversion of all values for all the indicators into standard scale of five grades or degrees provides simple and understandable indicators results. (Yigitcanlar and Dur 2010, p. 331).
- The SILENT model can not only be used for evaluating the current state of comparative urban sustainability levels and performing the benchmarking but also for forecasting the future scenarios. And so, it allows both current and future comparative sustainability levels to be taken into account in the process of appropriate policies and strategies formulation. These potentials are useful for each of the local authorities, the planning organizations, and the local society. (Yigitcanlar and Dur 2010, p. 332-333).

(5.5.10.2) Weaknesses of Australia’s Example:

- The grid cell size (100 × 100 m) is a bit large size, which gives less precise results. (Yigitcanlar and Dur 2010, p. 334).
- Sometimes, the available data (required for the indicators of the model) may not be on the required scope. This may cause a kind of bias in each of the assessment and forecasting processes. As well as, the fact of the presence of auto-correlation between indicators values may make the model unreliable. As the selection of data may be done in some way through the intuition and subjective judgment. The solution for this is to perform the indicator selection process in a way that guarantees more concise and cost effective data. However, the indicators of the SILENT model should be decided or chosen in a more cost-effective way. (Yigitcanlar and Dur 2010, p. 326).
- The model has concentrated only on the basic four key dimensions of urban sustainability (urban demography, land use and urban form, transport, and the environment). It has neglected other sustainability aspects like equity and other infrastructure networks like water and sewerage. (Yigitcanlar and Dur 2010, p. 334).

(5.6) China's Example (2):

(5.6.1) Objectives of China’s Example (2):

The general objective is to support the land-use management process of lake areas in urban fringes. This is through the integration some processes into a general framework. These processes are the land-use suitability assessment, the predication of potential land-use change, the land prices evaluation, and the allocation of various land-use types in the most appropriate locations for each type. (Liu et al. 2007, p.233).

(5.6.2) Research Problem of China’s Example (2):

The urbanization phenomenon with its negative impacts continuously increases in lake areas in Chinese urban fringes. This is due to the conflict between rapid urban sprawl and the maintenance of water bodies in such areas, which is an urgent problem that needs to be solved. (Liu et al. 2007, p.233).

(5.6.3) Focus/Major Issues of China's Example (2):

The main issue is the land-use management of lake areas as a multi-component and multidisciplinary process (social, economic, land-use or spatial, and environmental). (Liu et al. 2007, p.234).

(5.6.4) Methodology/ Approach of China's Example (2): (Liu et al. 2007, p..234-243)

The general framework forming the Integrated GIS-based Analysis System-IGAS includes four main stages or modules as follows:

The First Module is GIS-based Land-use Suitability Assessment:

The first module is responsible for the identification of the most appropriate future land-use pattern according to definite requirements and predictions of certain activities. This is through determining the alternative options and priorities for land-use types, as well as identifying the available land supply and the most appropriate uses for the available land lots. It consists of the following two steps:

1. A Multi-Criteria Analysis-MCA technique was applied, which includes the identification of targets of the land-use management process, the assessing factors (social, economic, environmental, and ecological factors), and the criteria for these targets. All of these were performed through cooperation with stakeholders, researchers, and local experts.

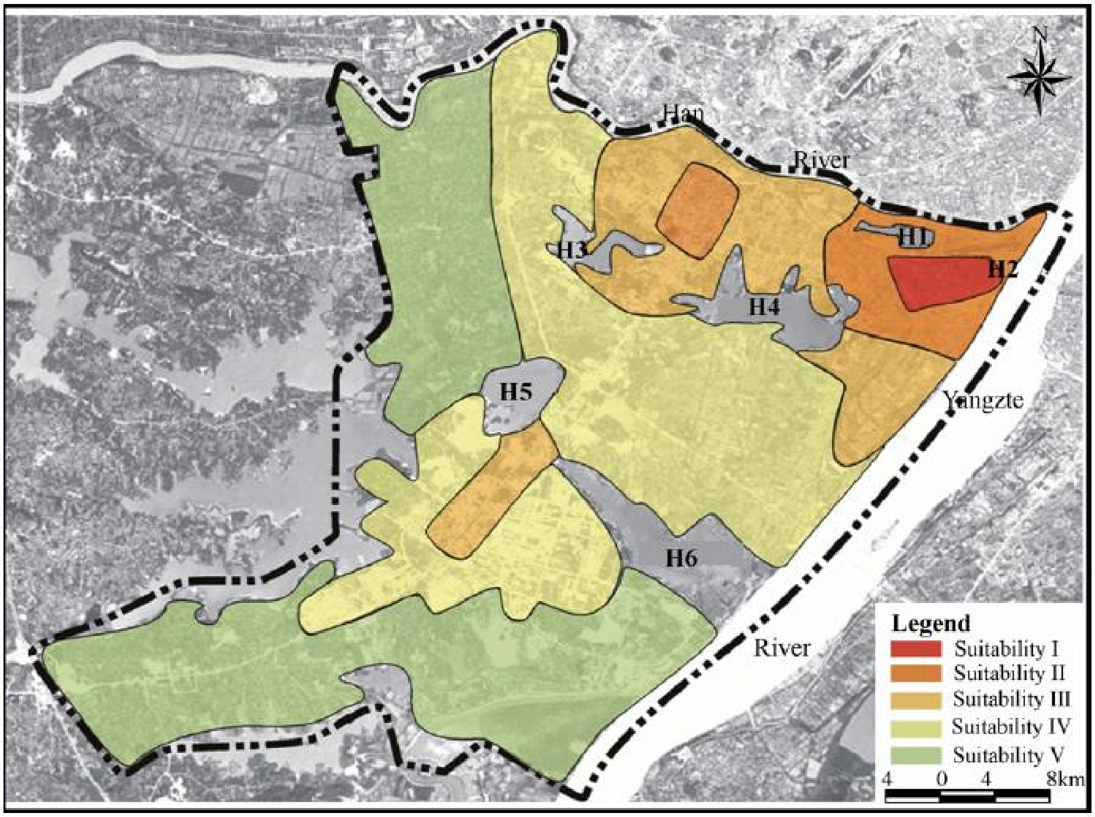
2.The quantitative analyzing of the criteria and standards was done, which includes scoring, ranking, and weighting. This analyzing process was done through a combination between the MCA technique and an analytical hierarchy process-AHP. As a group of experts [14] have cooperated in making what are called the "pair-wise comparisons" for forming the weighting matrix, so that a weight of each criterion was calculated by the AHP model. Then, the assessing criteria were combined by calculating the total score of land-use suitability for each assessment unit [15] by using definite equation.

The results of land-use suitability assessment process are what are called "land-use categories". These are five land-use categories of suitability. Each category is suitable for definite land-use type, which were determined based on 11 criteria using the related GIS data to obtain the distribution for the future land-use types within the available land supply. The next figure presents the land-use suitability assessment map for the study area, which shows the distribution of each suitability category.

14 The experts are in various sustainability aspects (land resources, water resources, environmental protection, aquatic ecology, commerce, urban planning, geology, and social development).

15 The minimum assessment unit for grids of the obtained land-use suitability assessment maps or maps of land available for supply was decided based on information from spatial satellite images, land-use maps, and administrative zoning information. This information was firstly entered into the GIS, and then overlapped over each other and saved in the GIS spatial database. The grids assessment unit for the locations near lakes were 100m×100m and in other locations were 200m×200m.

Fig. (5.9) The distribution of land-use suitability categories map within the study area



Source: Liu et al. 2007, p. 241(reprinted with permission from Elsevier).

<u>The Second Module is the System Analysis of Potential Land-use Changes:</u>

In this module, a System Dynamic- SD model is built for the determination of the demand of land from various land-use types. This is based on each of the expected rural and urban population, time, growth domestic product- GDP, as well as other parameters forming a series of equations for calculating the area required from various land-use types. The second module consists of the following four steps:

1.The analysis of four subsystems: each subsystem represents an aspect of sustainability aspects, which are the social subsystem, economic subsystem, land-use subsystem, and environmental subsystem. These subsystems help in identifying the potential land-use changes by measuring some factors like the population increase within rural and urban areas, changes in economic structure, and governmental policies affecting urbanization and urban planning. And so, consequent demands for various land types can be deduced.

2.The SD model is constructed.

3.The SD model is verified and validated, then performing what is called "sensitivity analysis".

4. The resulted scenarios for land-use patterns are drafted and investigated: In this study, there were two scenarios for potential changes from year 2006 to 2020. Scenario (I) has forecasted the land-use changes with regards to the current developmental attitude in the study area. Scenario (II) has considered the effects of local policies on urbanization level and changes in the economic structure in the study area.

<u>The Third Module is the Land Evaluation:</u>

The third module is responsible for the estimation of the land prices. As the land prices affect the land-use management process especially for areas under urbanization. This module consists of the following three steps:

1.Determining the stakeholders and objectives of the land evaluation process.

2.The evaluation units identification and the basic data gathering.

3.Designing the land evaluation methods and models, and so calculation and standardizing the results.

The Fourth Module is GIS-based Land-use Allocation:

This module is the last stage in the IGAS framework, in which the land-use allocation is decided that is considered a significant process within the land-use management. The results of this process affect the decision making regarding the identification of the future lands arrangements, the efficient management of uses of these lands, and the required ecological protection of the study area. This module consists of the following six steps:

1. Some areas are restricted and excluded from the GIS system because of reasons like the protection by legal requirements and being natural conservation zones.

2. The remaining lands are allocated or distributed according to the results of the three previous stages or modules.

3. Calculation process is performed. This process aims at attaining equilibrium among each of the value of the demand on land-uses (that is resulted from SD model for analyzing the potential land-use changes stage) and the value of the supply from land-uses (that is resulted from suitability assessment stage).

4. A workshop between stakeholders and the administrative offices is taken place. This to discuss the land-use management results for the primary land-use allocation, in which a quantitative allocation is decided using the GIS system.

5. The allocation results are investigated and validated by using a quantitative comparison between the land-use demand and supply for confirming the sustainability attainment in the resulted land-use allocation.

6.The feedback on the land-use allocation is collected for reallocating any inappropriate land-uses distribution.

(5.6.5) Developed or Used Tools in China’s Example (2):

The integrated GIS-based analysis system that consists of 4 modules was used in this example. The MCA technique was applied to assess land-use suitability. The SD model was used to predict potential land-use variation. These are in addition to a method of cost approximation that was applied to assess land resource, and a method of hypothetical development was used to estimate market values for land prices. (Liu et al. 2007, p..234).

(5.6.6) Scale of Application of China’s Example (2):

The Hanyang Lake area[16] (122.6 km^2) in the urban fringe of Wuhan City in central China was chosen as a case study for the system implementation because it suffers from obvious urbanization pressure. (Liu et al. 2007, p..233)

(5.6.7) Tasks Achieved in China’s Example (2):

16 The study area includes many water resources (six lakes and several rivers) (Liu et al. 2007, p.233).

Future scenarios for land-use allocation for areas affected by urbanization pressure (till year 2020) were identified. The better scenario was selected, which can attain the balance between the land demand and supply, and provide the land-use allocation in a sustainable way, (i.e. considering social, economic, land-use or spatial, and environmental factors). (Liu et al. 2007, p. 240-241).

(5.6.8) The State on which the Assessment Process is Done within China's Example (2):

The assessment process of the land-use management was for the current state for identifying a future land use allocation. (Liu et al. 2007, p..233).

(5.6.9) The Learned Lessons from China's Example (2):

1.The usage of MCA: which was based on GIS for performing the land-use suitability assessment to determine the available land supply and the most appropriate uses for the available land lots.
2.The AHP method: which is very beneficial in case of the multi-criteria assessment processes. This method helps in calculating the weightings of various criteria for obtaining the relative importance of each criterion. This is through consulting and surveying the opinions of experts in various specifications to formulate the weighting matrix.
3.Generating scenarios for potential land-use changes in the future by using the SD model and considering definite considerations.
4. Balancing between land supply and demand.
5. Considering all the sustainability aspects in land-use allocation process.
6.The collaborative attitude either with stakeholders or experts in the four main stages (modules) of the system.

(5.6.10) Discussion on China's Example (2):

(5.6.10.1) Strengths of China's Example (2):

- The developed assessment system can reflect long-term changes in land-use types. (Liu et al. 2007, p.243).
- The IGAS framework is characterized by integrated, systematic complex, and dynamic characteristics, which helps in addressing complex and dynamic problems like land-use management. (Liu et al. 2007, p.243)
- The results of the land-use allocation process are beneficial in the policy making process. (Liu et al. 2007, p.245)
- The multi-criteria analysis can integrate the various criteria.
- The combination between AHP and GIS for studying the land-use suitability assessment was successfully used in this experience. (Liu et al. 2007, p..245)
- The IGAS model can deal with each of the essential processes in land-use management systems and the external driving forces affecting them. In addition, it considers the special characteristics of lake areas, as well as the external economic, social, and ecological parameters (Liu et al. 2007, p.243).
- The selecting process for the used methods and tools within IGAS framework was successful. For example, the land-use suitability assessment was a practical tool for making decisions regarding land-use development or land supply. The system analysis of potential land-use changes was effective in predicting land-use change, as it has supported the process of future land-use management and allocation. The GIS is also a

very beneficial tool for integrating information and in decision-making. (Liu et al. 2007, p.245).

(5.6.10.2) Weaknesses of China’s Example (2)

- The area of the case study is larger than the scale of small or medium cities (122.6 km^2). It is closer to the regional level than the city level. Moreover, it has purposed general identification for the most suitable land-uses categories as zones. So, it will more complicated to apply the methodology of this example on a small scale of a city area to identify specific land-uses categories on this small scale, (e.g. administrative, recreational, medical services, utilities, etc.). Also, this may not be applicable in case of sustainability assessment in a detailed land use plan (parcel level).
- The number of resulted land-use suitability categories is a small number, (only 5 categories). The number of land-use types in any urban area can be more than 10 types or categories.
- There was no consideration for the probability of mixed land-uses, which is the most dominant case in many cities especially the existing Egyptian cities.
- It is not clear in this example how the planning for infrastructure and roads networks have been studied and whether these networks support sustainability attainment, or not.

(5.7) The Cyprus’ Example :

This example has been chosen not only as an example for applying PSSs in sustainability assessment and attainment in a rural area to illustrate how PSSs application covers all land types, but also it presents a system that is suitable for supporting both rural and urban sustainable development. This system is called "LACONISS" Land Consolidation Integrated Support System. It can automate the reallocation or the readjustment process that is considered an essential process in any land consolidation project for either rural or urban land. As the land fragmentation problem, which is the problem solved by the LACONISS system that affects both the regional and urban planning. (Demetriou et al. 2013, p.73-74). LACONISS is considered a promising tool in supporting land consolidation projects in urban areas in the future. (Demetriou et al. 2013, p.88).

Also in Egypt, the land fragmentation problem appears clearly in the informal urban areas, where there is an absence of division projects. People own these lands in a nonofficial way, which results in a fragmentation of these lands in the form of irregular shapes parcels that lack the required infrastructure network and services. And sometimes, these parcels have weak accessibility to roads, which causes many economic, social, environmental, and physical problems.

(5.7.1) Objectives of Cyprus' Example:

Land consolidation is a planned spatial readjustment process for the ownership of land parcels to form larger and more rational land tenure and to improve the infrastructure networks. The land consolidation process also enhances the developmental and environmental policies (Pasakarnis and Maliene 2010, p.546). Therefore, the land consolidation is considered a tool for sustainable rural development because it supports each of the agricultural production, employment, infrastructure, public facilities, housing, and the protection of natural resources (Pasakarnis and Maliene 2010, p.548). The general experience in land consolidation has shown that the land consolidation may become a strong base for sustainable rural development in Central and Eastern European countries. (Pasakarnis and Maliene 2010, p.545).

The general objective in this example is to deal with the land fragmentation problem by producing alternatives using LACONISS for the land reallocation or consolidation plans. LACONISS can simulate (emulate) the planners' way of thinking in solving the fragmentation problem. It can also evaluate these alternative to obtain a land consolidation plan for the study area to attain sustainable development in this area. (Demetriou et al. 2013, p.73).

(5.7.2) Research Problem of Cyprus' Example:

The research problem is summarized in that the land fragmentation phenomenon impedes the rural sustainable development and affects the implementation of the regional and urban planning. As the unsuitable structures of land parcels and the fragmented ownership of land result in a decrease in the agriculture production due to the lack of investments and the development of farms. Many negative social and economic consequences also happen, which impede the sustainable development in the rural areas. (Pasakarnis and Maliene 2010, p.545).

Land fragmentation is defined as the case in which a single agricultural land contains several spatially separated parcels, which are characterized by being small in area and with irregular shape. This phenomenon refers to a kind of a defective structure of land tenure. The land fragmentation may be caused from the mismanagement of land tenure structure and problems related to ownership rights, e.g. parcels are owned to more than one person or dual or multiple ownerships. As it has been mentioned above, this problem is also appears in urban land that impedes rational urban expansion. (Demetriou et al. 2013, p.74).

In order to alleviate the land fragmentation problem, certain land management measures should be applied along with environmental impact assessment and a feasibility study. However, there was no standard algorithm or rational methodology for measuring land fragmentation. This was the motivator for developing this system (LACONISS) with better methodology for assessing land fragmentation with a reliable way. Because the most two popular land fragmentation indices (Simmons and Januszewski) have big shortcomings, and their application may lead to wrong decisions. (Demetriou et al. 2013, p.74).

The land consolidation projects are considered to be the way to deal with land fragmentation problem. However, the land consolidation projects face many challenges like the long duration required for any land consolidation project, the high costs needed from operation such projects, and conflicts in interests of landowners. These problems lead to the difficulties in attaining consensus amongst stakeholders involved in such projects. (Demetriou et al. 2013, p.75)

All the previous lead to the urgent need to develop an automated system that can perform the land consolidation projects in a systematic, efficient, and transparent manner. As the GIS with all their potentials cannot appropriately deal with such complicated spatial decision making problems. Because GIS are too generic, and lacked to expert knowledge, and have no capability to generate alternatives for such problems' solutions or even evaluate these alternative without predefining or customization or programming knowledge. (Demetriou et al. 2013, p.75).

Moreover, all the previous attempts to automate the land redistribution[17] process have dealt with this process as a mathematical optimization problems and already succeeded in obtaining efficient results in sometimes. However, these results were not realistic or applicable. Other attempts have dealt with land partitioning process, and actually attained successful studies but unfortunately still unsatisfying. Even, the studies for evaluation of land consolidation projects have lacked from tools that can provide detailed inputs. Also, there is no integrated planning framework for dealing with land fragmentation problem. As studies have concentrated on a part or a process from several processes (e.g. land redistribution or land partitioning process), which was ought to be integrated with other parts to perform a complete land consolidation (reallocation) project. (Demetriou et al. 2013, p.75-76).

(5.7.3) Focus/Major Issues of Cyprus' Example:

Land consolidation: is considered one of the land management's solutions for the land fragmentation problem together with the agrarian (agricultural) spatial planning. Land consolidation (or land reallocation) aims at performing the optimal reformation for the current structure of land tenures in an area with the consideration of the suitable land consolidation legislation and the existing practices. The agricultural spatial planning is the provision of infrastructure networks including roads and other essential processes like environmental management, settlements renewing, and soil preservation. (Demetriou et al. 2013, p.74-75).

Land reallocation: is considered a synonym for land consolidation. It includes two main processes, which are land redistribution and land partitioning. Land redistribution is a decision making process that involves each of the existing legislation, current land tenure structure, definite rules, and the planners' experience. Land redistribution is the preparation of a preliminary plan for restructuring the ownerships, which are distributed in irregular land parcels' shapes. The restructuring of ownerships leads to changing of each of land parcels number, the land parcels' sizes, the land values, the approximate locations of land parcels, and the ownerships. (Demetriou et al. 2013, p.75).

The land partitioning: is the contrast of the land redistribution. Land partitioning is the subdivision process for the lands (resulted from the land redistribution process) into smaller land parcels. This is through defining the parcels shape, sizes, land values, and the final definite land parcels' locations. This process is considered a trial and error process using the suitable land consolidation legislation. It involves the following parameters: the current structure for lands, criteria for design, constraints, and rules to produce the final product that is the land consolidation plan. (Demetriou et al. 2013, p.75).

(5.7.4) Methodology/ Approach of Cyprus' Example:

The design concept and sub-systems within LACONISS: (Demetriou et al. 2013, p. 78-79)

LACONISS is based on a systematic, efficient, and automated approach in the whole process done by it. It integrates GIS, artificial intelligence, and multi-attribute decision-making methods. The operational framework (or the approach for developing this system) is based on a three stage decision- making model, which are: the intelligence, design or plan, and selection. The three stages were programmed in three sub-systems (based on ArcGIS™ platform) of this

[17] The concepts of land redistribution and land partitioning will be illustrated in the next section.

system. The three sub-systems are four modules, as the first and the third sub-systems are represented in two modules, and the second is represented in two modules.

The first sub-system "Land Fragmentation System" (LandFragmentS) is used in the intelligence phase of the decision- making model. This sub-system depends on the integration between GIS and multi-attribute decision-making method (MADM). These help in detecting and evaluating the fragmentation problem in the study area. So, in case that this sub-system detects the presence of a fragmentation problem, the second sub-system "Land Spatial Consolidation Expert System" (LandSpaCES) is used in the design phase of the decision- making model. This sub-system consists of two modules one for the design and another for the evaluation. The design module also depends on the integration between GIS and an expert system (ES) technique, and aims at creating a group of alternatives for a land-distribution plan. These alternatives are assessed through the evaluation module of the second sub-system using the MADM also. The output of the second sub-system (that is the best alternative) is the input for the third sub-system that represents the selection phase in the decision- making model.

The third sub-system "Land Parceling System" (LandParcelS) depends on the integration between GIS and a genetic algorithm (GA), as well as multi-objective decision-making method (MODM). This sub-system generates the final product of the land reallocation or consolidation plan, which is the optimal formulation for the land parcels in the study area with regards to their shape or form, size or area, and land value.

The development tools for establishing LACONISS were Visual Basic for Application (VBA) and ArcObjects.

The theoretical base for establishment of the LACONISS:

Before establishing any PSS, the developer should be aware of the way or the procedure that the planners manually perform, in order to emulate this procedure within the designing the flow chart of the proposed PSS. And this happened in the establishment of LACONISS. It was important first to study how planners perform the consolidation projects, and how they think and design these projects manually. As this is considered the theoretical base for establishment this system, then identifying the methodology for applying "LACONISS" in land consolidation projects:

How planners perform the consolidation projects:

There are nine main steps for the land consolidation or land reallocation project, as the following steps are usually applied in land consolidation projects in Cyprus: (Demetriou et al. 2013, p. 77-78)

1. The study area is subdivided into blocks with roads, streams, and external limits of this area.
2. The total area and the land value of each block are calculated.
3. The landowners (who will not own lands in the new division) take a decision. There are two parameters for this decision. The first is the minimum area for the land portion of any landowner in the current state that gives this landowner the right to own a land parcel in the new division or plan. The second parameter is the limits of land values estimated by a committee called "Land Consolidation Committee-LCC".
4. The land parcels in the current state are identified, which are excluded from the new division or plan in the previously mentioned decision in the previous step.

5. The percentage of the lands (that will be donated by some landowners) is calculated in terms of land value, as these lands will be allocated as public services. This percentage is called "contribution coefficient[18]".
6. The land values for land parcels are calculated that will be allocated for each owner. This is after the subtraction of the land values, which were multiplied by the percentage of "contribution coefficient ".
7.The maximum number of parcels are decided that can be allocated to any owner depending upon a rule called "small-medium-large-holding".
8. The initial available land in each block for the reallocation process is calculated in terms of its size and value.
9. The reallocation process of the ownerships is done for each block. First, the current ownerships in the block are determined. Then, the transfer of some ownerships in the block is studied based on various criteria (legislative, economic, social, environmental, and local). Therefore, for each block, the number of regular-shaped parcels after redistribution process is decided conditioning the accessibility of each parcel to at least one road. And the values and sizes of the targeted lands are also identified, which are the base of land reallocation criteria.

Since the previously mentioned manual methodology is an exhausting procedure, and may need more than one year to perform it according to the project volume even by using CAD and GIS software. Also there may be subjectivity in this methodology. Therefore, this procedure has needed to be programmed in the supporting system LACONISS.

<u>The methodology for applying "LACONISS" in land consolidation projects:</u> (Demetriou et al. 2013, p. 79-82)

The methodology for applying "LACONISS" in land consolidation projects (according to the previously mentioned manual methodology) is illustrated in the four modules composing this system. Each module performs a stage in applying this system in consolidation projects as follows:

<u>First: The "Land Fragmentation System" -LandFragmentS Module</u>: (Demetriou et al. 2013, p. 79-80)

The first module evaluates the current state of the fragmentation problem in the study area using the MADM. MADM is used to evaluate definite issue through many attributes or multi-criteria to compare the current state with the ideal state. The measurement's values are ranged from 0 (the most problematic state of fragmentation) to 1 (the least state of fragmentation problem). The LACONISS user or planner should execute the following steps:

- Identification of the factors measuring fragmentations from the following six factors: The scattering or dispersion of the parcels, the area of parcels, the form or shape of parcels, the accessibility to parcels, and the ownership's type[19] .

[18] There are some resembling points between this procedure and the procedure for performing master and detailed strategic plans for the Egyptian cities, which is illustrated in details in point (7.3.5) in chapter 7 of this thesis.
[19] There are two types of ownership. The first type is "dual ownership", which means that the land itself is belonged to someone, and the features in land (like trees or water) are belonged to another. The second type is "shared ownership", which means that the land itself is belonged to various landowners.

- Identification of weights for the factors according to the relative importance of each factor using either "direct rating of a numerical value[20]" method, or "qualitative rating[21]" method, so that the summation of all the factors' weights should equal to 1 in the two methods.

The system performs the following steps:

- The factors' scores for the current state are calculated. The outputs are listed in a table called "a land fragmentation table". Each row in this table represents one ownership. The calculated fragmentations' factors are represented in the columns of this table.
- The calculated values of the fragmentations' factors are standardized to be ranged from 0 to 1 using value function.
- The "land fragmentation index" (LFI) for each ownership is calculated by using the weights of the fragmentations' factors in a weighted summation method.
- The "global land fragmentation index" (GLFI) for the whole study area is calculated, which is the average of all the LFIs.
- The percentage of each factor contribution in both the LFIs and the GLFI is calculated using a sensitivity analysis tool for the identification of the sensitivity of LFIs and the GLFI for the weights assigned to the fragmentations' factors.

According to the value of GLFI, the system will decide whether there is a land fragmentation problem in the study area, or not. If yes, the system will move to the next stage that is performed by the second module.

<u>Second: The "Land Spatial Consolidation Expert System"- LandSpaCES Design Module</u>: (Demetriou et al. 2013, p. 80)

The second module performs the design of the alternatives for the land redistribution plan. As mentioned before, this module is based on the integration between GIS and an ES technique. ES is considered the most popular technique among the artificial intelligence techniques (as previously mentioned in chapter 4). Because ES can emulate the human way of thinking in solving complicated (multi-aspect) decision-making problems like redistributing a fragmented area. The main two components of typical ES are a knowledge base and an inference engine.

The knowledge base of the applied ES in this system consists of 74 IF-THEN rules, these rules are built according to the legislation, planners' experiences, thumb's rules, and others. The following steps are performed in the second module:

- The inputs entering that are a cadastral map, the databases for the land parcels, landowners, and the ownerships. These are the base for developing various scenarios.
- The identification of the rules that are fulfilled in the current state and others rules that are not fulfilled in the current state as a preliminary step for formulation of land redistribution alternative solutions.
- Generation of alternatives of the land redistribution plan that will be evaluated by the next module.

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[20] The direct rating of a numerical value method is a method, in which a value less than 1 is assigned as a weight for each factor.

[21] The qualitative rating method is a method, in which a qualitative scale from seven degrees is used for expressing the weights of factors (factors' relative importance). These degrees are (extremely high, very high, high, intermediate, moderate, low, and very low). These qualitative degrees or categories are converted afterwards to quantitative categories.

Third: The "Land Spatial Consolidation Expert System"- LandSpaCES Evaluation Module: (Demetriou et al. 2013, p. 81)

The third module is responsible for the evaluation of the alternatives for the land redistribution plan. It is based on the integration between GIS and MADM. The steps in this module are:

- The planners select a set of criteria for evaluating the alternatives including an alternative formulated by experts to be compared by alternatives generated by the system. These criteria include the mean size of the new parcels, a coefficient called "the mean parcel concentration coefficient (PCC)", and the change in landowners number.
- The output is a table called "effect table", in which the alternatives are represented in columns and the criteria in rows. The evaluation of each alternative with regards to each criterion is stated as a score and is represented in a specialized cell in this table.
- The obtained scores are standardized using suitable values functions, so that the scores' values are ranged from 0 to 1, (0 represents the worst alternative and 1 the best).
- A weight for each criterion (from the criteria for evaluating the alternatives resulted from the design module) is assigned either through "direct rating of a numerical value" method or "qualitative rating". LACONISS can also apply different scenarios for assigning the weights for the criteria at the same time. These scenarios are equal weights for all criteria, descending order of weights, ascending order of weights, and according to expert judgment.
- The overall performance for each alternative is calculated using a decision rule or aggregation model.
- The alternatives[22] are ranked with regards to the overall performance for each alternative using the aforementioned four weighting scenarios.
- A sensitivity analysis for identifying the sensitivity of the performance scores to the weights of the criteria using a method called "Triantaphyllou[23]".
- The optimal alternative is selected through trading-off among the results of ranking the performance of all the alternatives with regards to different weighting scenarios for the criteria. The selected optimal alternative is the input of the last module performing the last stage .

Fourth: The "Land Parceling System" -LandParcelS Module: (Demetriou et al. 2013, p. 81-82, and 86-87)

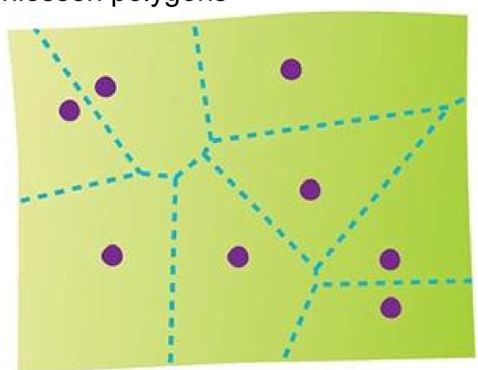
The fourth module is based on the integration between GIS and GA and MODM. This module is responsible for performing of automated land partitioning. As mentioned before, the land reallocation (or land consolidation) includes two main processes, which are land redistribution and land partitioning. After identifying the optimal alternative for land redistribution plan in the previous module, the second process of the land consolidation (that is the land partitioning) is performed in this module through the following steps:

- The optimization factors or parameters for the new parcels are selected, (e.g. the parameter of the targeted shape of new parcels, the size, and the land value).

[22] Alternative no.1 was developed by experts to be compared by the other 9 alternatives generated by the system with regards to four different criteria weighting scenarios.
[23] The sensitivity analysis method is named after the man, who developed it " Evangelos Triantaphyllou".

- Each parameter is calculated with regards to the selected alternative in the previous module using a suitable formula. This process is called optimization.
- In case that there are more than one parameter in the optimization process, a weighting method is used. The weight of each parameter represents its relative importance.
- A group of functions can be added to be used to detect and omit infeasible cases for parcels like parcels that are not connected to roads.
- The user identifies the first land block that will be partitioned and the area and number of parcels or ownerships that are supposed to be in this block.
- The system generates of a large number of solutions (alternatives for partitioning this block) by using a method called "Thiessen polygons[24]". The next figure shows an example for the Thiessen polygons.

Fig. (5.10) An example for the Thiessen polygons[25]



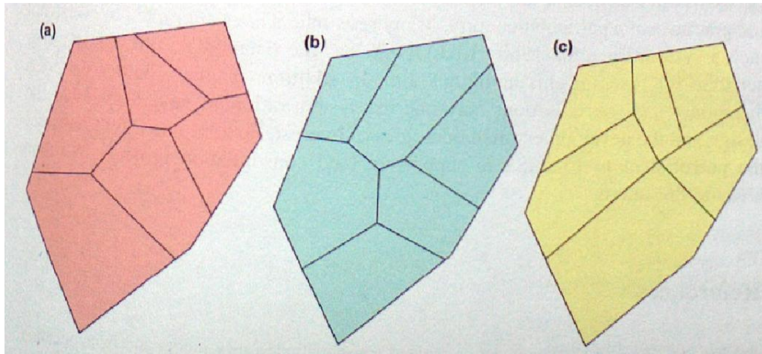
Source: The website of Esri support, GIS Dictionary, 2017

- A large number of solutions for lands partitioning are resulted, which are considered a multi-objective optimization problem. These polygons are evaluated using the MODM based on a function called "fitness function" that includes three probable combinations among the three parameters of land shape, value, and area. So, the final output for the first block are three partitioning cases as shown in the next figure.

[24] "Thiessen Polygons" are polygons that are generated from a group of sample points. Each Thiessen polygon identifies an area of impact surrounding its sample point, so that any point located within the polygon is nearer to the sample point of this polygon than any of the other sample points. Thiessen polygons are named after the American meteorologist, who developed these polygons "Alfred H. Thiessen" (1872-1931).(The website of Esri support, GIS Dictionary, 2017).

[25] Each polygon represents the area of impact surrounding the point called "the sample point of the polygon ". So, any point located inside each polygon (the area of impact) is nearer to the sample point of that polygon than any of the other sample points.

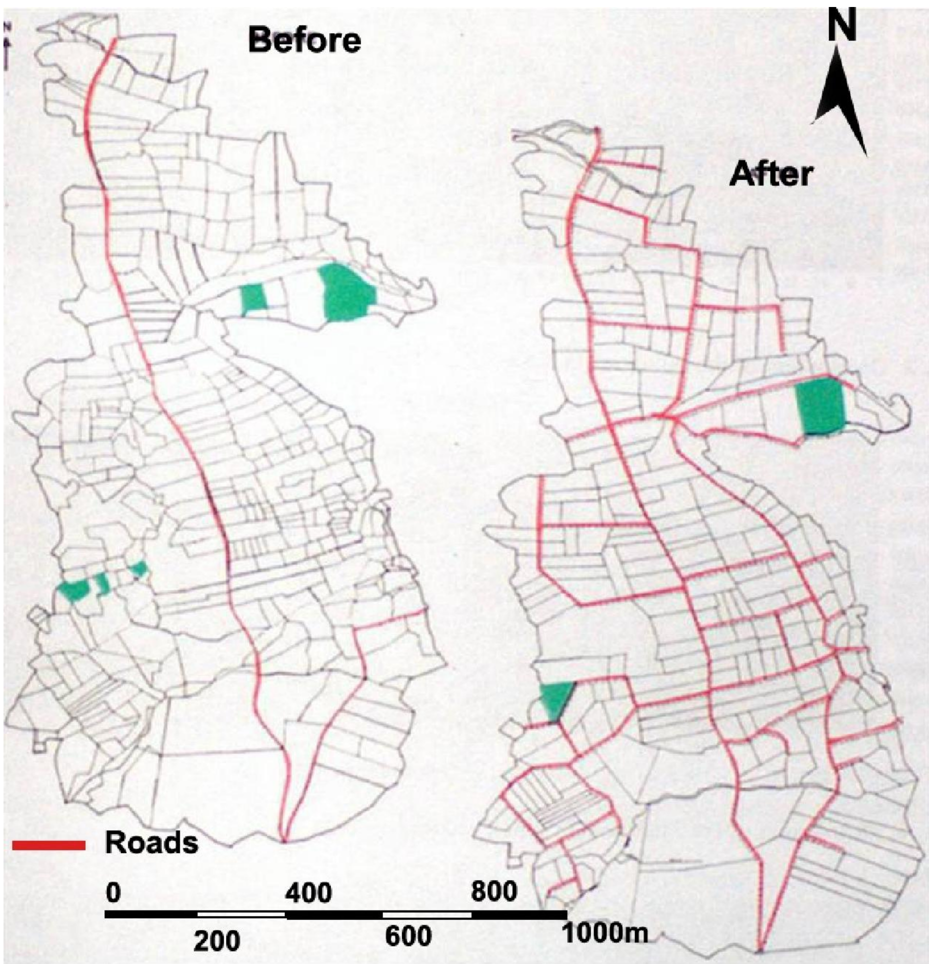
Fig. (5.11) The three optimization cases for the final output of the partitioning of the first block into six parcels using "LACONISS"



Source: Demetriou et al. 2013, p. 87 (reprinted with permission from Springer)

- All the previous is repeated for all blocks. The resulted subdivision for each block is visualized using GIS to obtain the final land consolidation plan as shown in the next figure.

Fig. (5.12) The study area before and after the application of "LACONISS"[26]



Source: Demetriou et al. 2013, p. 83 (reprinted with permission from Springer)

[26] The green plots were 5 lands before the application of the LACONISS, and became 2 after the application of the LACONISS.

(5.7.5) Developed or Used Tools in Cyprus' Example:

LACONISS system is the main tool in this example that consists of the three sub-systems with four modules. The first and the third sub-systems are represented in two modules, and the second is represented in two modules. The four modules are "Land Fragmentation System" (LandFragmentS Module), "Land Spatial Consolidation Expert System" (LandSpaCES Design Module), "Land Spatial Consolidation Expert System" (LandSpaCES Evaluation Module), and "Land Parcelling System" (LandParcelS Module).

Techniques:

- Expert System- ES, an artificial intelligence technique.
- The genetic algorithm (GA), which is a stochastic optimization technique that is used for solving complex non-linear optimization problems. (Demetriou et al. 2013, p. 81)

Methods:

- Multi-objective decision-making method (MODM),
- Multi-attribute decision-making method (MADM).
- Weighting methods either by "direct rating of a numerical value" method or "qualitative rating".
- A method called "Triantaphyllou" for performing sensitivity analysis.
- Thiessen polygons method.

(5.7.6) Scale of Application of Cyprus' Example:

"LACONISS" was applied on a case study area in Cyprus. This area is located in a district called "Paphos" in a village called "Chlorakas". (Demetriou et al. 2013, p. 82).

(5.7.7) Tasks Achieved in Cyprus' Example:

LACONISS is used in evaluating the current state of land fragmentation and generating alternatives for land redistribution plan, as well as selecting the most optimal alternative, and so obtaining the land consolidation (reallocation) plan.

(5.7.8) The State on which the Assessment Process is Done within Cyprus' Example:

The assessment process deals with a land management issue, as land consolidation is considered one of the land management's solutions for the land fragmentation problem. Because it aims at performing the optimal reformation for the current structure of land tenures in an area with the consideration of the suitable land consolidation legislation and the existing practices. (Demetriou et al. 2013, p. 74-75)

(5.7.9) The Learned Lessons from Cyprus' Example:

1. LACONISS integrates each of GIS, artificial intelligence, and multi-attribute decision-making methods.
2. ES is considered the most popular technique among artificial intelligence techniques because ES can emulate the human way of thinking in solving complicated (multi-aspect) decision-making problems like redistributing a fragmented area. The main two components of ES are a knowledge base and an inference engine. The knowledge base consists of IF-THEN rules. These rules are built according to the legislation, planners' experiences, thumb's rules, and others.
3. The genetic algorithm (GA) that is used for solving complex non-linear optimization problems.

4. MADM that is used to evaluate definite issue through many attributes or multi-criteria. This helps to choose the optimal alternative from many alternatives.
5. MODM that is used to evaluate large number of solutions using a function called "fitness function" within a multi-objective optimization problem.
6. On one hand, a definite weight is assigned for each criterion using weight methods ("direct rating of a numerical value" method or "qualitative rating"). On the other hand, different scenarios are applied for assigning the weights for each criterion.
7. The calculated values of the fragmentations' factors are standardized to be ranged from 0 to 1 by using a function that was developed through experts in land consolidation.
8. The study area is divided into blocks.

(5.7.10) Discussion on Cyprus' Example:

(5.7.10.1) Strengths of Cyprus' Example:

- LACONISS can use different scenarios for assigning the weights for the criteria for evaluating the alternatives. (Demetriou et al. 2013, p. 85).
- The generated alternatives by LACONISS are considered more efficient than the alternatives that are manually developed by experts. (Demetriou et al. 2013, p. 86).
- The procedure performed by LACONISS for the land consolidation plans emulates the planners' way of thinking for solving the fragmentation problem. (Demetriou et al. 2013, p. 73).
- LACONISS is considered the base for establishing a generic system that can be flexible to be applied in any country for land consolidation projects. (Demetriou et al. 2013, p. 74)
- Planners from various specifications' backgrounds may see LACONISS as a rational system. (Demetriou et al. 2013, p. 88).
- As aforementioned in the introduction to this system, LACONISS is promising in supporting land consolidation projects in urban areas in the future. (Demetriou et al. 2013, p. 88).

(5.7.10.2) Weaknesses of Cyprus' Example:

- A new algorithm for the module concerning with partitioning process in LACONISS is required to be developed, so that the parameters (like land shape and area) can be directly involved in the optimization process, which is not the current case in LACONISS. There is also a need to introducing a " local optimizer" to be included in the current optimization process. (Demetriou et al. 2013, p. 87).
- The applied methodology is complicated that leads to a long running time for the algorithm, which may take between five to ten hours for each land block. This means that LACONISS needs a more powerful programming language. (Demetriou et al. 2013, p. 88).
- LACONISS lacks the option to be customized by land consolidation legislation and practices for various countries. As it is only customized by the land consolidation legislation and practices in Cyprus. (Demetriou et al. 2013, p. 88).
- Despite the results of the application of LACONISS on the case study are seem to be successful, LACONISS still needs several improvements. For example, an editable knowledge base and more rules should be added to improve the performance. Extra data should be also added like the preferences of the actual landowners needs. As well as, it

will be beneficial to formulate an explanation facility for how the decisions are made using LACONISS to facilitate the communication process between planners or projects' managers and the landowners. (Demetriou et al. 2013, p. 85).

- LACONISS needs to be tested on other cases study areas to confirm on its performance. (Demetriou et al. 2013, p. 85).

(5.8) INDEX

INDEX is considered a kind of rule-based geographic information system. INDEX includes a group of indicators that are applied to evaluate scenarios for choosing the best one, which can attain the user predefined goals. (Allen 2008, p.139).

It has a spread application in many locations all over the world. By the year 2006, it has been used in 690 locations in 36 states and the district of Columbia in USA, as well as in Australia, Canada, China, Japan, and Spain (Allen 2008, p.153). Within all these applications, a number of 4100 scenarios were created through INDEX (Allen 2008, p.156). INDEX was licensed to 157 organizations, which are local governments and regional planning agencies (Allen 2008, p.154). It has been used within a number of 19 universities in various research projects (Allen 2008, p.155). All the previous indicate the success of INDEX as a PSS, so that it is beneficial to study this software as an example for PSSs, which can be applied on several cases.

Before analyzing INDEX as a PSS software, it is important to introduce when, where, and how this PSS emerged, and what were the motivations for developing it: (Allen 2008, p.139)

The first introduction for INDEX in the planning field was in 1994 to be a support system for people, who work in reviewing the plans of the land use and transportations in institutions on each of the local or regional levels. There were two targets for developing INDEX. The first was to increase the quantity and quality of the outcomes of the consulting process of the stakeholders sharing in the planning activities. The second target was supporting the planning institutions, which work on local or regional levels, and are interested in new PSSs offered in the market.

The vision of INDEX's developers is to make a simple or easy-going tool, which is used to generate scenarios and select the best one to be a practical tool for institutions, which have limited technical resources and time to achieve plans. The current planning activities and long-term activities were the target activities for this tool, as many institutions' activities have concentrated on current development projects at that time.

The target users for INDEX are specialized people in land-uses and transportations (serving not a large number of persons from 50,000 to 500,000). These specialized people should have sufficient technical resources to benefit from this tool.

<u>(5.8.1) Objectives of INDEX Example:</u>

<u>There are five main objectives for establishing INDEX, which are</u>: (Allen 2008, p.141-142)

1. Improvement the decision making process: The main task of this PSS is to evaluate suggested scenarios by using urban indicators, and provide score for each scenario, so that the quantitative form of the indicators results help to attain more logical, reliability, and objectivity in deciding or selecting the most appropriate scenario.

2. Attaining an integrated framework for dealing with the issues of the land-use planning, transportation, and environment: It was targeted from the design of INDEX to use the

interdisciplinary indictors group in it in the assessment of the scenarios regarding the land-uses and transportation. However, the environment preservation had be considered in this assessment process. For instance, when evaluating some land-uses changes, INDEX provides the user with expectation regarding the effects of these land-uses changes on the travel behavior and the greenhouse gas as well.

3. Supporting stages from the planning till implementation: INDEX can work as an institutional tool for supporting long term projects. So, it is not necessary that the team, who begin any project to finalize it. Because INDEX informs the users with the original goals of the project to confirm on the consistency of the decision making process with the original goals. In order to ensure that, INDEX performs the following tasks for every project:

- The establishment of the integrated database to support the community information regarding the study area.
- The identification of the benchmark conditions and the issues to analyze the existing conditions.
- The creation and evaluation of the alternative plans or scenarios.
- Selection of the most appropriate scenario.
- Checking the feasibility of the selected scenario and performing the necessity modifications in it to confirm on its suitability for the community needs.
- Evaluating the progress of the implementation and the review of the updates in benchmarks with regards to the goals of the project.

4.Provision of interactive environment for the participants in the planning process: As it will be illustrated latter, INDEX has the potential of involving many participants in the planning process.

5.Supporting the smart growth and the formulation of the sustainable development policies: The indicators set in INDEX concentrate on the assessment of environmental suitability of multimodal travel on the neighborhood level.

<u>The target users for INDEX are categorized on three levels</u>: (Allen 2008, p.143)

1. The software administrators level; this category of users should have advanced experience with the ArcGIS™ to deal with INDEX.
2. General users level; who should have minimum level of knowledge in ArcGIS™.
3. Stakeholders or citizens level; who have basic knowledge in computer usage.

<u>(5.8.2) Research Problem of INDEX Example:</u>

About 40,000 agencies in USA that manage municipalities, townships, counties, regional, and state agencies, were making huge amount of decisions. These decisions have deeply affected each of built and natural environments for tens of years. These decisions have concerned with changes in plans, or changes in zoning, or subdividing lands, or extraction permits for many site projects. The problem was that the results from these decisions were sometimes contradicting with the environmental and the economic points of views, which has caused many negative consequences. Also, despite the effective usage of much known PSS such GIS on the local level, the GIS was used only as libraries or storage tool for cartographical data instead of utilizing and benefiting from its potentials in planning and evaluation processes. In 1994, GIS was seen as unused tool. Therefore, there was a need for INDEX to be the tool for efficiently utilizing the unused potentials in the GIS. (Allen 2008, p.139-140).

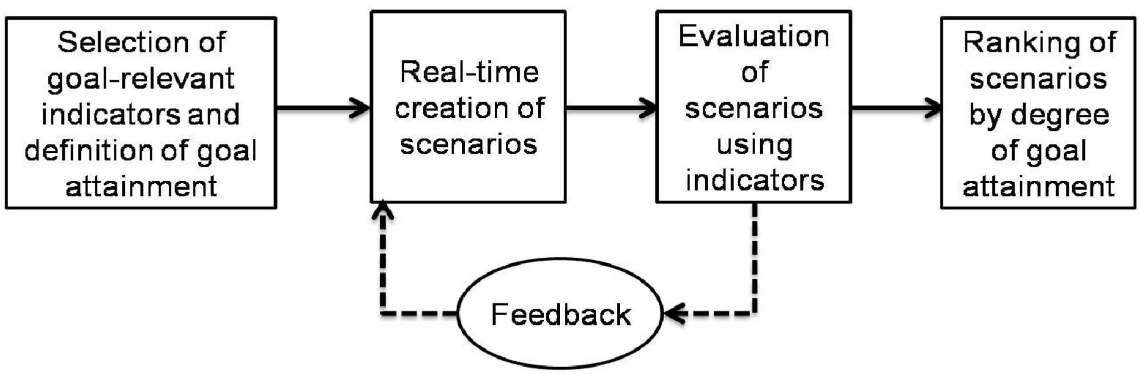
(5.8.3) Focus/Major Issues of INDEX Example:

The main focus is the scenarios' formulation of plans for zoning and transportations with regards to the demographics, land-uses, housing, employment, recreation facilities, environment preservation, and travel conditions.

(5.8.4) Methodology/ Approach of INDEX Example: (Allen 2008, p.144-153)

It takes a couple of weeks[27] to apply INDEX on any study area depending on the professionalism of the team work (one to three persons) and the data availability. Scenarios may be sketched in minutes or hours depending on their size, the indicators' number, indicators' types, and the complication of the scenarios. The next figure shows the general approach for generating plans using INDEX. First, the development goals from the proposed plan are identified. Then, the indicators measuring these goals are selected. Afterwards, the alternative scenarios from the plan are created in real time. And finally, the scenarios are evaluated, and the most appropriate scenario is selected.

Fig. (5.13) The general approach for generating plans using INDEX



Source: Allen 2008, p.143 (reprinted with permission from the Lincoln Institute of Land Policy, USA)

The methodology in applying INDEX includes two main stages, which are the preparation of the study area (a city or region) and the preparation of the studies concerning the study area. The steps are stated in the following:

1.The boundary for the study area is identified. The appropriate indicators for this area (normally 75 indictors or more) are selected regarding the fields of demographics, land uses, housing, employment, recreation facilities, environment preservation, and travel conditions.

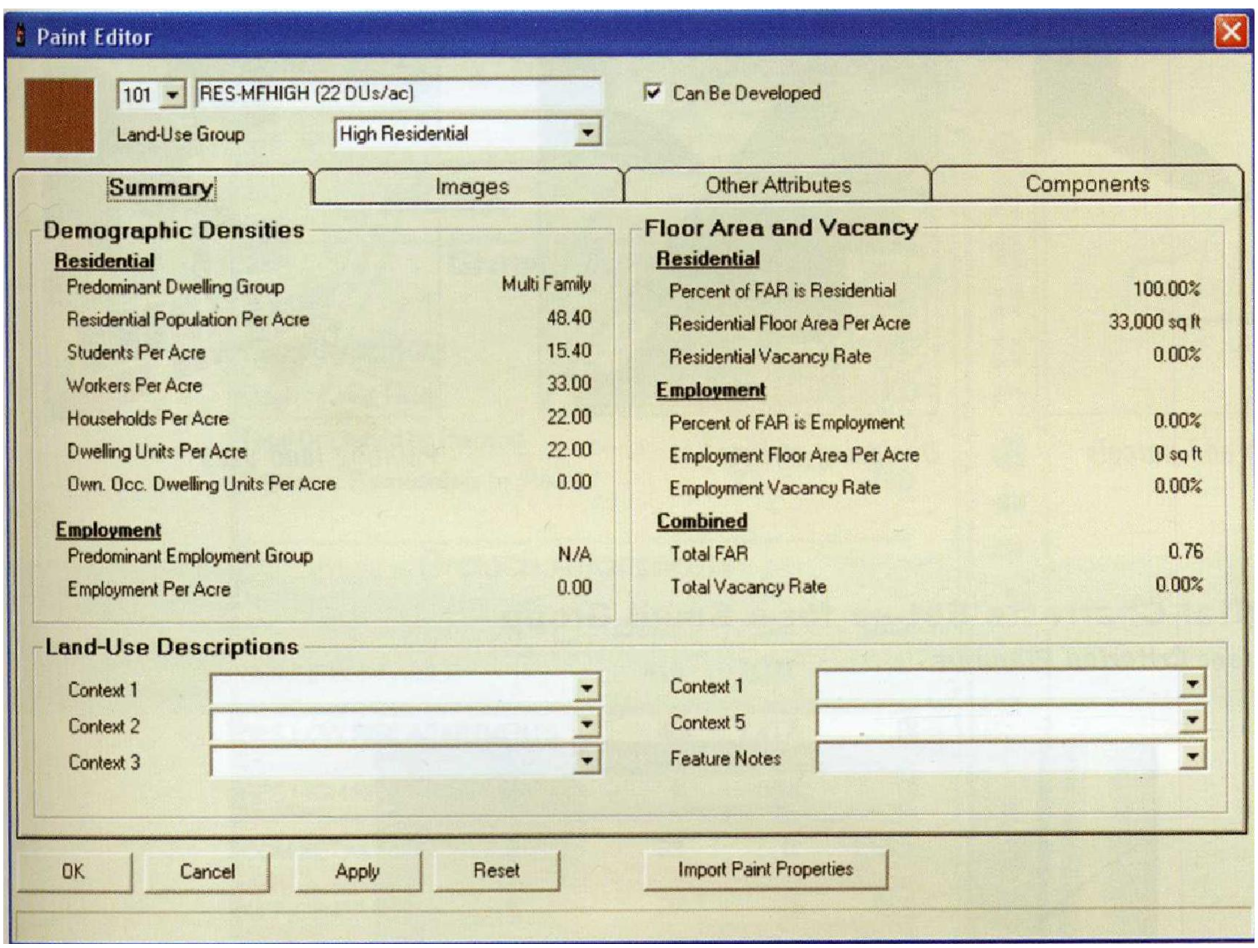
2. The indicators are applied on the current state of the study area, and so the results fulfilling the plan's goals are identified. First, the indicators are applied on the current state of the study area to identify, where the study area is from the plan goals. Then, the users should identify the accepted values range for each indicator' score. This means the minimum and maximum values for each indicator. As less than the minimum value or more than the maximum, the plan's objectives will not attained. The weight for each indicator is also identified, which represents the relative importance for the factor measured by this indicator with regards to the indicators group. This is to calculate the overall scenario score or the degree of each scenario's attainment for the plan's objectives or goals.

[27] This period increases in case of establishment of the digital charrette (as it will be illustrated latter) because this requires time for the preparation of this charrette.

The outputs of this step are represented in a table. The table includes each of the overall importance of each topic (e.g. housing) with regards to the overall goal and the weight of each indicator with regards to the topic, which this indicator is belonged to, (e.g. dwelling distance is related to the housing topic). The positive or negative movement of each indicator's score regarding the plan goal is also included in the table. For example, the decrease in the value of the “distance to transit” indicator supports the attainment of the plan goal and vice versa. Or, the increase in the value of “the employee density” indicator supports the attainment of the plan goal, and vice versa. The table also includes the worst indictors' scores, the medium for the indictors' scores, and the best indictors' scores. And finally, the actual indictors' scores resulted from applying the indicators on the current state of the study area (before and after multiplying them with the assigned weights) are stated in the table.

3. The land-use plan is combined with the transportation palette. This is the step preceding the sketching for the scenarios. In this step, the features representing land-uses and transportation are predefined. Using INDEX, up to 250 land-use types can be predefined with all the related characteristics for each, (or as they are named “land-use paints”). The next figure shows the window concerning the predefinition of the features representing land-uses and transportation.

Fig. (5.14) The dialogue for defining the land-use properties (land-use paint editor)



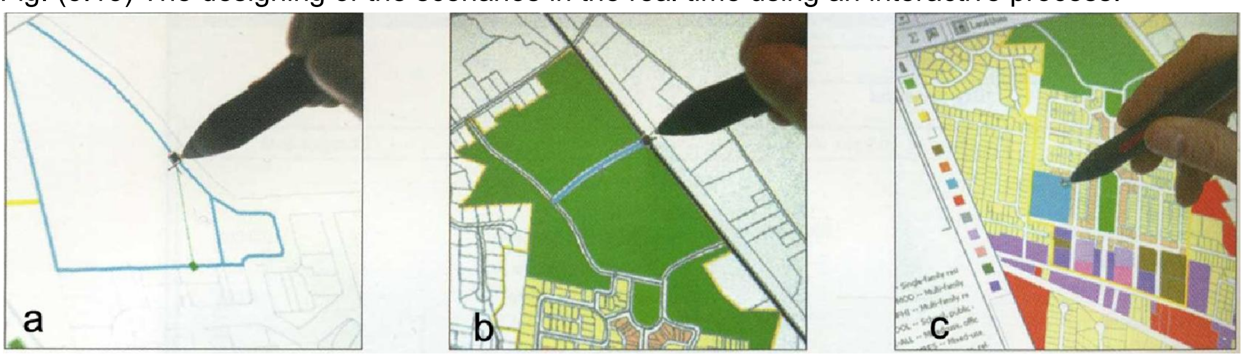
Source: Allen 2008, p.149 (reprinted with permission from the Lincoln Institute of Land Policy, USA)

At the top, the user can select the "land-use group" (e.g. the high residential type). And all the related characteristics or properties are predefined in the tab called "summary" (e.g. the households per acre or the type of the predominant dwelling group). In case that there are available images, these images are entered using the second tab called "images" in addition to two more tabs for "other attributes" and "components". At the bottom, there are land-use descriptions, where all the descriptions concerning the type of the land-use group are identified. Also, there is an option to import the land-use properties from other source to INDEX.

4. The scenarios are designed via an interactive process. Many public consulting meetings (in the form of workshops) are held to create some scenarios for the study area with the help of what is called "the digital charrette" in INDEX. Within these workshops, the stakeholders can decide and negotiate about zoning, land-uses, the street networks, and other issues. And so, the land-uses types are selected from the predefined palette by just clicking on each parcel, and then identify its land-use type with all its properties, which were predefined in the previous step.

The next figure shows how blocks are divided into parcels (a), and how the street network is designed (b), and how each land-use type for each parcel is identified(c).

Fig. (5.15) The designing of the scenarios in the real time using an interactive process.



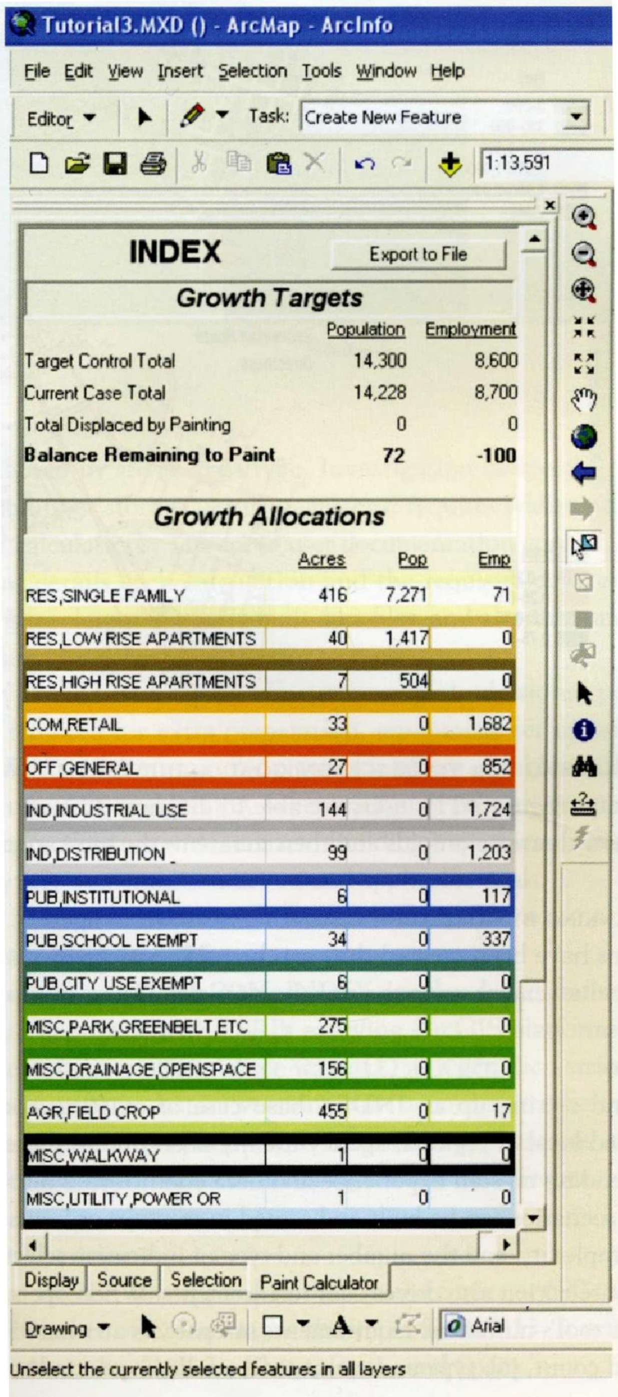
Source: Allen 2008, p.150 (reprinted with permission from the Lincoln Institute of Land Policy, USA)

5. The scenarios are tracked using what is called "paint calculator". In this step, the development volume and the expected growth in each scenario are tracked or identified. INDEX identifies how much area is allocated for each land-use type, and how many population are expected to be in this type (e.g. commercial land-use has no population or residents in it), and others.

The next figure shows the scenario tracking process using INDEX in the ArcMap™ interface[28] with regards to the volume of the development in each land use type.

[28] ArcMap is the main program of Esri's ArcGIS package of geospatial processing software, and is used mainly for visualizing, editing, creating, and analyzing of the geospatial data.

Fig. (5.16) The scenario tracking process (paint calculator) regarding development volume of each land-use type in the ArcMap™ interface [29]



Source: Allen 2008, p.151(reprinted with permission from the Lincoln Institute of Land Policy, USA)

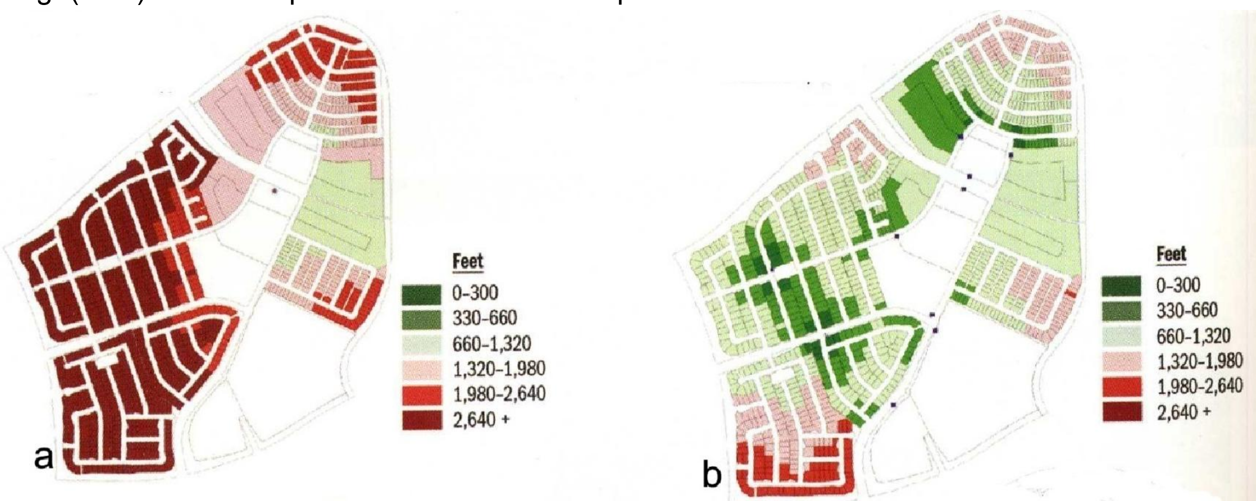
6. The plan's goals achievement in each scenario is assessed by using indicators scoring. In this step, the indicators are applied on each scenario to rank the scenarios and identify the best one. Then, the visualization of the indicators' scores is performed by using maps called "indicators

[29] Each row concerns with a land-use type.

maps". Each map represents one indicator and clarifies (using colored areas) the results of each indicator with regards to each part in the study area.

For example, the next figure shows two examples for indicators maps of two factors, which are “the housing areas connection with grocery stores” (a) and “the housing areas connection with transport stations” (b). As shown, the areas that have problems regarding the factor measured by each indicator are colored in red. And so, the scenario presented in this figure should be modified by concentrating on the factors (measured by these indicators) in the study area. Therefore, the purpose from these maps is to clarify the strong and the weak points in each scenario to consider them in editing or modifying this scenario.

Fig. (5.17) Two examples for the indicators maps



Source: Allen 2008, p.152 (reprinted with permission from the Lincoln Institute of Land Policy, USA)

7. The scenarios and the current state of the study area are ranked with regards to their attainment to the overall goal of the plan. This is through applying the weights of the indicators on the scenarios, which were previously identified and applied on the current state in the second step. And so, the overall results for each generated scenario and the current state are compared and ranked according to the overall indicators’ results. Then, the best scenario that attains the highest overall result value is selected.

<u>(5.8.5) Developed or Used Tools in INDEX Example:</u>

The assessment tool in this example is INDEX software application (non-open source), which is an ArcMap extension running through ESRI's ArcGIS™ and the operating system Microsoft® Windows. It is developed from ArcObjects and Visual Basic elements, which facilitate the operation process with the programs ArcView®, ArcEditor™, or ArcInfo®. It is optional to work with programs ArcScene and ArcIMS®. INDEX has two forms or versions, the first form is called "INDEX Plan-Builder", which is on the parcel level, and the second form is called "Paint the region", which is on the region level. (Allen 2008, p.143).

INDEX has nine modules, which are the “regional”, “research”, “case”, “element”, “indicator”, “evaluation and weight”, “case comparison”, as well as “visualization” and “link” modules: (Li and Jiao 2013, p.10,11)

- The regional module offers a geographical and hierarchical way for the study area organization and preparation.

- The research module is dependent on the geographic scale of the study area or on the focus of the research's content.
- The case module is the tool for performing a planning scheme (case) that may be either for current or expected state.
- The element module is the database for the indicators calculations.
- The indicator module offers the group of indicators.
- The evaluation and weight module provides the indicators and introduces the accepted rating range of indices' scores.
- The case comparative module works using tables and maps.
- The visualization and link module are used for presenting the results and connecting with other models.

(5.8.6) Scale of Application of INDEX Example:

The scales of application of INDEX are on the area, city, and regional levels. However, the average size for applying INDEX is the neighborhood size with area range between 100 to 500 acres[30]. (Allen 2008, p.155)

(5.8.7) Tasks Achieved in INDEX Example:

The main tasks are: (Allen 2008, p.143)

1.Generation or updating plans and obtaining alternative scenarios for them.

2.Processing the proposals for the current development.

3.Studying the suitability of the regional transportation models with the scenarios for the land-use planning.

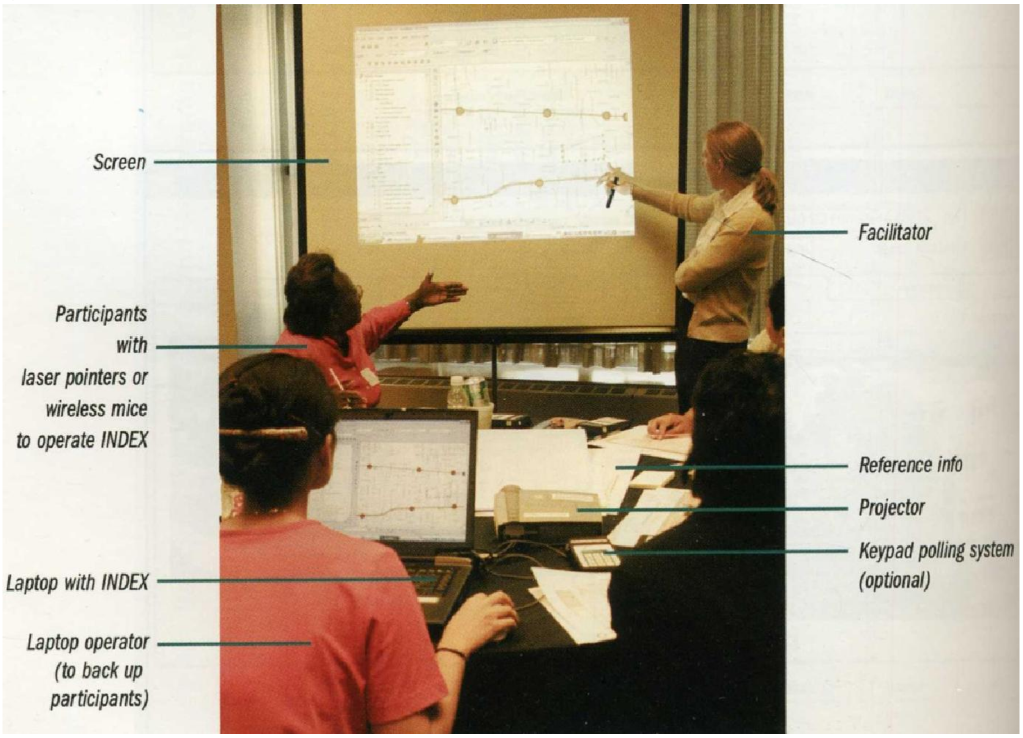
The duties performed by INDEX (that are considered the steps of any assessment process done by INDEX) are: (Allen 2008, p.143-144)

1. The current conditions of the community are evaluated in the assessment of the current circumstances in the study area. This means the determination of each of the strong points and the weak points in this area. These points represent the inputs for the identification of the plan's objectives, the benchmarks for comparing the future scenarios, and the updating of the gradual progress in case of long term objectives.

2. The future scenarios are formulated through the interactivity of INDEX. INDEX gives the opportunity to design the scenarios for land-use and transportation in real time. This means that the stakeholders can sit together. And with the help of the "the digital charrette", they can decide and negotiate about zoning, land-uses, the street networks, and other issues by using laser points or wireless mice. This is through a coordinator or facilitator person to organize the discussions and an operator performs their decisions immediately as it shown in the next figure.

[30] 1 acre= 4046.85642 m^2

Fig. (5.18) The digital charrette using INDEX for a small group



Source: Allen 2008, p.150 (reprinted with permission from the Lincoln Institute of Land Policy, USA)

3.The generated scenarios are evaluated by using indicators. And so, the indicators' scores are visualized using maps to clarify the strong and the weak points in each scenario, and take them in consideration in editing or modifying this scenario.

4. The scenarios are ranked, so that each scenario gets a score expressing to what extent this scenario achieves the overall goal by using rating and weighting functions.

5. The best scenario is selected and is put in a formal plan. Each stage in implementing the plan is evaluated, and the gradual progress is monitored as well. At the same time, the current circumstances are updated to confirm on the feasibility of the plan.

<u>(5.8.8) The State on which the Assessment Process is Done within INDEX Example:</u>

INDEX evaluates the current state, and supports the generation of planning scenarios for the study area and compares between the current and planning scenarios using urban indicators (Li and Jiao 2013, p.10).

<u>(5.8.9) The Learned Lessons from INDEX Example:</u>

1.The list of indicators used in INDEX is beneficial. It is available in a user document that contains indicators' dictionary to clarify the concept of each indicator with the details for indicators’ formulas and calculation and their required data. (Allen 2008, p.153).

2.There is an integration between land-use and transportation planning with the consideration of the environmental issues.

3.The features of the land-uses and transportation are predefined with all the related characteristics or properties for each feature.

4.The scenarios are tracked through the identification of the development volume and expected growth in each scenario. INDEX determines how much area is allocated for each land-use type, and how many population are expected to be in each type.

5.The attainment of the plan's goals is assessed in each scenario by using indicators scoring for ranking the scenarios and identifying the best one.
6.The indicators' scores are visualized using maps called "indicators maps". Each map represents one indicator, and clarifies through colors the results of each indicator for identifying the strong and weak points in each scenario to consider them in modifying this scenario.
7. The sustainability of the built environment is evaluated on a small level like the detailed parcel level.
8. INDEX provides an interactive potential among stakeholders during the sketching scenarios process.

(5.8.10) Discussion on INDEX Example:

According to Allen (2008), the benefits from using PSS (especially INDEX) are more than their application's difficulties like the lack of experience of the employers in using such tools in the local and regional organizations. The use of these tools is still limited to some simple tasks like the permits' tracking, simple GIS mapping processes, and the modeling of traffic impact on the site level. (Allen 2008, p.163).

(5.8.10.1) Strengths of INDEX Example:

INDEX has potentials of GIS mapping, and at the same time is considered an efficient tool for evaluating the developed scenarios and monitoring the implementation processes of long-term land-use plans. (Li and Jiao 2013, p.11).

The following strengths were concluded after analyzing its application the planning field between the two years 1994 and 2006 by Allen (2008). Allen confirmed that these strengths can be increased or decreased depending on to what extent the users in organizations adopt INDEX: (Allen 2008, p.163-164)

- INDEX provides the decision making process with more objectivity. The idea of scoring scenarios using indicators has been approved by practitioners and public. Because the indicators scores support the decision making process in selecting the best scenario for land-use and transportation plans with regards to the environmental considerations.
- INDEX helps to perform the integration among each of land-uses, transportation, and environmental issues in the assessment process of the scenarios.
- INDEX supports the whole planning process from the plan's formulation till the plan's implementation, which is considered process that is performed in a long period rather than supporting day by day processes.
- INDEX supports the interactive process between stakeholders in real time by using digital charrette, which is considered the widest used potential in INDEX. Practitioners believe that involving the stakeholders in sketching scenarios for a plan helps in the success of this plan.
- INDEX is considered sensitive for each of smart growth and sustainable development polices. INDEX has increased the awareness of each of practitioners and public towards sustainability and smart growth. Because the indictors used in INDEX can assess the sustainability of the built environment on a small level like the detailed parcel level.

(5.8.10.2) Weaknesses of INDEX Example:

The main disadvantage in INDEX is that it requires detailed GIS data, which may be not available all the time. (Li and Jiao 2013, p.11). There are many environmental and economic problems resulted from the weak integration between the land-uses and transportations. Despite the previously mentioned strengths and benefits gained from applying INDEX, there are still the following challenges facing INDEX. These were concluded after analyzing its application the planning field between the two years 1994 and 2006 by Allen (2008): (Allen 2008, p.164-165)

- The staffs in organizations have limited experiences in using INDEX because of several causes. These are shortage in available time for staff to learn how to use INDEX. The concept of using each of urban formulation, transportation, and environmental factors in modeling land-use scenarios is also considered a bit new. As well as, the quick improvements in these kinds of tools make the matter difficult for the practitioners to update themselves with these improvements. In addition to this, there is a lack of experience of stakeholders in applying INDEX in a real time interactive process.
- There are complications and bureaucracy problems within some organizations, which cause the separation between the land-use planning and the transportation planning. Also, the weak application of the information technology-IT within these two types of planning has limited the success of INDEX and other PSSs.
- There is a problem of limited equipments, as local governments normally have limited equipments and facilities.
- The cost of the license of INDEX is considered high. As despite the deceasing of its price by time, it is still higher than many local governments' budgets.
- There is a lack of authorities' support, which is resulted from their unawareness of the PSSs’ effectiveness in planning process.
- There is a shortage in data either the data is not available in the required types or on the required scale.

(5.9) USA's Example:

The story of the tool in this example began with initiatives of Federal government in USA (partnership for sustainable communities) to assign some financial resources for developing scenario planning tools. This is to attain an integration among housing, urban development, transportation, and environmental planning in the planning process. (Minner 2015, p. 410).

So, a scenario planning analytics tool called “Envision Tomorrow-ET [31]” (an open source tool) was developed as an extension of the ArcMap™ software (ESRI)[32]. After a year of discussions with IBM (a partner in the initial proposal for the tool), a university-based research team and the Fregonese Associate[33] decided to develop a PSS as an extension to GIS rather than creating of a PSS from scratch (Minner 2015, p. 413). Then the ET was completed later through a research project called “Sustainable Places Project” in Central Texas. (Minner 2015, p. 412).

[31] The ET was established between 2010 and 2012.

[32] The market domination of ArcGIS™ as a GIS platform in the local and regional governmental planning departments was the main cause for choosing this platform in establishing this scenario analysis tool (Minner 2015, p.413).

[33] Fregonese Associate is a well-known consulting company in Portland, Oregon (USA) that developed the ET tool with the research team.

This example was chosen to be studied as a guide example because the tool (used in it) has been applied on the community and the district level, which is the proposed application level in this dissertation. Also this example has aimed to assess the sustainability attainment in the scenarios for land use plans, which is also aimed in this dissertation.

According to Minner (2015), it was a competition among the invited local governments within the proposed region to apply the ET in performing their plans as pilot areas. The sites were selected according to the possibility to demonstrate the sustainability of mixed-use development in each site. (Minner 2015, p. 412-413)

(5.9.1) Objectives of USA's Example:

The main objective is the establishment an open source PSS, which is an analytical GIS tool for facilitating each of the public participation and analysis processes in the planning activities of local and regional planning agencies in the Austin metropolitan region (Texas). (Minner 2015, p. 411). So, this open source tool mainly aims at supporting the planning process in generating and assessing development scenarios on the local and regional levels in this region.

(5.9.2) Research Problem of USA's Example:

The main problem is the need for scenario planning models or tools, which support the public participation in planning. As GIS can just provide simple mapping and access to basic information with rare support for the spatial analysis processes. (Minner 2015, p. 411).

(5.9.3) Focus/Major Issues of USA's Example:

The main issues in this example are scenario planning tools and their usage in the creation, visualization, and analysis of alternative scenarios. This is in order that each of land-use, transportation, the economic, environmental, and social concerns are comprehensively considered. (Minner 2015, p. 409-410).

(5.9.4) Methodology/ Approach of USA's Example**:**

The main idea in this experience is based on the interaction between each of human actors[34] and non-human actors[35] within the planning process, which are considered in Envision Tomorrow's assessing calculations. (Minner 2015, p. 412).

The ET tool was applied on four small suburban communities and another urban district in Austin. The approach used with these four small communities has differed than what was used with this district. (Minner 2015, p. 414)

The first approach used with the four communities has included three public participation processes and consisted of three steps, which are visioning workshops, a planning charrette, and an open house. (Minner 2015, p. 414).

The first step was the preparation for the visioning workshops. These were prepared by some planning consultant companies, experts in scenario planning and public engagement, "the Capital Area Planning Council of Governments-CAPCOG", and the research team of Austin in Texas University. These workshops began through a committee of stakeholders from each

[34] E.g. planners and consultants, representatives of organizations involved in establishing and testing the ET, and public participants in assessment process.

[35] E.g. the tool itself, the systems of buildings, trees, and storm-water management, other built environment features, and green infrastructure.

community to perform an initial community visioning workshop. The committee's members were supposed to choose the most significant indicators for evaluating the scenarios, discuss goals and values, as well as present ideas concerning the development in their community. (Minner 2015, p. 414).

The second step was the planning charrette, in which planning consultants presented a brief on forming planning scenarios for each community, after that the participants were divided into small groups of 5–10 people. In each group, the participants were provided with large aerial maps for their community and a facilitator to motivate them to browse a list of development directions or planning scenarios. These were various mixes of options for the uses of the buildings and lands, as well as the number of expected jobs or housing units that would be available per acre in each area. The participants were also provided by some images to clarify what each development direction would look like in case that it is executed. Then, the facilitator of each group asked the participants to put what are called "development chips" on the map of their community to generate a vision for what would be the community look like in the future. At the same time, the selected development direction or planning scenario was drawn by a trained digitizer on a laptop installed with each of ArcGIS™ and the ET extension for ArcMap™ software. And so, the participants chose a title expressing their common vision for their community. After that, representatives from each group presented their common scenario and vision to all participants from all groups at the end of the charrette (Minner 2015, p. 414).

The third step is called the open house, which was a third meeting for each community. The main purpose from this meeting was to select the best scenario out of three scenarios, which have the best indicators results. The results of the most important indicators (assessing these three scenarios) were also presented to facilitate the comparison among the three scenarios. Conversions were performed among the attendees and the team work, in addition of filling out a questionnaire to identify the finally selected scenario. (Minner 2015, p. 414).

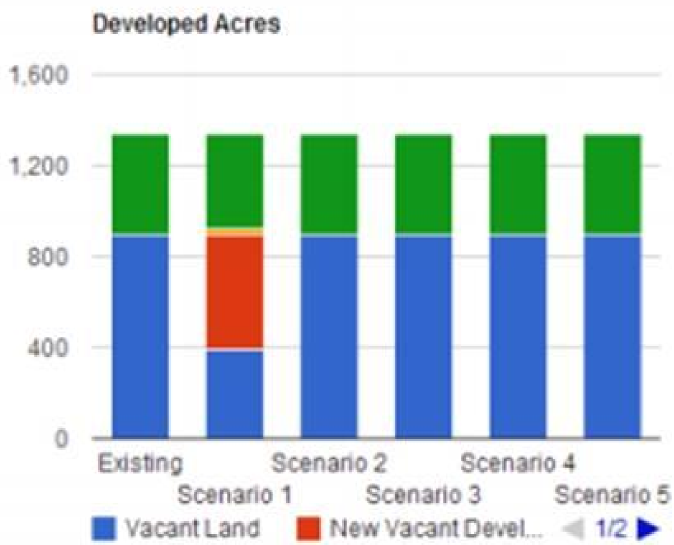
The next figure shows an example for the indicators results of a current state and some planning scenarios.

Fig. (5.19) An example for the indicators results of a current state and some planning scenarios

View Results

Developed Acres

Description	Existing	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Vacant Land	895	390	895	895	895	895
New Vacant Developed Land	0	504	0	0	0	0
New Developed / Infill	0	29	0	0	0	0
Existing Developed Acres	443	414	443	443	443	443



Developed Acres

Description	Existing	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Vacant Land	66.9%	29.2%	66.9%	66.9%	66.9%	66.9%
New Vacant Developed Land	0.0%	37.7%	0.0%	0.0%	0.0%	0.0%

Source: a guide for using web-based Envision Tomorrow, the website of Envision Tomorrow Online- ETO, 2017.

The second approach used with the "South Shores District" in Austin was different, as the planning process in Austin differed from the other four small communities. The following steps were done: (Minner 2015, p. 415)

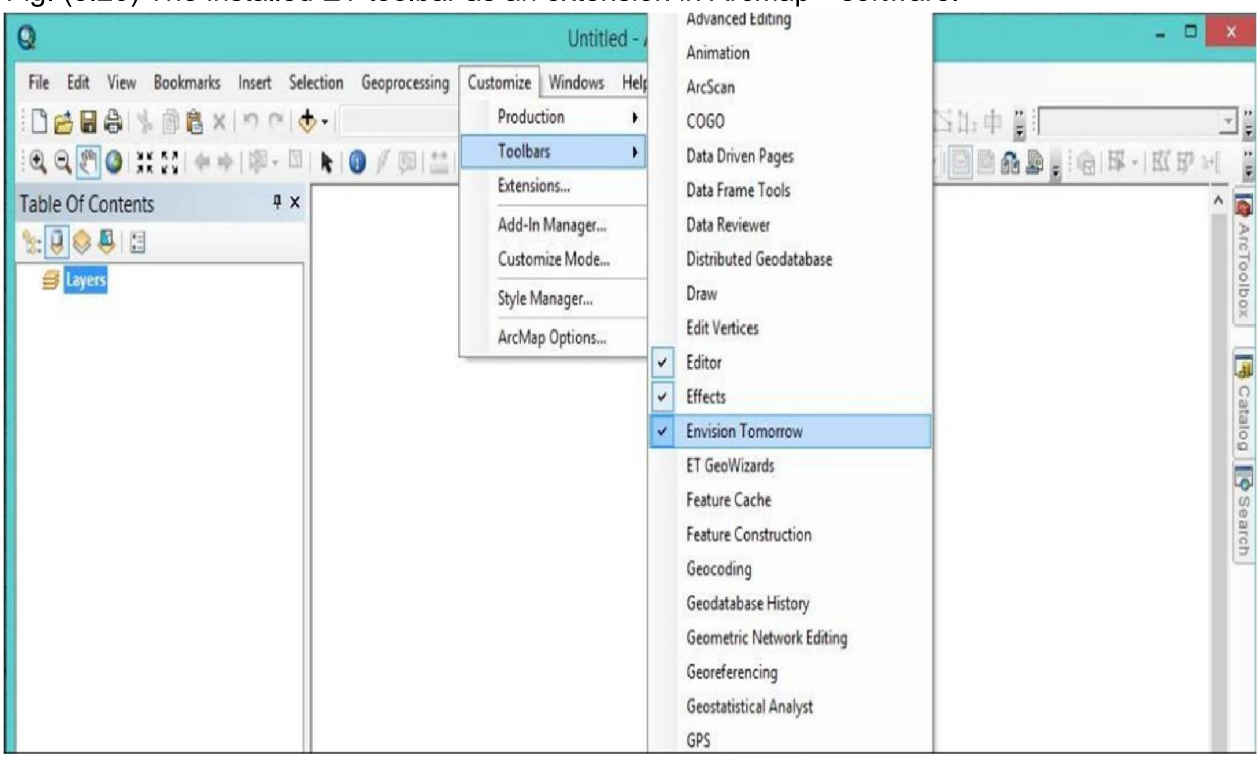
- The current conditions were analyzed by the planners and the company that developed the ET to identify a scenario before establishing the public meeting. The priority in generating this scenario was the current market conditions.
- An additional scenario was also generated through ET by students of the Urban Futures Lab in the University of Texas.
- Then a workshop was organized in the "South Shores District" for presenting these two planning scenarios and the ET tool for the participants from the district as well.

Notice: The ET was used in the South Shores District process only for supporting the planners and researchers or students to realize the market conditions, and to study the feasibility and outcomes of the scenarios. As the tool was not functioned there to integrate the public participation into the process of scenarios generation (as it happened with the other four communities), but just used in organizing an informational meeting with the public. (Minner 2015, p. 415).

(5.9.5) Developed or Used Tools in USA's Example:

The main tool is Envision Tomorrow- ET (an open source scenario planning package as an ArcMap™ extension). The data entry for this extension is represented in linked Excel spreadsheets with the geodatabase including the scenarios layers.

Fig. (5.20) The installed ET toolbar as an extension in ArcMap™software.



Source: a Tutorial for using the Envision Tomorrow 'Sample Dataset', the website of Envision Tomorrow, 2017)

This ArcMap™ extension includes a group of analysis tools for assessing the current state and scenario design tools for generating alternatives of future development scenarios. And recently, there are updates for adding 20 analysis tools and scenario indicators to be used through the standard Envision Tomorrow tools. (The website of Envision Tomorrow, "About Envision Tomorrow", 2017).

(5.9.6) Scale of Application of USA's Example:

The Envision Tomorrow can be applied on the district, community, and regional-scale. There is also another version for this tool (not illustrated here), which is applied on the building scale. (Minner 2015, p. 417).

(5.9.7) Tasks Achieved in USA's Example:

ET helps in analyzing the current state for the community growth and the effects of any future development direction within the generated scenarios on each of the public health, financial issues, and sustainable environment. This analyzing process is done through a group of urban indicators on the community and district level. (The website of Envision Tomorrow, "About Envision Tomorrow", 2017).

Notice: due to many critiques of the limitations of the potentials of ET, some versions of it were developed to perform the following tasks: (Minner 2015, p.419)

- Evaluating more sustainability aspects like equity and green infrastructure.
- Helping the planners to identify and differentiate between parcels that their redevelopment will lead to positive effects, and others parcels that their redevelopment will lead to displace the low income people by other higher income categories. This is in order to guarantee the equity and supply of affordable housing units in the study area.
- Other tasks concerning ecosystem services and street trees in the development scenarios in the land use planning.

(5.9.8) The State on which the Assessment Process is Done within USA's Example:

The ET assesses the current state and compares it with the generated future scenarios. And so, it supports the selection of the best future scenario.

(5.9.9) The Learned Lessons from USA's Example:

1.The list of urban indicators in the scenario builder of ET are beneficial, which are represented in three types: (Minner 2015, p.418)

- Indicators of basic calculations: developed acres, population, and net new growth.
- Indicators of compact and mixed use development: infill development, building square footage mix, land area mix, and density.
- Indicators of sustainability: energy use (million BTU/yr), carbon emissions (tons/yr), landscaping water use (g/day), internal water consumption (g/day) , waste water (g/day), and solid waste (lbs/day).

2.The "Envision Tomorrow" was developed as an open source ArcMap™ extension. As most of commercial software require huge costs, which represents one of the obstacles facing the improvement of the planning process in the developing countries. ET offers a free support for planning organizations to improve the plans' formulation process.

3.The potential of the incorporation between human actors and non-human actors has a great impact in support the planning process. This is through the active interaction of the public with each of planners, the responsible organization, and the research team (human actors), along with the tool itself and non-human actors like the buildings, trees, water management systems, and components of the built environment and green infrastructure. This active interaction leads to obtain more effective and feasible development scenarios. (Minner 2015, p. 413).

4.The research team from the University of Texas was serious and interested in taking the public opinion into consideration during the process of assessing the scenarios alternatives. (Minner 2015, p. 416).

(5.9.10) Discussion on USA's Example:

(5.9.10.1) Strengths of USA's Example:

- ET provides an analysis for the development scenarios for a period of 20-25 years. This helps the local governments to identify to what extent the planning process will fulfill the community's needs. (The website of Envision Tomorrow, "What is scenario planning", 2017).
- Scenario planning helps in browsing directions for improving plans to be more feasible. (The website of Envision Tomorrow, "What is scenario planning", 2017).
- The comparison between scenarios using a group of indicators covers important aspects. These are financial issues, economic growth, feasibility of the development, land-use, transportation, housing, demographics, environmental aspects, and quality of life. (The website of Envision Tomorrow, "What is scenario planning", 2017).
- ET provides the users with a potential for generation of future development scenarios based on the landscape of the study area and comparing them in real time. (The website of Envision Tomorrow, "What is scenario planning", 2017).
- ET can be a beneficial tool for any community to formulate a common vision for its future. (The website of Envision Tomorrow, "About Envision Tomorrow", 2017).
- There is a wide range for the ET applicability beginning from a land parcel to a metropolitan region. (The website of Envision Tomorrow, "About Envision Tomorrow", 2017).
- ET is considered a flexible tool that can be used in several assessment purposes. Because the calculations within its spreadsheets can be modified according to the needs of the local government planners. According to the research team of ET, the research project that was done in the Austin metropolitan region can be adapted to be applied in many communities that already work with ArcGIS™. (Minner 2015, p. 413)
- The international familiarity with the MS Excel platform that manages the processes of scenario measurement and analysis in ET gives the opportunity for the easiness for the data supplying and modifications. (Minner 2015, p. 419)
- ET is able to perform inter-disciplinary integration, which makes it more feasible. (Minner 2015, p. 420)
- ET provides an effective channel for knowledge exchange among each of practitioners and researchers and among planners and the public. (Minner 2015, p. 423).
- The ET outputs have made a clear description for the benefits of scenarios in a quantifiable way in Austin's project. E.g., an application called green infrastructure (which was developed from ET) was used to show (through one of the scenarios) how storm-water could be prevented. (Minner 2015, p. 416).

(5.9.10.2) Weaknesses of USA's Example:

- The structure of ET has not allowed the full representation of equity as a sustainability indicator. (Minner 2015, p. 419). As the economic indicators have taken more interest from the residents and city officials than the environmental or social indicators. (Minner 2015, p. 422).
- ET has not provided the expected encouragement for planners to use it. For the reason that its connection with the GIS datasets and other software packages (used by planning departments in Austin region) has not been clarified. (Minner 2015, p. 413).
- The time for developing scenarios was not enough, so it was restricted to just concentrating on placing development chips and making discussion on scenarios between the facilitators and public participants. So, there was not an opportunity to establish conversations for discussing and selecting the sustainability indicators. (Minner 2015, p. 415). Moreover, the presentation of the indicators was so quick without enough time for explaining them. And so, presentation of their results at the charrettes was also quick, as only few sustainability indicators were actually discussed. (Minner 2015, p. 415)
- The analytical potentials in ET do not depend on GIS, but mainly depend on the Excel spreadsheets, which leads to not benefiting from the analytical processes embedded in GIS (especially environmental analyses like fragmentation and interaction analyses). Because in order to attain more dependence on ArcGIS™, this would need more coordination with ESRI (the ArcMap™ owner). Also, the difficulties in modifying GIS as a proprietary software have hindered the improvement of the ET as an open source tool. (Minner 2015, p. 421)
- There were four problems in the scenario planning process within what is called the “Sustainable Places Project”. The first problem was in the roles and the effective presence of various publics categories in the planning process (especially lower income residents, who should be the first priority in this process). The second was the lack of efficiency of the analytic processes. The third was concerning the political pressures affecting the development and redevelopment processes. The fourth was the lack of consideration of the equity issue, as the application on the four communities and the urban district did not lead to form a common regional approach for equity. (Minner 2015, p. 423).
- The open houses, charrettes, and workshops were supposed to show all the calculations and assumptions that the scenarios were based on, in order to have convincing information and reaching public agreement. (Minner 2015, p. 423-424)
- Goodspeed studied the efficiency of the “Sustainable Places Project” in attaining social learning in the four communities, in which ET was used in performing scenario planning. He observed that the analytical potential of its indicators were only four indicators (three were used for making summations and one only was used for analysis). (Minner 2015, p. 423).
- So, there are some doubts on how efficient ET was in formulating the scenarios development in the charrettes. As the indicators used in Envision Tomorrow were not effectively used as a guide for the scenario development process, but they were just used as a kind of checking the plans rather than were used as a way for clarifying the analyses that the scenarios were based on. And this shows the weak social learning problem that was noticed by Goodspeed. As many of these indicators were not

integrated in the participatory process with the public because they were complicated to be shared in public meetings. (Minner 2015, p. 422-423).

- The material shared with the public was in the form of print-out or web materials. And at public meetings, the material included only a few indicators. This was seen as superficiality for the public's involvement in performing the indicators unlike the actual and effective role of the planners in these indicators. (Minner 2015, p. 423)

(5.10) The Netherlands' Example:

This example is not introduced here because it is an example for systems assessing sustainability in urban land use planning only, but there is another important reason. This reason is that this example also illustrates a very significant point of view. This point is that mixing various land-uses types does not necessarily result in conflict and negative effects, but it may result in synergy, and may be a catalyst for attaining sustainable land-use planning. This in case that the mixing is scientifically studied to perform an integrated land-uses structure without land-uses conflicts.

The first person, who adopted this point of view was Jane Jacobs (1961), who believed in the importance of what is called "the functional diversity". Jane Jacobs (an American-Canadian writer and city activist) supported the idea of the benefits from the functional diversity back since the sixties of the last century. Jacobs thought that urban vitality can be attained from successful integration of different building types and uses. As the mixing between definite land-use types and several users is considered important for attaining each of economic and urban development. (Han et al. 2013, p.2).

Jacobs did not know that her idea would be supported by another important concept. This concept has become the focus of many researches in urban planning all over the world in the recent years after half a century, which is "the sustainable development". Changing the locations of some land-uses can support a more sustainable environment, if the interrelationships between land-uses help in attaining the socio-cultural, economic, and ecological values of the stakeholders. So, what is called "smart urban development" should use these values to attain synergy by connecting between them in a coordinated way to attain mutual benefits. And at the same time, this development should be without negative impacts. (Han et al. 2013, p.2).

Han et al. present other researchers, who also support the relation between the functional diversity and sustainable development, whether it is negative or positive like Taleai et al. and others. So, it was considered as a challenge and target to study the impacts of various uses combinations on economic, ecological, and socio-cultural values of sustainability. (Han et al. 2013, p.2).

The results of the study of Han et al. show the positive impact of mixing land uses on the 11 aspects, which represent the sustainability attainment in land-use planning considering the way of arranging various functions or uses. One alternative for mixed land-uses was chosen as the best alternative that attains sustainability out of four alternatives on each of building, location, and area levels.

Worth to be also mentioned that these results have shown that the functional diversity not necessarily lead to positive sustainable impacts, but may lead to negative ones. (Han et al. 2013, p.18).

(5.10.1) Objectives of Netherlands' Example:

The general objective was to support the sustainable land-use planning at three levels (building, location, and area) in all directions (horizontal, vertical, and diagonal) regarding the three sustainability axes. This was done by analyzing sustainability impacts resulted from the rearrangement of functions in a densely built-up urban area by using the Sustainability Impact Assessment Model (SIAM model) for measuring the sustainability impacts. This model can be used as an assessment and as a communication tool. (Han et al. 2013, p.1).

(5.10.2) Research Problem of Netherlands' Example:

There is a need for an integrated approach for analyzing the sustainability impacts, which result from (re)arranging uses in densely built-up urban areas. As conflicts may happen due to the existence of some uses near some other uses. (Han et al. 2013, p.1).

(5.10.3) Focus/Major Issues of Netherlands' Example:

The main focus is on the positive and negative impacts of the functional diversity on sustainability in each of the horizontal, vertical, and diagonal direction at the building, location, and area levels.

(5.10.4) Methodology/ Approach of Netherlands' Example:

Three main stages:

The First Stage: the Preparation of the Input Data:

The input data included the data of the study area, the land-use alternatives (that were based on the compatibility matrices' results) and what are called "the stakeholder values".

(A) The study area data collection: This data mainly concerned with the functionalistic arrangement in the study area. This was determined by identifying the uses in all parcels in a basic parcel map and structuring them in a land-use table. This table clarified the land-uses for each floor[36] in each parcel in the study area, and so determining the current functional arrangement in horizontal direction on building level.

With regards to the vertical direction, another procedure was done, as each building was classified in the vertical direction into three parts, (each part includes one floor or more). The first part is the plinth, (the lower part including the basement and the underground functions like the transport). The second part is the center section, and the third is the top layer. Then, the use of each part was determined. (Han et al. 2013, p.11).

Afterwards, all the determined uses were classified into functional groups including sub-functions forming main function groups, which have formed the aforementioned map and the land-use table. The land-use map and table are considered like abstraction of the functional urban environment, which helps in the calculation process for the sustainability impacts resulted from the combination between uses or functions. (Han et al. 2013, p.12).

[36] In case that different land-uses exist in the same floor, the floor's use will be the major or the dominant land use type found.

Then, the scale levels were defined according to the distance between urban land-uses. This distance identified the probable sustainability impacts (whether positive or negative) that were resulted from the interactions between various land uses types. The model in this example worked at three levels the building level, location level, and (local) area level. As determining these levels not only helps in sustainability impact calculation, but also supports the visualization process of these impacts on each of these levels. (Han et al. 2013, p.12).

(B) The formulation of the land-use alternatives: According to Han et al., the SIAM model can analyze and compare the sustainability impacts for up to four different land-use arrangement alternatives. It also supports decision making in selecting the best alternative. The model offers the essential knowledge about probable sustainability impacts resulted from combining specific functions. (Han et al. 2013, p.12).

Four alternatives were formed based on the results of the compatibility matrices. Each compatibility matrix can determine to what extent every functions combination is compatible with regards to one sustainability aspect. The compatibility means the degree to which the presence of two or more land use types makes positive (or negative) sustainability impacts on multiple scale levels. This means that the compatibility is the degree of synergy resulted from definite functional diversity. However, the degree of these impacts may be different from one scale level to another. (Han et al. 2013, p.8).

In the model, a sustainability matrix was established to assess various combinations with regards to each aspect of the 11 considered sustainability aspects. These aspects are energy, air, accessibility to social services and recreational facilities, social safety, noise nuisance, area and identity, social cohesion, space and land usage, sustainable transport, quality perception area, and flexibility. Eleven experts (from various backgrounds) shared in evaluating the sustainability impact of 105 unique pair-wise functions combinations with regards to the field of their specifications using a five-point scale[37]. This scale was afterwards converted into a standardized score to be used in an aggregation process for analyzing four alternatives. In this process, the sustainability impacts for every possible functions combination were considered with regards to the three scale levels. These levels represent the distances between different land-uses, because sustainability impact varies from one sustainability aspect to another and on one scale to another. (Han et al. 2013, p.8,9).

The results of the compatibility matrices for the eleven sustainability aspects shown that none of the land-use combinations can make a positive impact for the eleven sustainable aspects. (Han et al. 2013, p.10).

So, based on the previous results, four land-use alternatives were formed to be entered to the SIAM model and to be analyzed to choose the best alternative. This was using the analytical hierarchy process (AHP) and the majority additive-ordered weighted averaging (MA-OWA) method as illustrated in the next two stages.

[37] Each sustainability matrix was formed according to the expert direct judgments. Unlike the Australia’s example that used the Delphi sharing method for identifying the parameters affecting the sustainability (Yigitcanlar and Dur 2010, p. 330), the Netherlands’ example depended on individual expert judgments (Han et al. 2013, p.8).

(C) The stakeholders’ values[38]identification: The effects of the stakeholders' participation in urban development have recently become important and effective within the planning process. Stakeholders with different interests should have decisive roles in this process. Therefore, it is essential to involve their values in the planning process. The SIAM model has involved stakeholders in defining a set of weighting factors for each criterion of the 11 criteria concerning the sustainability in the AHP process, and the pair-wise comparisons. (Han et al. 2013, p.10,11).

The Second Stage: the Calculation of the Sustainability Impact Value for each Floor in the Building in each Parcel by using (MA-OWA):

The MA-OWA process was used in this stage to calculate the sustainability impact values on each of building, location, and area level. This process was repeated for each floor and building (or parcel) and regarding each sustainable aspect for all the alternatives. (Han et al. 2013, p.6).

The Third Stage: the Calculation of the Sustainability Impact for the Four Alternatives and Selecting the Best one by using the AHP:

As previously mentioned, the AHP is a process used in the multi-criteria decision-making process. The AHP was used for identifying the relative importance of each criterion or aspect of the 11 sustainability aspects in the assessment process of the four alternatives. The AHP process is an hierarchy that consists of a goal on the top, then the decision criteria in the middle, and the alternatives at the bottom. The goal of the AHP was attaining positive sustainable impacts from the land-uses rearrangements, its criteria were regarding 11 sustainability aspects that were applied on 4 alternatives for multiple functional arrangements. The sustainability aspects were integrated to a total score by using AHP using an aggregation process, so that the alternatives could be compared on various levels and various sustainability aspects (Han et al. 2013, p.6,7).

The final value was determined using the aggregation process of AHP for each alternative of the 4 alternatives. This value identified to what extent a certain land-uses composition probably generates positive (or negative) sustainability impacts on the building, location, and area levels in each alternative. (Han et al. 2013, p.8).

All the previous led to choosing the best alternative. The best alternative was the alternative with the highest “average compatibility value” resulted from the aggregation process. The results also enabled the model's user to compare between the alternatives in a comprehensive way (i.e. with regards to all the sustainability aspects). (Han et al. 2013, p.12.13).

(5.10.5) Developed or Used Tools in Netherlands' Example:

The SIAM model was used in this example. It includes two methods, which are the AHP and the calculation method MA-OWA. The input data used in SIAM model were the land-use alternatives (that are based on the results of the compatibility matrices), stakeholder values, and the study area data. (Han et al. 2013, p.6).

(5.10.6) Scale of Application of Netherlands' Example:

As mentioned before, there were three levels of application, which are the building (or parcel), location, and area (local) level (as shown in the next figure). The building level is the same size of the parcel. The location level for each parcel includes the neighboring parcels, which are

38 There were four categories for stakeholders, who were involved in urban development. These are the government agencies, commercial participants, civil society organizations, and citizens.

adjacent to, or directly opposite, or diagonal to the subject parcel. The area level was approximately 300 meters around the center of the study area. (Han et al. 2013, p.12).

Fig. (5.21) The three levels of application of the SIAM model [39]

Source: Han et al. 2013, p.14

(5.10.7) Tasks Achieved in Netherlands' Example:

The impacts on the sustainability of each alternative (from four alternatives for rearrangement of land-uses in the study area) were evaluated on each of the building, location, and area level. The best alternative from these alternatives was also identified. (Han et al. 2013, p.13)

(5.10.8) The State on which the Assessment Process is Done within Netherlands' Example:

The state is the suggested land-use alternatives, which were formed based on the knowledge obtained from the compatibility matrices.

(5.10.9) The Learned Lessons from Netherlands' Example:

1.The sustainability impact was decomposed into several aspects, which allowed the comprehensiveness in analyzing the sustainability.
2.The compatible matrices analysis were used as a tool for assessing impacts on sustainability, which are resulted from the combinations between various land-use categories.
3.Deducing the probable negative impacts on sustainability from the combination of various land-uses or functions (beside the positive and synergetic impacts) has discovered any hidden gap in the design of the land-use structure of the study area.

[39] Number (1) refers to the building level, (2) refers to the surrounding or the location level, and (3) refers to the study area level. The building level here is a complex of a group of high buildings that are named "the Peak". These are located next to the Marconi-square in western Rotterdam in the Netherlands. These high buildings are known as the Europoint-buildings. This complex consists of a building named 'Overbeekhuis' (Europoint I) that was built in 1965 and three office towers of 90 meters high that were built in the period 1971-1975 (Europoint II, III and IV).

4.The usage of the MA-OWA (to calculate the sustainability impact values regarding each aspect of the 11 sustainability aspects) and the AHP (as aggregation process for all the impacts on the sustainability aspects) provided accurate results to a good extent.
5. Analyzing and visualizing the probable sustainability impacts were systematic and integrated.

(5.10.10) Discussion on Netherlands' Example:

(5.10.10.1) Strengths of Netherlands' Example:

- The SIAM model offers a more integrated approach, which includes both positive and negative impacts for visualizing and analyzing probable sustainability impacts in a systematic way. On the contrast, other approaches (like Compatibility Evaluation Model - CEM) concentrate only on the negative impacts. (Han et al. 2013, p.7,8)
- The stakeholder’s role were empowered by the SIAM model. The stakeholder values have represented important influences on the results, as they have identify various weighting factors for sustainability aspects. For instance, the higher weights were for the social safety and flexibility aspects because of the stakeholders values. Therefore, the SIAM model is considered as a communicative tool because of the involvement of the stakeholders values in its methodology. (Han et al. 2013, p.17).
- The idea of decomposing the sustainability impact into multiple aspects facilitates the detailed analysis, in addition to calculating and visualizing the results concerning the sustainability impact for each individual aspect at three different levels. All of these give the user the opportunity to analyze the effect of missing various functions or uses in a systematic way. (Han et al. 2013, p.18)
- The compatible matrices analysis is beneficial in identifying the most appropriate land-use combinations, which may make positive impacts, and create a synergetic effect. Also, taking into consideration the land-uses of the surrounding areas around any study area (and not concentrating only on the study area itself) has led to attain the optimum impacts on the sustainability. (Han et al. 2013, p.18)
- Assessing the combination between a number of 105 pair-wise of land-uses (through the compatible matrices) with regards to each sustainability aspect is seen by Han et al. as an accurate assessment process. (Han et al. 2013, p.8).
- As mentioned before, SIAM can be used as both a measurement tool for sustainability impacts resulted from land use rearrangement and a communication tool. (Han et al. 2013, p.18).

(5.10.10.2) Weaknesses of Netherlands' Example:

- This study is considered a very specific study that dealt with densely built urban area that contains high towers, which is considered a special case in urban areas.
- According to the Han et al., the data used in this study is independent, which means that the sustainability matrices do not depend on the study area’s characteristics, but on the socio-cultural background of the experts. This might lead to inaccurate results concerning the study area. However, it could be accurate in some sustainability aspects. (Han et al. 2013, p.9).
- With regards to the feasibility of the model‘s outputs, it will be a huge challenge to find new occupants for the vacant 8000 m^2 space of these three office buildings that were recommended to be replaced by residential uses. So, the SIAM model should be

supported with an executive study to verify the feasibility of the outputs suggested by it. (Han et al. 2013, p.14)

- Although choosing one expert only for each sustainability aspect in this study was a conscious choice for manageability reasons. It would be better to involve several experts for each individual sustainability aspect to improve the reliability of the entered data. (Han et al. 2013, p.18)
- The SIAM model has dealt with general land-use categories, not with sub-categories related to these general categories like the educational land uses, which may be a small elementary school or a huge university. According to some of the experts, it is difficult to study the combinations of some land-use categories in a general way. Because the assessment of impacts resulted from certain functional combinations with some educational land-uses may differ from educational land-use sub-category to another. (Han et al. 2013, p.18)
- According to Han et al., the number of sustainability aspects considered in this project was limited, which were selected after discussions with experts. As the selected aspects were the most sensitive aspects for functional diversity. However, increasing this number may result in more accurate outputs. (Han et al. 2013, p.19)
- The SIAM model is not based on GIS that can facilitate the processing of the spatial data in a precise way. (Han et al. 2013, p.19)

(5.11) India's Example:

This example was chosen not only as an example for a prototype of a SPSS as a model, but also because it was developed for dealing with urban sprawl problem, which is one of the most pressing problems in the existing Egyptian cities. Also, the application of this example was in a developing country with circumstances (in some ways) close to the circumstances of Egypt.

It is known that the urban sprawl inhibits the sustainability, as it leads to the inefficient utilization for resources (Sudhira and Ramachandra 2009, p.175). And so, it causes several environmental, social, and economic problems. Therefore, evaluating the urban sprawl reflects the degree of sustainability attainment.

(5.11.1) Objectives of India's Example:

The main objective was to define, understand, and evaluate the current state of the urban sprawl problem through developing appropriate metrics (or measurements) for assessing the urban sprawl quantitatively. This was done using modeling processes for the urban sprawl's dynamics that generate various alternatives of policies for controlling and alleviating the urban sprawl. And so, these policy alternatives were revised and assessed to obtain the most appropriate policy recommendations for controlling and alleviating the urban sprawl. (Sudhira and Ramachandra 2009, p.179-180) .

(5.11.2) Research Problem of India's Example:

The urban sprawl is defined as the outgrowth along the boundaries of cities and highways. Although there is no precise definition for urban sprawl till now, most of researchers agree that the urban sprawl is a kind of an unplanned growth without any definite pattern, and it leads to the inefficient utilization for resources. The urbanization has increased recently in India in a very rapid way. Despite the fact that the Indian economy is considered one of the fastest growing economies in the world, India is challenged by problem in controlling the urban sprawl with all its consequences like congestion. Also, there is a lack of providing essential services and infrastructure, despite that the urban areas represent more than 50% of GDP. (Sudhira and Ramachandra 2009, p.175) .

There is an improper and unsatisfactory implementation of master or development plans in India. The city planning focuses on the land-use plans preparation through zoning process to provide the targeted populations with their needs from various land uses. This is considered a main problem in the current planning practice because the land-use plans are static and just concentrating on land-use issues. The other authorities that are responsible for provision of infrastructure and services are not involved in the planning process. Also, there is no evaluation for policy decisions in a dynamic way through visualizing the probable impacts of these decisions, which may lead to urban sprawl phenomenon. (Sudhira and Ramachandra 2009, p.187) .

All the previous refer to the need for a kind of a PSS for the administrators and planners that can provide them with a more clear and better understanding, as well as tools for tackling the problem of urban sprawl. The administrators and planners can then be informed with possible areas of sprawl phenomenon to take the right actions to alleviate the implications resulted from this phenomenon. As many researchers see that the problem of urban sprawl is a result of improper planning practices and inappropriate policies, along with the lack in appropriate spatial databases and urban indicators. (Sudhira and Ramachandra 2009, p.187-188) .

Therefore, the main challenge was to enclose the spatial information with models to perform policy analysis, assessment, and visualization of these implications into a SPSS. (Sudhira and Ramachandra 2009, p.177) .

(5.11.3) Focus/Major Issues of India's Example:

The main issues are the urban sprawl problem, the modeling of the urban sprawl dynamics in the Indian context with the focus on Bangalore, and the specifications of an integrated SPSS for controlling the urban sprawl in India. (Sudhira and Ramachandra 2009, p.175) .

(5.11.4) Methodology/ Approach of India's Example:

The approach for addressing urban sprawl problem and obtaining policies (to control it) is based on the integration of different processes related with the sprawl phenomenon's dynamics. (Sudhira and Ramachandra 2009, p.179) .

First the Theoretical Background for Developing the SPSS for Bangalore:

The applied framework for formulating policy recommendations for controlling and alleviating the urban sprawl using this SPSS is like the framework for any planning and decision making process. It includes the phases of intelligence, design, and decision/choice. (Sudhira and Ramachandra 2009, p. 179) .

The idea, which this SPSS was based upon, is the understanding of the urban dynamics that cause the urban sprawl in Bangalore and how to assess the current state of the urban sprawl problem. This was done through the "the process model" of the SPSS that represents the intelligence phase, (which is the first phase in the process of planning and decision making process for controlling and alleviating the urban sprawl). After that, suggested alternatives for policies of alleviating the urban sprawl were generated through "the planning model" that represents the design phase, (which is the second phase). (Sudhira and Ramachandra 2009, p.179-180).

The third phase is the decision/choice phase, which was performed through "the evaluation model". In this phase, the revision and assessment of the consequences of different policy options were done to decide definite policy recommendations for controlling the urban sprawl, and so visualizing the resulted decisions. (Sudhira and Ramachandra 2009, p.180).

The current state of the urban sprawl was evaluated through modeling the urban sprawl's dynamics by using a combination between system dynamics and agent based land-use models in a geospatial domain. Firstly, the patterns of the land-uses in Bangalore region were pictured using the satellite remote sensing data. Then, the measurements that characterize the urban sprawl patterns were calculated through each of the spatial metrics, built up area, built-up density, population number, and density. In addition these measurements, the percentages of different land-uses were monitored. (Sudhira and Ramachandra 2009, p.180,181).

Then, the whole landscape was classified into main land-use categories using a classification process. The land-use changes of the urban sprawl's dynamics were modeled through the identification of various variables. The formulation of polices for controlling the urban sprawl required considering multiple effects or consequences, which resulted from multiple factors in the urban sprawl's dynamics[40]. Therefore, the relations between the variables of the urban sprawl's dynamics were studied using a method called "Causal Loop Diagram" (CLD), which can deal with multiple causes and effects. (Sudhira and Ramachandra 2009, p.181,182).

Second the Design and Implementation of the Prototype of the SPSS for Bangalore:

The prototype of the SPSS was developed as a model called "the BangaloreSim model". It was implemented using NetLogo that is an agent-based modeling environment. The interface of the BangaloreSim model includes all the key parameters (measurements), which are the built up area, built-up density, population, the percentage of different land-uses, and others. The user just adjusts the parameters in the interface and the study period (from base year to target year). And the model automatically generates scenarios, which enables the dynamic interaction between the model and the user. (Sudhira and Ramachandra 2009, p.184-185).

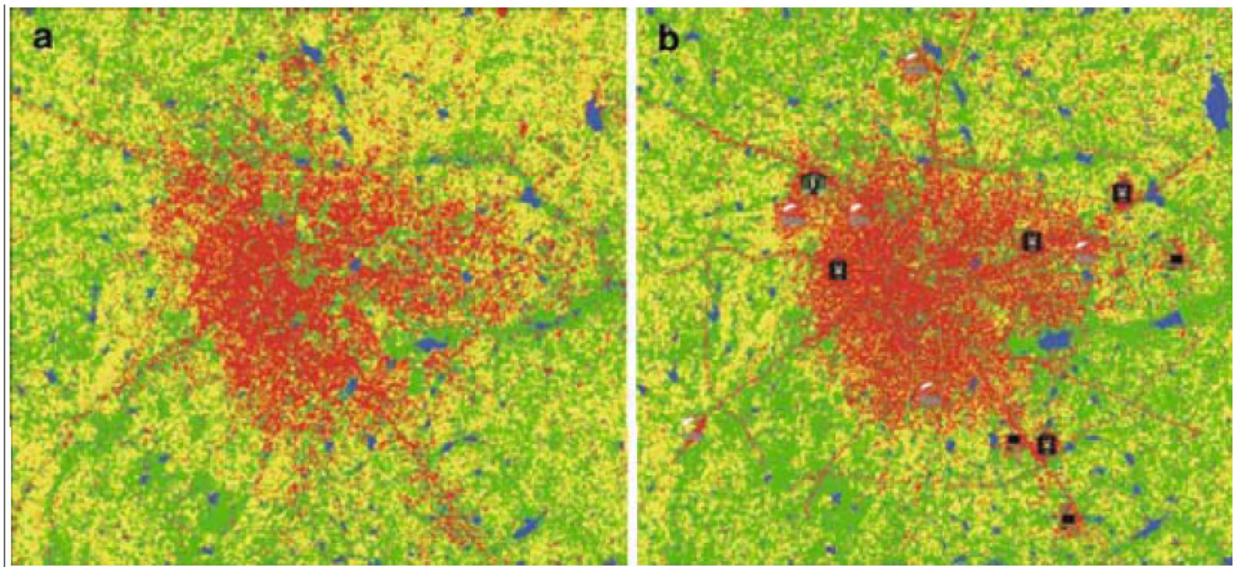
Third the results and the policy analysis:

The results of the BangaloreSim model (a prototype of the SPSS) were represented in a simulation for the expected scenario for urban growth in the target year. This simulation was according to the entered parameters to the model, (e.g. suggested policy of using growth-poles and using definite value for "floor area ratio-FAR", as well as the study area data like the birth rate, and population number). Therefore, the BangaloreSim model can not only generate a scenario of probable changes in the urban land-uses in a study area, but also it can perform scenarios for suggested policies (like increasing the FAR) to understand the respective consequences of these policies. (Sudhira and Ramachandra 2009, p.186).

[40] Example, one of the most popular strategies for limiting the growth is putting restrictions on buildings' heights. Therefore, the variable "floor area ratio (FAR)" was chosen as one of the important measures to limit growth of Bangalore. This is because of the increase that happened in Bangalore's mass with changes in its land-use patterns. (Sudhira and Ramachandra 2009, p.181).

The next figure shows an example for the results of the BangaloreSim model application on Bangalore. The map to the left (a) represents the actual classification for land-uses in 2000 (base year). The map (b) to the right represents the simulation for the expected scenario for the urban growth and the land-use classification in 2006 (target year). When comparing the two maps, the success of the BangaloreSim model in forecasting the land-uses change is clear. And so, the experts suggested the adoption of growth poles policies for controlling the urban sprawl in the study area. (Sudhira and Ramachandra 2009, p.185).

Fig. (5.22) The classified land-uses of Bangalore in 2000 and the simulated land-uses in 2006[41]



Source: Sudhira and Ramachandra 2009, p.186 (reprinted with permission from Springer)

Also, the results shown that the high FAR would cause an increase of built-up areas with high densities. However, the overall rate of built-up growth was decreasing, as the population density over built-up areas would decrease in the beginning of the study period, then it would increase after certain time. This means that the residents may prefer to live within the city’s areas rather than live in the outskirts. The increase in built-up areas with high densities referred to more congestion in some parts of city, and so the infrastructure and services should be increased to satisfy the predicted population densities in these areas. Therefore, the policy analysis referred to the probable impacts of change in FAR on the built-up areas, and so the required actions that should be done to deal with these impacts. (Sudhira and Ramachandra 2009, p.186).

(5.11.5) Developed or Used Tools in India's Example

The used main tool in this example is the prototype of the SPSS called “the BangaloreSim model”, which was developed using NetLogo. The remote sensing was used for characterizing the land-uses of the Bangalore region using satellite images. The modeling of the urban sprawl dynamics was done through the combination of system dynamics and an agent-based model in a geospatial context. (Sudhira and Ramachandra 2009, p.180).

[41] The black spots in the map (b) represent the growth poles.

The variables related to urban sprawl were identified and mapped in the "causal loop diagram" (CLDs) method. This was later reformulated using a method called "the stock-and-flow diagram" to be with a less number of variables.

(5.11.6) Scale of Application of India's Example

The scale of application of the model was Bangalore region level.

(5.11.7) Tasks Achieved in India's Example:

The main task is to evaluate the current state of the urban sprawl problem by applying appropriate measurements for assessing the urban sprawl quantitatively. This is done through the modeling processes for the urban sprawl's dynamics, which generate various alternatives of policies for controlling and alleviating the urban sprawl. And so, the user can assess these different policy alternatives to obtain the most appropriate policy recommendations for controlling and alleviating the urban sprawl . (Sudhira and Ramachandra 2009, p.179-180).

(5.11.8) The State on which the Assessment Process is Done within India's Example

The BangaloreSim model (prototype for a SPSS) deals with the current state of the urban sprawl to suggest policies for managing and alleviating the urban sprawl in the future.

(5.11.9) The Learned Lessons from India's Example

1. Identification of the locations of areas with high built-up densities that require an increase in the infrastructure and services to avoid the expected congestion in these areas.
2. The common interface for all the key criteria, which is easy for the user.
3. The concept of growth poles agent that can cause land-use changes.
4. Forecasting the respective consequences or impacts of policies.
5. Studying the relations between the variables of the urban sprawl's dynamics using "CLD" method, which can deal with multiple effects or consequences resulted from multiple factors.

(5.11.10) Discussion on India's Example

(5.11.10.1) Strengths of India's Example

- The BangaloreSim model, as a prototype for a SPSS, is beneficial in the regular monitoring of urban sprawl phenomenon, and checking the response of this phenomenon for policy interventions by time. (Sudhira and Ramachandra 2009, p.188).
- The interface of the model includes all the key criteria (requisite measurements). The user can adjust these criteria within a common interface of the model. (Sudhira and Ramachandra 2009, p.184).
- The BangaloreSim model is effective in identifying the locations of areas with high built-up densities, which require an increase in the infrastructure and services to satisfy the expected congestion in these areas. (Sudhira and Ramachandra 2009, p.186).
- The BangaloreSim model is not only beneficial in generating a scenario of probable changes in the urban land-uses in the study area, but also it can perform scenarios for suggested policies to understand the respective consequences or impacts of these policies. (Sudhira and Ramachandra 2009, p.186).
- The future development of the SPSS can help in exchanging of standard geospatial data formats, and this SPSS can be developed as a web-based system. (Sudhira and Ramachandra 2009, p.188).

(5.11.10.2) Weaknesses of India's Example

- Despite that the BangaloreSim model helps in the analysis, visualization, and assessment of some policy decisions, the success of these tasks totally depends on the experiences of the modelers and planners in identifying certain processes[42] that lead to land-use changes. (Sudhira and Ramachandra 2009, p.186-187).
- Despite that the model can help the modeler in testing various options and assessing their impacts in the current state, the predictive accuracy of this model is still under discussion. (Sudhira and Ramachandra 2009, p.187).
- There are challenges facing the model to be used in supporting participatory decision making process. The first challenge is how to integrate different models that are required to perform the simulations. The second is how to synchronize each of the model inputs, feedbacks, and outputs over place and by time. The third is how to incorporate the complex urban system in a dynamic modeling framework that can support participatory decision making. (Sudhira and Ramachandra 2009, p.188).

(5.12) Reflections

The previous examples, (which can be used as guides for the proposed system), were chosen based on two classifications as previously mentioned. The first classification is with regards to the purpose of the example. The second classification is with regards to the nature of the assessment tool used in the example. Each example has definite learned lessons that can be connected to the proposed system in this research, as the next table illustrates.

Table (5.1) The causes of selecting the studied examples as guides for the proposed system:

The example	Its category in the first classification	Its category in the second classification	Causes for choosing the example
1.China's Example (1)	Assessing the sustainability within current state only	Assessing using urban indicators	The assessment process focused on the current state of land-use planning on the local level of existing cities, which is the target level of the proposed system.
2. Taiwan's Example	Assessing the sustainability within current state only	Assessing using urban indicators	The assessment process focused on the current state of the city level. Also, the used methodology in this example is simple, and easy to be programmed within a framework of a SPSS.
3. Iran's Example	Assessing the sustainability within current state only	Assessing using (S)PSS, which is based on GIS, and is designed especially for definite case to be applied on urban land	The assessment process focused on the analysis of spatial equity of services on the parcel level of a residential area, which is similar to the proposed level of application of the proposed SPSS.
4.Australia's Example	Assessing the sustainability within current state for forecasting the changes in the future	Assessing using (S)PSS, which is based on GIS, and is designed especially for definite case to be applied on urban land	The assessment process is based on an integrated sustainability assessment framework considering all related domains affecting urban sustainability. The indicators list and their formulas are applicable in the proposed system .
5. China's Example (2)	Assessing the sustainability within current state for choosing the best alternatives for the suggested state	Assessing using (S)PSS, which is based on GIS, and is designed especially for definite case to be applied on urban land	The assessment process is based on an integrated, dynamic, systematic, and complex framework, which can support addressing complex and dynamic problems like land-use management.

[42] E.g. The creation of growth poles and how to study the effect of outgrowth through the FAR.

The example	Its category in the first classification	Its category in the second classification	Causes for choosing the example
6. Cyprus' Example	Assessing the sustainability within current state and generating alternatives for the suggested state	Assessing using (S)PSS, which is based on GIS, and is designed especially for definite case to be applied on rural land	The assessment process is suitable for supporting both rural and urban sustainable development. It deals with the land fragmentation problem that is a known problem in the informal urban areas in Egypt, which results in many economic, social, environmental, and physical problems.
7. INDEX	Assessing the sustainability within current state and generating alternatives for the suggested state	Assessing using (S)PSS, which is based on GIS, as a commercial software and can be applied on several cases.	INDEX supports the interactive process between stakeholders in real time. And it can assess the built environment sustainability on the parcel level, which is the target level of the proposed system.
8.USA's Example	Assessing the sustainability within current state and generating alternatives for the suggested state	Assessing using (S)PSS, which is based on GIS, as an open source software and can be applied on several cases.	The assessment tool in this example was applied on the community and district scale, which is the proposed application scale in this dissertation. As well as, this tool aims to assess the sustainability attainment in the land-use plans, as it is also aimed in this dissertation.
9. The Netherlands' Example	Assessing the sustainability within current state and generating alternatives for the suggested state	Assessing using (S)PSS, which is NOT based on GIS	This example presents the concept of mixing various land-uses types as a synergy and catalyst for attaining sustainable integrated land-uses structure. Also the application was on three levels including the area level, which is the target level of the proposed system.
10. India's Example	Assessing the sustainability within current state for identifying policies for attaining sustainability in future	Assessing using a Prototype for a (S)PSS	The assessment process focused on urban sprawl problem, which is one of the most pressing problems in the existing Egyptian cities. Also it has been applied in a developing country with circumstances near in some way to the circumstances of Egypt

Source: by own

The learned lessons from the previous examples are presented in the next table.

Table (5.2) The potential learned lessons from the studied examples as guides for designing the proposed system:

The example	The potential learned lessons for the proposed SPSS	
	As theoretical base for designing the proposed system *(either its knowledge base or its technical framework)*	As practical procedure for the establishment of the proposed system
1.China's Example (1)	1. Some of indicators used in this example can be applicable in assessing the sustainability for assessing the urban land-use planning in the Egyptian cities. 2.The indicator framework used in this example is comprehensive for assessing sustainability of urban land-use planning. 3. The methodology of grouping analysis for the factors results can be programmed within a SPSS.	The cooperation with the local practitioners and academics gives the opportunity to benefit from the assessment results.
2. Taiwan's Example	1. Some of indicators used in this example can be applicable in assessing the sustainability in the urban land-use planning in the Egyptian cities. 2.The consideration of institutional aspects with the environmental, social, and economic aspects is important to be done in the Egyptian case, in which the institutional problems negatively affect the sustainable development. 3. The idea of analyzing the trends of the indicators (towards/away) sustainability helps in adjusting the values of the indicators in the calculation of the sustainability index to obtain accurate results. 4.The idea of identifying the dimensions that are moving towards sustainability and those which are moving away helps in the orientation towards the aspects, which are in more need for intervention or changing. 5. The simplification of indicators' values (through the standardization of these values into simple numbers) and unifying these values (through simplification) allow comparisons between indicators.	Studying the trend of sustainable development in several years helps in discovering long-term problems, which hinder the sustainability.
3. Iran's Example	1.The modeling of the spatial equity of services using MCA methods based on GIS. 2.The methodology of studying the paths between any residential parcel and services parcels using the network analysis. 3.The CoT and the LPC evaluating factors. 4. The methodology of identifying the locations to allocate the services in the undersupplied areas.	1.AHP for weighting various criteria through the consultation of experts. 2.The visualization of results by coloring to be easily understood results by non-expert people.
4.Australia's Example	1. The SILENT model covers four various fields (demography, land-use and urban form, transport, and environment). 2. The list of the individual indicators and the formula of each individual indicator are beneficial in the proposed system in this dissertation. 3. The methodology of the weighting process using Delphi method, in which an experts team have identified the most suitable weight for each indicator can avoid any bias in the indices' results. 4. The idea of converting all the indicators values into standard scale of five grades or degrees helps in the interpretation of the indicators results in a simple form to be understandable for public.	1. The usage of the grid-based system in performing the sustainability analysis provides the same comparable size of grid-units. 2. Using the aggregation method for placing the grid cell values and obtaining a multicolour composite urban sustainability map helps in easily identifying the areas that have low sustainability levels, and others that have high sustainability levels. And so, it provides an easy way for the results interpretation by the decision makers and public.

The example	The potential learned lessons for the proposed SPSS	
	As theoretical base for designing the proposed system	As practical procedure for the establishment of the proposed system
5. China's Example (2)	1. Balancing between land supply and demand. 2. Considering all the sustainability aspects in land-use allocation process. 3. Generating scenarios for potential land-use changes in the future and considering definite factors or parameters like the expected population, time, and growth domestic product- GDP. 4.The Combination between AHP method and MCA to form the assessment system. 5.The usage of GIS based MCA for performing the land-use suitability assessment and determining the available land supply and the most appropriate uses for the available land lots.	1.The collaborative attitude either with stakeholders or experts in the four main stages or modules of the system. 2. Consulting and surveying the opinions of experts in various specifications to formulate the weighting matrix within the AHP method for calculating the weights of various criteria through obtaining the relative importance of each criterion.
6. Cyprus' Example	1. Using different criteria weighting scenarios at the same time for evaluating the alternatives. 2. The standardization of the calculated values of the fragmentations' factors to be ranged from 0 to 1. 3.The integration of GIS, artificial intelligence, and multi-attribute decision-making methods. 4.The usage of Expert System technique-ES, which can emulate the human way of thinking in solving complicated decision-making problems. 5.The genetic algorithm-GA, which is used in solving complex non-linear optimization problems. 6.MADM, which is used to evaluate definite issue through many attributes: This helps to choose the optimal alternative from many alternatives. 7.MODM, which is used to evaluate a large number of solutions within a multi-objective optimization problem.	Dividing the study area into blocks.
7. INDEX	1. The indicators dictionary of NDEX. 2.The integration between land-use and transportation planning with environmental issues. 3.The assessment of the plan's goals achievement in each scenario by using indicators scoring, then ranking the scenarios to identify the best one. 4.The predefining of the features representing the land-uses and transportation with all the related characteristics or properties for each feature. 5.The tracking of the scenarios, which is identification of the development volume and expected growth in each scenario, and the determination of each of the areas allocated for each land-use type and the expected population in each type.	1. The visualization of the indicators' scores using coloured maps called "indicators maps" to indicate the strong and weak points in each scenario and considering them in modifying this scenario. 2. Assessing the built environment' sustainability on a small level like the detailed parcel level. 3. The interactivity among stakeholders in sketching scenarios.
8.USA's Example	1. Three types of urban indicators used in the scenario builder of ET can be applicable in assessing the sustainability in the urban land-use in the Egyptian cities. These are indicators of basic calculations, indicators of compact and mixed use development, as well as indicators of sustainability. 2.The potential of the incorporation between each of human actors and non-human actors has a great impact in supporting the planning process.	1.ET was developed as an open source ArcMap™ extension, so it offers a free support for planning organizations to improve the plans’ formulation process. 2. The developer team of ET considered the public opinion in the process of assessing the scenarios alternatives.

The example	The potential learned lessons for the proposed SPSS	
	As theoretical base for designing the proposed system	As practical procedure for the establishment of the proposed system
9. The Netherlands' Example	1.The decomposing the sustainability impact into several aspects. 2. The compatible matrices analysis as a tool for assessing impacts on sustainability, which are resulted from the combination between land-use categories. 3.Deducing the positive and synergetic impacts, from the combination of various land-uses or functions to show the hidden gaps. 4.The usage of the MA-OWA to calculate the sustainability impact values regarding each aspect of the sustainability aspects. 5.The usage of the AHP as aggregation process for all the impacts on the sustainability aspects.	Analyzing and visualizing the probable sustainability impacts in a systematic and integrated way.
10. India's Example	1. The growth poles as an agent for land-use changes. 2. Forecasting the respective consequences or impacts of policies. 3. Using "CLD" method in studying the relations between the variables of the urban sprawl's dynamics to deal with multiple effects resulted from multiple factors.	1. Identification of the locations of areas with high built-up densities to increase the infrastructure and services in these areas to avoid the expected congestion. 2.A common interface for all the key criteria.

Source: by own

This research may not directly benefit from these previous examples or experiences for various reasons:

- Some examples have objectives, which are a bit different from the objective of this research. There are examples that only concentrate on assessing the spatial equity and the balance between demands of the residents on services, as well as the supply from services provided to them (Iran’s example). Other examples focus on forecasting future scenarios (Australia’s example). And others analyze sustainability impacts resulted from the rearrangement of functions in a densely built-up urban (towers) (the Netherlands’ example), or deal with the urban sprawl problem (India’s example).

- Some examples deal with urban areas under circumstances, which are not similar to the Egyptian ones like lake areas in urban fringes (China’s example 2).

- Some examples depend on collaborative methods, which cannot be exactly applied in the Egyptian system like using digital charrette in INDEX example.

However, the differences between the focus of this research and these previous experiences are considered as an advantage to have a new contribution in the field assessment of the sustainability attainment in urban land-use planning. This is through the presented design of the technical framework of the proposed system in the next chapter, which is based on some of the learned lessons from these experiences.

Chapter 6
The Comprehensive Technical Framework of the SPSS

(6.1) Introduction:

The previous chapter illustrates selected previous examples either in the assessment or supporting the attainment of sustainability in planning. These selected examples have used various assessment tools, which are guides to design the technical framework for the SPSS. This SPSS is proposed to assess the sustainability attainment in the land-use planning process in the existing Egyptian cities. However, the SPSS can be applied on other countries through changing the predefined criteria in it according to the country of application.

This chapter focuses on the technical framework of the SPSS and the requirements for establishing it. The SPSS technical framework includes the suggested methods and techniques, which perform various stages and tasks of the assessment process. This framework consists of seven sections as the next point illustrates.

(6.2) The Technical Framework of the Proposed SPSS Based on the Literature Review:

(6.2.1) The Main Concept for the Technical Framework Design:

The main concept behind the design of the technical framework of the SPSS requires applying artificial intelligence techniques to emulate the human way of thinking in the decision making processes. This includes the phase of intelligence or realizing the problem, then phase of analyzing and designing potential solutions for it, and finally deciding or choosing the appropriate solution. (Sudhira and Ramachandra 2009, p. 179).

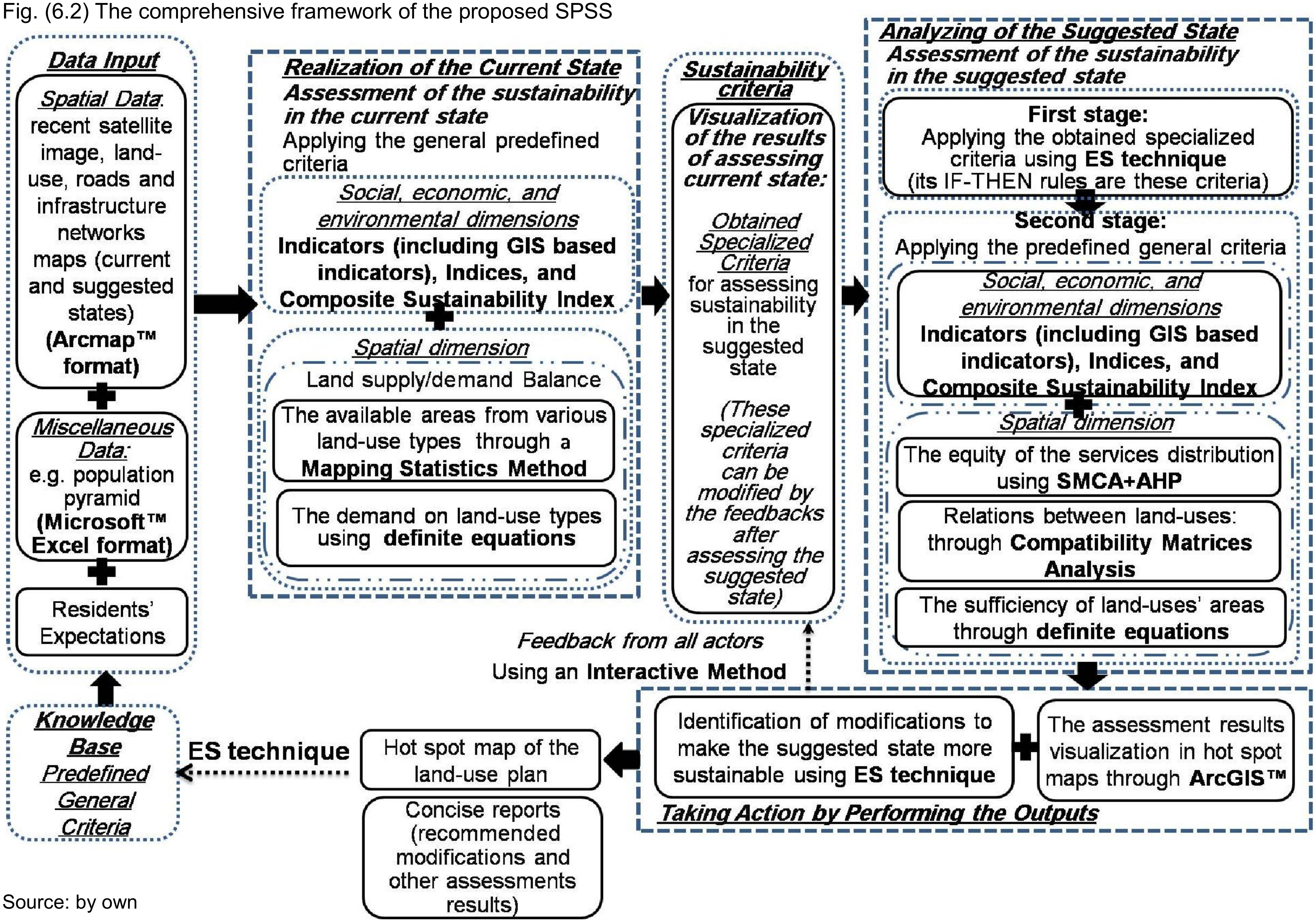
The data (regarding the current and suggested state of the study area) is entered. Then, the system realizes problems within the study area. And so, it analyzes to what extent the suggested state can deal with the current problems and future needs. Therefore, the system takes action by deciding whether the suggested state can succeed dealing with these current problems and future needs, or not. Then, the system presents the final assessment results.

Fig. (6.1) The main concept for the technical framework design

Source: by own

The next figure shows the comprehensive framework for the proposed SPSS. It can be established through a multi-partner research project. This project aims at raising the efficiency of the land-use planning process in the existing Egyptian cities in a way that guarantees the sustainable development and growth for these cities.

Fig. (6.2) The comprehensive framework of the proposed SPSS



Source: by own

(6.2.2) The Data Input Section:

In this section several data types are entered in the SPSS. These data types are spatial data in an Arcmap™ format, which include recent satellite image for the study area, the current and planned state for the land-use, roads, and infrastructure networks maps, (which are preferred to be on parcel level). The input data also includes miscellaneous data in Microsoft™ Excel format, which is mainly for the study area’s current state like the population number, population pyramid, (population age categories and gender), average family number, average family income, the current and expected population· These are in addition of the residents’ expectations, in the form of a definite service type, or definite area for each person in a definite land-use type that should be taken into consideration as input data.

A Common Interface for all types of the data entry of the study area in order to be easy for the SPSS user. (Sudhira and Ramachandra 2009, p.184).

(6.2.3) The Realization Section:

This section concerns with realizing the current problems in the study area through assessment of the sustainability attainment in the current state by using the predefined general criteria in the knowledge base of the system. The results of the current state assessment will be the assessing criteria for the sustainability in the suggested (planned) state, which are specialized for the study area.

There are two parts in this section. The first part assesses the social, economic, and environmental dimensions of sustainability in the current state of the study area including the evaluation of the current state of roads and infrastructure networks. The assessments in the first part are done through three groups of urban indicators[1]. Some of the indicators are GIS-based indicators, which are connected with GIS maps, which assess the roads and infrastructure networks. The indicators groups form three sustainability indices (economic, social, and environmental), which form the composite sustainability index. (Yigitcanlar and Dur 2010, p.323) (Lee and Huang 2007, p.510) and (Zhang et al. 2011, p.144)[2].

The second part assesses the spatial dimension of the sustainability with regards to the balance between the land supply and demand. This is to identify whether there are current needs or a current excess of lands to be the guide in the planned state assessment. The land supply is evaluated through a mapping statistics method to identify the available area from each land-use type. The determination of the demand on lands from various land-uses types is done based on the current population[3] through definite equations.

(6.2.4) Section of Formulation of the Criteria for Assessing the Sustainability in the Suggested State:

1 Examples on urban indicators: female/male employment rate, average number of students per classroom, road area per capita, and daily waste production per capita.

2 The references here refer to the guide example (mentioned in chapter 5), which have used the same suggested assessment tool.

3 Because the shortage in land-uses types in the current state should be the priority to be fulfilled in the suggested state.

This section is considered the assembling and visualization (in maps and report form) of the output of the previous section, which is (at the same time) the input of the next section. The output and input are the specialized criteria for the study area, which should be fulfilled in the suggested state to compensate the gaps in sustainability attainment in the current state of the study area through its suggested plan. However, the fulfillment of the future needs (till the plan’s target year[4]) will be taken into account through applying the predefined general criteria as the next section illustrates. These specialized criteria may be modified by the feedbacks from the actors (involved in the assessment process) after assessing the suggested state of the study area.

(6.2.5) The Analyzing Section:

This section assesses the sustainability in the suggested state with regards to the current and the future needs through two stages. The first stage is applying the obtained specialized criteria for assessing the plan's fulfillment for the current needs using an Expert System (ES) technique that is based on IF-THEN rules, which are the specialized criteria (Demetriou et al. 2013, p.80). In other words, the specialized criteria will form the IF-THEN rules used within the ES technique. For example, if there is shortage with a definite percentage in the area of the medical service within the current state of the study area, this will be an IF-THEN rule. So, “IF” the plan does not fulfill this shortage, “THEN” this plan does not fulfill the current needs of the residents, and so it cannot fulfill their future needs either.

Therefore, if the assessment of the first stage shows that the plan cannot fulfill any of the current needs of the study area according to the specialized criteria, the assessment process of the SPSS will stop, and will not perform the second stage. As failure of the plan in fulfilling the current residents’ needs means its failure to fulfill the future residents’ needs.

The second stage is assessing of the plan's fulfillment for the future needs through applying the predefined general criteria. This stage consists of two parts (like the realization section). The first part assesses the social, economic, and environmental dimensions of sustainability in the plan (i.e. the future state of the study area) including the evaluation of the planned state of roads and infrastructure networks. These are through the same group of urban indicators, three sustainability indices, and composite sustainability index.

The second part[5] assesses the spatial dimension through checking three parameters. These are the equity of the services distribution (social sustainability aspect), the sufficiency of the areas specialized for various required land-uses (economic sustainability aspect), and the compatible relations between land-uses (environmental sustainability aspect). It could happen that the services are equally distributed, but the land-uses areas are not sufficient for residents. Or the services are equally distributed, and land-uses areas are sufficient for residents, but the relations between the land-uses are not compatible.

The equity of the services distribution is evaluated using SMCA with AHP (Taleai et al. 2014, p.63). The compatibility of the relations between land-uses is evaluated through identifying the

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4 It is the year till which, the plan aims to fulfill the city needs.

5 This part is the established assessment model within the empirical part of this dissertation, but using other methods techniques as illustrated in chapter 8.

positive or synergetic and negative impacts on sustainability from various land-uses combinations by using the compatibility matrices analysis (Han et al. 2013, p.8). The sufficiency of the areas specialized for various required land-uses is checked based on the expected population through definite equations.

(6.2.6) The Action Section:

This section performs the SPSS outputs, which are the visualization of the land-use plan assessment in hot spot maps form through ArcGIS™ software. Also, the suggestions for modifications to make the plan more sustainable using ES technique are identified. (Demetriou et al. 2013, p.80).

These suggestions are presented to the actors, (involved in the assessment process[6]) through a coordinator to take their feedback using an interactive method (Allen 2008, p.150). The feedback may cause a modification in the aforementioned specialized criteria, and so the suggested state is re-assessed until the plan is accepted by actors responsible and affected by its execution.

(6.2.7) The Final Results Section:

This section provides the hot spot maps expressing the assessment results of the land-use plan and concise reports regarding the suggestion of modifications to make the plan more sustainable. This section also formulates the assessment results of the social, economic, and environmental dimensions with the roads and infrastructure networks as well.

(6.2.8) The Knowledge Base Section:

It is considered the base-point and the end-point of the SPSS as this base contains the knowledge base for the sustainability assessment standards. It is able to be modified through feedbacks resulted from several cases assessed by this SPSS, which is a self-learning potential in it by using ES technique. For example, several cases for cities with resembling circumstances show that it is important for the citizens to be provided by definite service type, so the SPSS can deduce that. And the user has the choice to add this criterion in assessing the sustainability for the next resembling cases, or not.

(6.3) Requirements for Establishing the SPSS:

There are requirements that should be studied before the establishment of the proposed SPSS. The SPSS performs three main tasks. The first is the assessment of the current and suggested or planned state for the study area. The second is the suggestion for modifications in the planned state to be more sustainable. The third is the self-learning from resembling study areas to add new criteria in the general predefined criteria of the system.

Therefore, these requirements are also classified into three categories. The first is the knowledge base or the general predefined criteria for the assessment process of the current and planned state. The second is the rules for formulation of the recommended modifications of the planned state. The third is the rules for the extraction of new criteria from resembling study areas, as follows:

[6] Chapter 7 illustrates in details these actors and the administrative framework for applying the SPSS in assessing the planning process of the Egyptian cities.

(6.3.1) Identification of the General Predefined Criteria for the Assessment Process of the Current and Planned State:

These predefined criteria (the knowledge base) should be according to the Egyptian circumstance. These criteria include two types:

(6.3.1.1) The Standards of the Assessment of the Social, Economic, and Environmental Dimensions of Sustainability:

Experts in sustainability are supposed to design the three urban indicators groups (economic, social, and environmental), the three sustainability indices, and composite sustainability index. The standards values of the indicators including the specifications of the roads and infrastructure networks are also identified.

(6.3.1.2) The Standards of the Assessment of the Spatial Dimension of Sustainability:

(6.3.1.2.1) The Standards of the Assessment of the Spatial Dimension of Sustainability in the Current State:

As aforementioned, the spatial dimension of the sustainability in the current state is evaluated with regards to the balance between the land supply and demand. The land supply evaluation requires the identification of the required land-uses types in any Egyptian city to check the available areas of these types using a mapping statistics method. The land demand evaluation requires the identification of the area required per person from these land-uses types for all the age categories[7].

(6.3.1.2.2) The Standards of the Assessment of the Spatial Dimension of Sustainability in the Planned State:

The spatial dimension of the sustainability in the planned state is evaluated with regards to the equity in distribution of services among residents, and the land-uses areas sufficiency to them, as well as the compatibility in the land-use structure among various land-uses. This requires the identification of:

- The "Cost of Travel" (CoT): which is the ideal cost (distance / time / money) to travel to/from a service parcel for studying the equity of the services distribution.
- Formulation of the compatibility matrices: which are appropriate for the Egyptian circumstances. These are formulated through the decomposition of the sustainability into several aspects (environmentally, economically, and socially), which are the most sensitive aspects for the land-uses diversity. Then, experts in each aspect assess the sustainability impact of all the probable pair-wise land-use combinations (e.g. residential and commercial) from their perspective and according to their expertise field. The sustainability impacts are ranked according to grades scale, (e.g. highly positive impact, moderate positive impact, neutral impact, moderate negative impact, etc.). Then, each aspect or criterion is assigned by definite weight according to its importance in the sustainability. The compatibility matrices will show which land-use combination may have a positive impact on sustainability, and which may have a negative impact.

(6.3.2) Identification of the Rules for Formulation of the Recommended Modifications of the Planned State:

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7 The standards of the areas needed from various land-uses types are required for the assessment of the spatial dimension of sustainability in each of the current and planned states.

These rules are the IF-THEN rules for suggesting the modifications to make the plan more sustainable.

For example, “IF there is a shortage in the area of definite type of land-uses, THEN:

- *Calculate the required area to be added to this type.*
- *Write this area in the report*”.

Or, “IF there is a conflict between two land uses in two neighboring parcels, THEN:

- *Mark the common edge or node between the two parcels with red in the colored map presenting the assessment results of the plan.*
- *Identify another appropriate alternative land-use type.*
- *Replace the conflicting land-use type with the new appropriate type.*
- *Write a note about this in the report ”.*

<u>(6.3.3) Identification of the Rules for Extraction New Criteria from Resemble Study Areas:</u>

These rules are the IF-THEN rules for extracting new criteria from common learned lessons of resembling cases .

For example, “IF there is a preference by the residents for definite type of recreational service in three or more cases, THEN:

- *Suggest the user to add this type in the predefined criteria (knowledge base) of the SPSS*”.

Or, “IF the residents’ expectations in three or more cases focus on the increase of the person portion from a definite land-use type, THEN:

- *Suggest the user to increase the person portion from this land-use type in the predefined criteria*”.

<u>(6.4) Reflections</u>:

This chapter presents the comprehensive technical framework of the proposed SPSS. The SPSS is flexible to be applied on master land-use plans (zones level) and detailed land-use plans (parcel level), and also flexible to be applied in other countries after identifying their own sustainability criteria.

An assessment model is selected from the comprehensive technical framework of the SPSS. The assessment model represents the second part of the second stage of the “analyzing section” of the SPSS, which is the assessment of the spatial dimension of the sustainability through evaluating the sustainability in the land-use structure of a study area. However, the model is based on a different methodology in assessing the sustainability of the land-use structure of a study area, as it is illustrated in chapter 8.

The assessment model was developed in the form of a new toolbox in the software ArcGIS™ within the empirical part of this dissertation through geo-scripting process using Python language (chapter 8). The toolbox is also flexible to be applied on either master or detailed plans.

The next chapter presents the Egyptian context by focusing on the planning and administration systems in the Egyptian cities and problems in these systems, as well as the expectations from the proposed SPSS to deal with these problems. And so, the design of administrative framework for applying the SPSS in the Egyptian context is deduced.

Chapter 7

Urban Planning Process in Egypt (*The Egyptian Context and the Administrative Framework for the Sustainability Assessment of Urban Planning Process in Egypt*)

(7.1) Introduction:

In this chapter, the main focus will be on the local level for cities’ planning in Egypt, as it is the level of the proposed SPSS in this research. However, the urban planning process in Egypt in general will be also illustrated to deduce the gaps in the planning and the local administration systems in these cities. As applying SPSS for supporting land-use planning process will firstly require investigating to what extent this process in Egypt is prepared on the managing or the administrative level to use this tool.

Sharifi and Murayama confirmed that the institutions performance in planning management directly impacts the sustainability to the degree that the institutional sustainability criteria should be considered in the sustainability assessment process. This is due to the importance of the governance issue and the usage of more effective administrative procedures (Sharifi and Murayama 2013, p.78).

This is the experience of many countries. For example, it is confirmed that the main problem in the current planning practice in India is represented in the focus of the city planning process. As this focus is only on the preparation process of land-use plans (for providing the targeted populations with their needs from various land uses) with the weak attention on attaining the proper and satisfactory implementation of these plans. (Sudhira and Ramachandra 2009, p.187).

This has made the land-use planning process in India static and just concentrating on land-use issues. According to Sudhira and Ramachandra, the authorities responsible for the provision of infrastructure and services do not perfectly plan to provide the required infrastructure and services suggested by planning authority within the land-use plans. Also, there is a lack in evaluating any policy decisions in a dynamic way through visualizing the probable impacts of these decisions. This may also lead to other problems like urban sprawl phenomenon (as previously stated in Chapter 5). (Sudhira and Ramachandra 2009, p.187). This is a similar experience to the Egyptian cities as it is illustrated in details in this chapter.

This chapter illustrates the components of the planning system for the Egyptian cities and how the land-use plans are developed and implemented. Then, some critiques on the procedure of performing plans for cities are presented. Two important issues have to be discussed in details. The first is problems within the local administration system, which hinder the physical development in Egypt. These are classified to gaps or problems from inside and outside the local administration system in the Egyptian cities.

The second issue is the gaps or problems in managing the physical planning and development processes in Egypt in general and in managing the land-use planning process in the existing Egyptian cities in particular. Then, the spatial problems resulted from the spontaneous generation of most of the existing Egyptian cities are presented, as well as the funding problem facing the physical planning and development processes in Egypt.

So, the expectations from the proposed SPSS to deal with the administrative and spatial problems in the Egyptian cities have been deduced to identify the requirements and challenges of adopting the SPSS in the planning process in these cities. And so, the administrative framework for applying the SPSS in the Egyptian context was designed. This chapter also puts the light on the positive and negative effects of the 25th of January revolution concerning the physical development process in Egypt.

(7.2) The Administration Division and the Urban Communities in Egypt:

(7.2.1) Introduction about Egypt:

Egypt is the northeast gate to Africa, its capital is Cairo city. It is an afroasiatic transcontinental country, as its peninsula “Sinai” is located in Asia. Egypt is bordered by the Mediterranean Sea from the north, the Gaza Strip and Israel from the northeast, Gulf of Aqaba and the Red Sea from the east, Sudan from the south, and Libya from the west. The population in Egypt was over 93,173,619 inhabitants in June 2017, according to Central Agency for Public Mobilization and Statistics-CAMPAS (The CAMPAS website, 2017).

Fig. (7.1) The bordering countries to Egypt

Source: Weltzeit website, 2017

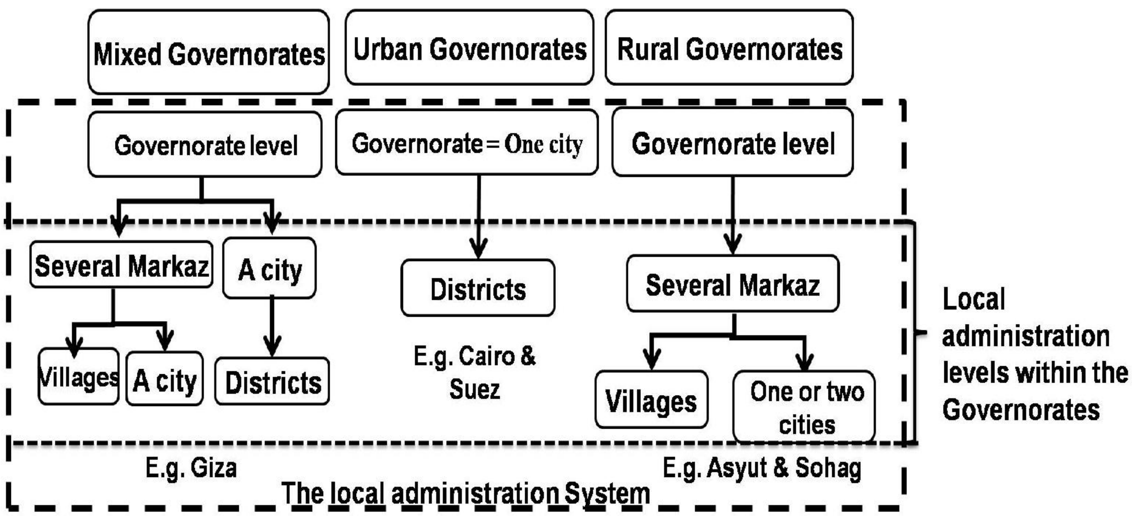
Egypt has a unique situation with regards to the distribution of the population all over Egypt’s area (1,010,407.87 square kilometre). The majority of the population live in a very small percentage of this large area (about 5%). The remaining area (95%) is represented in desert lands, which are owned by the Egyptian government, and the majority of these lands are undeveloped lands (World Bank 2006, executive summary). So, the main problem of the congestion in Egypt is not because of the lack of area, but because of the way the population are distributed in this area. And this is a mismanagement problem of the physical communities in Egypt.

(7.2.2) The Administration Division in Egypt:

There are two types of “physical communities” within every administration system, which are the urban and the rural communities (cities and villages). In this section, some information concerning the administration division in Egypt, should be stated in order that the reader has a background on some important Egyptians terms, which will be mentioned several times later. Then, the types of urban communities and the planning and economic regions in Egypt are illustrated.

The administration system of Egypt is divided into 27 “Governorates[1]”. There are three types of governorates in Egypt within the local administration system of these governorates as shown in the next figure. These are the rural, urban, and mixed governorates.

Fig. (7.2) The governorates types in Egypt



Source: Nada 2011

The rural governorates consist of several Markaz[2], each Markaz has one (or in rare cases two cities), in addition to some villages, e.g. Asyut and Sohag governorates. The urban governorates consist of only a group of districts, which means that each governorate is represented in one main city that consists of some districts, e.g. Cairo and Suez governorates.

The mixed governorates are considered a mixture between the two previous types. The mixed governorate includes one independent city that consists of some districts, in addition to several markazs that each one consists of one city and some villages, e.g. Giza governorate.

Each item within the local administration system of the governorates (i.e. Markaz, or city, or village, or district) is considered a local administration level. The district is considered an administration level (only in cases of the mixed and urban governorates).

(7.2.3)Types of Urban Communities in Egypt:

Since the focus in this study is on the urban communities or cities, figure (7.3) shows that there are three types of urban communities in Egypt. Two are new planned, and the third is the old existing cities (e.g. Asyut city- the capital of Asyut governorate in the upper Egypt). Traditionally,

1 The word “governorate” means states and it is managed by governors.

2 Unfortunately, there is no accurate translation from Arabic to English for "Markaz".

many existing Egyptian cities spontaneously generated, lacking any formal planning process. Even after the consideration of the planning principles in this process, still there are many spatial problems, which resulting from their spontaneous generation. In addition, there are some administrative problems hindering the sustainable development attainment in these cities, which are illustrated in details in this chapter.

The existing cities have been chosen to be the target of this study because they are in more need (than the other two kinds) for effective interventions to deal with these problems and move them forward towards sustainability, as far as it is possible.

Fig. (7.3) Types of urban communities in Egypt

Source: by own

The new planned urban communities are two types, the first type is the new governmental cities. After the 6th October War, 1973, the Egyptian government began in establishing new cities based on planning principles to alleviate the congestion problems[3]. The second type of the new urban communities is cities or resorts that have been established by private communities. These are characterized by a high living standard and life style (e.g. Elrehab city) as rich people live in these cities or spend their vacations in them.

<u>(7.2.4) The Planning and Economic Regions in Egypt:</u>

Egypt is divided into seven planning or economic regions[4]. Each region includes two or more governorates as shown in figure (7.4). The "General Organization for Physical Planning-GOPP[5]" is the organization responsible for the physical planning process in Egypt. It has seven "regional planning centers" related to it. Each regional planning center is responsible for two or more governorates. These planning or economic regions are the Great Cairo Region, Alexandria Region, Delta Region, Suez Canal Region, the north Upper Egypt Region, the south Upper Egypt Region, and Asyut Region.

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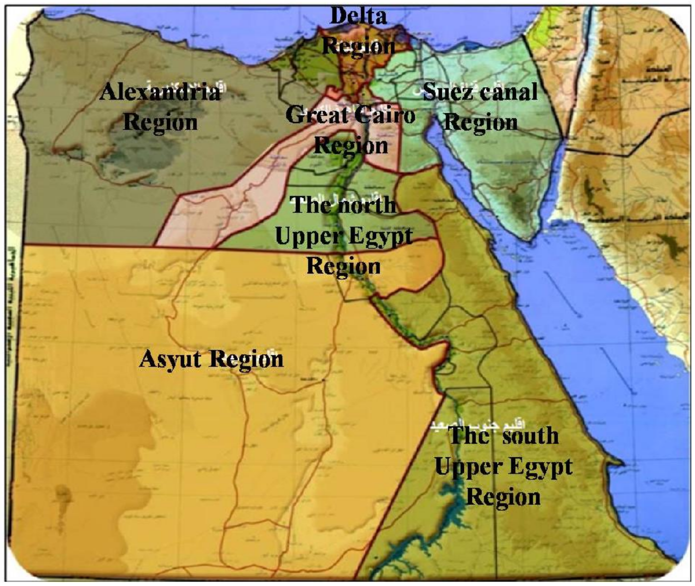
3 Worth to mentioning that the government has also established new villages in the desert backyard areas of the Nile valley, so there are new governmental cities and villages.

4 As will be illustrated later, there are “regional financial planning organizations”, which are related to the “the planning and the international cooperation ministry”, and responsible for the economic regions. These regions are the same planning regions.

5 The GOPP was established in 1973.

Fig. (7.4) The Planning and Economic regions in Egypt



Source: GOPP website “Geographical maps ”, 2017

(7.3)The Planning System for the Egyptian Cities:

This section illustrates each of the planning levels in Egypt, planning system's elements, areas covered by cities' planning, laws affecting the physical planning process directly and indirectly, and how plans are developed for cities:

(7.3.1) Planning levels in Egypt:

There are four levels of the strategic plans, which are the national, regional, governorate, and master plan on the local level of cities/villages. However, the actors affecting the planning process are classified into five levels (as will be illustrated later), which are national, regional, governorate, markaz, and cities/villages. The four levels for the strategic plans are (Article 2 Law 119/2008, p.3,4):

- National level, which is represented in the national strategic plan. It proposes the formulation of the goals, policies, and programs of the physical development for the whole country, and identifies the national projects on the level of the country.
- Regional level, which is represented in the regional strategic plan. It proposes the formulation of the goals, policies, and programs of the physical development for the region. It also identifies the regional projects that should be within the framework of the national strategic plan.
- Governorate level, which is represented in the governorate strategic plan. It proposes the formulation of the goals, policies, and programs of the physical development for the governorate. It also identifies projects on the level of the governorate, which should be integrated into the framework of the regional strategic plan for the region that the governorate locates inside it.
- Local level (City or village), which is represented in the master and detailed strategic plans. It proposes the fulfillment of the future needs from the physical development for a city or village. It also identifies the projects for implementing the economic, social,

environmental, and physical development strategies for attaining the sustainable development, which should be within the framework of the framework for the future vision of the governorate. The main outputs are land-use and infrastructure maps, as well as the plans for some development projects.

(7.3.2) The Elements of the Planning System of Egypt:

The elements of cities' planning system include the actors affecting and affected by the planning process:

(7.3.2.1) Actors Affecting the Planning Process:

Figure (7.5) illustrates actors directly affecting the planning process in Egyptian cities. As it will be mentioned later, this planning process is centrally managed. So, the actors affecting the cities' planning are mainly on the national level. However, the actors affecting the planning process can be classified according to their geographical level of impact on the planning process.

(7.3.2.1.1) Actors Affecting the Planning Process on the National Level:

A. “The Supreme Council for Planning and Urban Development (SCPUD)”[6]. The SCPUD includes members of various respective ministries for the physical development process, the managers of the entities affecting the urban development and governmental land management processes. Also a group of ten experts are members in the SCPUD, who are specialized in relevant issues (Nada, 2012, p.1). The SCPUD main tasks are:

- The Supervision on the “GOPP” with “the housing, utilities, and urban development ministry” in performing strategic plans on various planning levels (Article 10 Law 119/2008, p.11).
- Approving the strategic plans on the national, regional, and the governorates levels. (Moustafa 2015, p.20).
- Putting the general goals and policies for planning and urban development processes on the national level. (Nada 2012, p.1)
- Coordination among concerning entities in developing and implementing the national strategic plan. (Nada 2012, p.1).
- Presenting opinions in the draft of the laws that concern with the physical development. (Nada 2012, p.1)
- Identifying definite restrictions for any special area within a city for attaining a national purpose from that. (Article 17 Law 119/2008, p.16), (Moustafa 2015, p.20).

B. “The Ministry of Housing, Utilities and Urban Development (MHUUD)” is responsible for the economic, urban, and social development. The MHUUD main tasks are (Moustafa 2015, p. 26-27):

- Setting policies and programs according to the national framework.
- Sharing the SCPUD in supervising the performing strategic plans on various planning levels (as aforementioned).
- Planning for the provision of water and sewage networks.
- Housing sector.

6 The chair-man of this council is the prime-minister.

- Coordination among the entities involved in the housing, utilities, and physical development fields.

C. “The General Organization of Physical Planning (GOPP)” is the main authority responsible for performing the strategic plans on various planning levels (as mentioned before). In addition to:

- Sectoral research and studies in planning and physical development.(Nada 2012, p.1)
- Preparation the terms of references (TOR) for the performing the strategic and detailed plans, as well as the guide for the standards of services provision according to the Egyptian circumstances. (Article 6 Law 119/2008, p.10)
- The evaluation and monitoring of the physical planning process using the urban indicators through the national urban observatory within the GOPP with the cooperation with information centers on various geographical levels.(Nada 2012, p.1)
- Technical support for the general administrations for physical planning and development within the governorates, as well as consulting the local communities to identify their problems and development goals through the participatory planning approach (Moustafa 2015, p. 29).

D. An important committee called "the legal construction boundary committee” (or in Arabic called “Haiez committee") is responsible for the studying and assignment of the new legal boundary for any existing city (proposed to planning) (Article 18, executive regulations- Law 119/2009, p.27). This is in order to occupy the expected increase in population and provide areas required for various land-uses types in the plan, as this legal boundary identifies the construction activities' limits, (i.e. outside this boundary any construction activities are forbidden). This committee includes members from various institutions like GOPP, the antiquities ministry, agriculture ministry, ministry of defense, members specialized in law, and others.

E. “The National Center for Planning the State Lands Usages (NCPSLU)” is responsible for the counting of the governmental lands, which are located outside the legal outside the construction boundaries of physical communities (Article 7, executive regulations- Law 119/2009, p.19). The NCPSLU also shares in studying suggestions for development projects on these lands according the national development policy of the whole country with each of the SCPUD and the ministry of defense. This studying includes the land-use maps preparation for these lands and the coordination with various ministries that need lands to establish their development projects. And so, each of the revenues and expenditures of these development projects, the controlling prices of the lands used in these projects, and the protection rules of these lands are identified. (Nada 2012, p.1).

F. “The National Organization for Urban Harmony (NOUH)” is responsible for identifying the areas with valuable architectural heritage in the whole country. NOUH then presents the criteria and programs for preserving these area to the SCPUD to assign them. In case that any valuable architectural area is located within the study area of the plan of any city or village, the NOUH should be informed with that in order to study the boundaries of the valuable architectural area with regards to the study area of the plan under preparation. (Article 3, executive regulations- Law 119/2009, p. 17,18).

G. The ministry of defense controls the lands inside and outside the construction boundaries of physical communities :

- For the lands located inside the construction boundaries of physical communities, the ministry of defense has the authority to validate and give the permission regarding each of the boundaries of the study areas for cities and villages plans(Article 17, executive regulations- Law 119/2009, p.27) and the legal construction boundaries identified within these plans. (Article 18, executive regulations- Law 119/2009, p.27).
- For the lands located outside the construction boundaries of physical communities, the ministry of defense supervises the NCPSLU in managing the governmental lands.(Article 7, executive regulations- Law 119/2009, p.19).

H. There are a group of experts and consulting offices that are registered in GOPP to cooperate with the GOPP in performing the plans under its supervision and its regional offices or centers. These experts and consulting offices affect the planning process on all levels especially on the cities' local level. (Article 11, executive regulations- Law 119/2009, p.13).

(7.3.2.1.2) Actors Affecting the Planning Process on the Regional Level:

A. “The regional planning administration” is an administration in the GOPP in its head office that is responsible for the strategic regional plans.

B. “The Regional Centers for Planning and Physical Development” related to GOPP (regional planning centers) are located in the biggest city in each planning region. These centers represent the GOPP in their region, as they are responsible on all the activities of the GOPP within their regions. They also follow up the preparation of the master strategic plans for the cities and villages located within their regions. (Article 7 Law 119/2008, p.11).

The regional planning centers should also support and cooperate with "the General Planning and Physical Development Administrations" in the governorates (located within their region). This support is within the preparation of the detailed plans for areas within the cities and villages of the governorates under the supervision of “the governor” (Article 8 Law 119/2008, p.11).

(7.3.2.1.3) Actors Affecting the Planning Process on the Governorate Level:

A. “The general administration for planning and physical development” is responsible for collecting the citizens’ remarks on the master strategic plans for cities and villages, so that the required modifications in these plans are transferred to the regional planning center of the GOPP. (Article 12 Law 119/2008, p.13),(Moustafa 2015, p.32)

B. The “Local Popular Councils (LPCs)” include elected persons from citizens by voting. There are local popular councils on the levels of the governorate, markaz, and city or village[7]. The cities or villages plans are presented in a public meeting for each of the citizens, stakeholders, and these councils for discussing and obtaining the agreement of these councils before the governor assignment on these plans. (Article 18, executive regulations- Law 119/2009, p.27).

C. “The Executive Councils” are also on the levels of the governorate, markaz, and city or village[8]. However, the governorate executive council is the responsible council for setting the urban goals and policies on the local governorate level. This is according to the governorate needs, which are identified by the local popular council of the governorate, and should be within the national and regional framework. These local urban goals are set with the cooperation of

[7] Only in cases of the mixed or urban governorates, there are LPCs on districts level.

[8] Only in cases of the mixed or urban governorates, there are also executive councils on districts level.

each of the general administration for planning and physical development of the governorate and the regional centers of GOPP. (Article 9 Law 119/2008, p.11). (Moustafa, 2015, p.20).

D. “The governor” supervises the heads of each of markaz, city or village, and districts to facilitate the expert team mission. This team is delegated by the GOPP to perform the master and detailed plans for cities or villages. (Article 13, executive regulations- Law 119/2009, p.13).

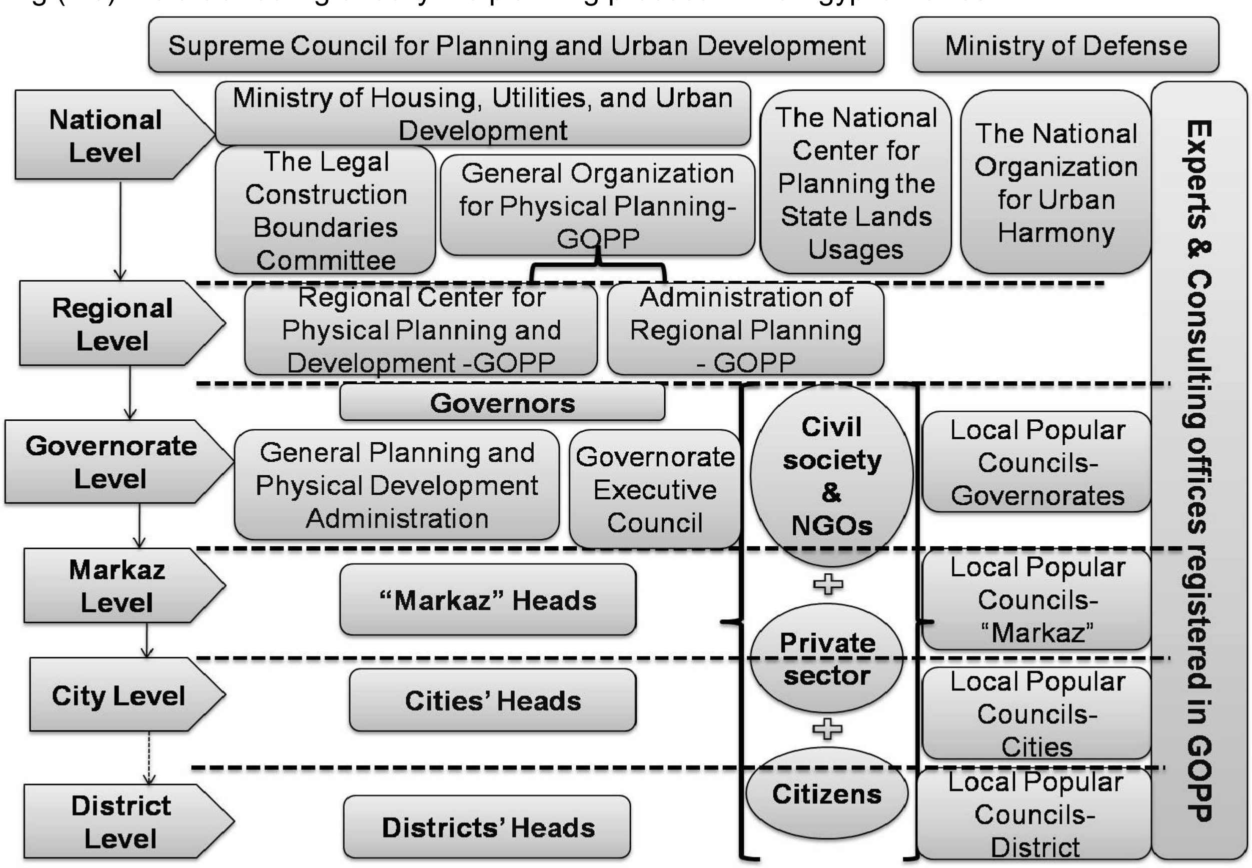
(7.3.2.1.4) Actors Affecting the Planning Process on the Local Levels:

A. The “civil society organizations”, “non-governmental organizations-NOGs”, and “the private sector” affect the planning and development process on the governorate, markaz, and cities (or villages). As these institutions can support the development by funding and other contributions like training programs and raising the citizens awareness for environmental and social issues.

B. “The citizens” (by the law) can greatly affect the planning process on the local level. As they can donate their lands for allocating and establishing utilities and services. Also, their agreement on the city or village plan is important in the public meetings for presenting these plans. As in case of citizens objection on any part in the plan, the expert team is committed to perform the required modifications. (Article 14, executive regulations- Law 119/2009, p.26). The citizens also share by opinions in workshops (taken place in various steps of the plans) as stakeholders.

C. The heads of markaz, city or village and district cooperate in the master strategic plans by organizing the public meetings and providing the expert team with information. This is through employees from construction activities’ administration and other administrations.

Fig.(7.5) Actors affecting directly the planning process in the Egyptian cities



Source: according to Nada 2011 and modified according to the aforementioned references

(7.3.2.2) Actors affected by the Planning Process:

The citizens, the investors, and other categories can be *positively or negatively* affected by the planning process. For example, when the plan provides appropriate areas for industrial uses. This encourages the investors to establish industrial projects. Or, when the plan fails to provide the needed areas in appropriate locations for various services, this demotivates the citizens.

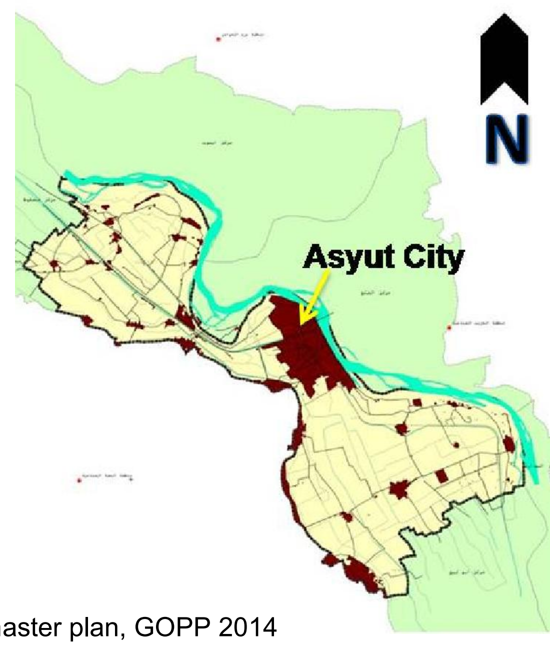
(7.3.3) Areas Covered by the Planning Process for Physical Communities:

In order to illustrate the areas covered by the planning process in Egyptian cities, three types of official boundaries in Egypt should be explained:

- The first type was previously mentioned that identifies the legal boundary for construction activities, (i.e. it is totally forbidden to construct any building outside this boundary). This is called “Haiez” in Arabic as shown in the next figure.
- The second type is the administrative boundary for the security and the administrative authority for any physical community. As in most cases the second type is larger than the first one. This is called “Cordon” in Arabic.
- The third type is the boundary for the agricultural lands (cultivated and uncultivated), which are subject to the agricultural land tax or property tax. This is called “Zimam” in Arabic, and is mainly connected to villages. (World Back 2006, Arabic Terms).

The planning and development activities on the local level of the physical communities deal with the areas limited by the first type (the legal construction boundary), which should be studied and upgraded every 20 years for limiting the urban growth of cities. Applying limits for growth (Urban Growth Boundaries-UGBs) is one of the main Egyptian policies to manage the physical expansion for cities. This is in addition to other two policies, which are the application of betterment levy (taxes for selected properties to support infrastructure provision on the local level) and performing detailed plans for extension areas of cities (Nada 2014, p.150, 158).

Fig.(7.6) Legal construction boundaries “Haiez” for physical communities (cities and villages) in Asyut governorate in Upper Egypt (the dark-colored shapes).



Source: Asyut city's strategic master plan, GOPP 2014

(7.3.4) Laws Affecting directly and indirectly the Physical Planning Process:

There are three significant laws that directly affect the physical planning process, which are represented in:

- The unified construction law (act no. 119 for the year 2008) and its executive regulations (activated on May 2009) concern with the physical planning, construction activities, and urban design.
- The planning law concerns with the preparation of the general plan of the state and following up its implementation (act no. 70 for the year 1973). It regulates the comprehensive planning on the moderate and long run for all the country’s sectors for attaining the socioeconomic justice among various society categories. And so, it affects the implementation of the development projects, as this laws regulates the identification of the priorities from these projects.
- The local administration law (act no. 43 for the year 1979) concerns with the local administration system that reflects on the management of the physical planning process.

There are some other laws that affect the physical planning process but in an indirect way, which are:

- The state budget law (act no. 53 of 1973) deals with the execution of the financial program of the annual budget in each finance year[9] according to the plan organized by the previously mentioned planning law. This is because the state budget law affects the development processes in an indirect way, whereas the planning law affects it in a direct way.
- The law of the architectural heritage preservation (act no. 144 of 2006) regulates the organizing of the demolition of buildings and structures that are ramshackle and the preservation of the architectural heritage. As each re-planning process for any city may be affected by the restrictions decided by this law.
- The expropriation of property for public benefit law (act no. 10 of 1990) concerns with converting the ownership of buildings or lands from private ownership to governmental ownership to be used for the public benefit. As each re-planning process for any city could be affected by the availability of public benefit buildings or lands.
- The environmental law (act no. 4 of 1994 and modified as act no. 9 of 2009) concerns with the environmental preservation and avoiding all pollution types (water, air, noise, etc.). This law indirectly affects the physical planning process. As there is no connection between its articles and articles of the unified construction law, unlike the case in most of the developed countries, where the environmental impacts assessment-EIA is one of the main processes that should be applied in the planning procedure.

(7.3.5) How Plans for the Existing Egyptian Cities are Developed and Implemented:[10]

The re-planning process for the existing communities in Egypt in general adopts the strategic planning approach. This is based on the idea of the stakeholders and the citizens’ involvement

9 The finance year is from July1st to the June 30th in the next year.

10 According to Terms Of References-TOR- for preparing strategic master and detailed plans for the Egyptian cities, GOPP 2010.

in the planning process. This is a recent approach for planning in Egypt, which has been adopted by the GOPP since the activation of the unified construction law (act 119, 2008) and its executive regulations (2009). The strategic planning is not only land-use planning, but also it includes the roads and infrastructure networks planning and the identification of projects supporting the development ("priority projects”).

The procedure of the re-planning process for any existing Egyptian city is divided into three stages[11] (as shown in the next figure). These stages are proceeded by a preliminary stage for the plan project preparation. In this preliminary stage, a report concerning the needs, priorities, and suggestions for the required projects for developing the city proposed to planning is prepared by the physical planning administration in the governorate in cooperation with some other entities so that the team of experts (responsible for performing the plan) take the recommendations in this report into account in the planning procedure. (Article 10, executive regulations- Law 119/2009, p.20). The three stages are:

The first stage is the master strategic plan, which is the city planning as zones (like industrial areas, residential, etc.) and the identification of the "priority projects". These projects are called "priority projects" because they are selected as a priority for the stakeholders. In some cases these projects are non-spatial projects like the establishment of a training center for a kind of hand made products in case that the city proposed to planning is famous with this kind of products, or its raw material is available in this city.

The second stage is the detailed planning for the priority projects including the preparation of the executive plans and feasibility studies for the development priority projects, as well as the detailed land-use planning[12] projects. Definite areas of the city are selected to be planned in detail (on the parcel level). As in most cases (especially the large cities) not all the city’s areas are planned in details (due to the high costs of the detailed planning works), but only definite areas that have the higher priority to be planned using the detailed planning. There are several kinds of the detailed planning for the city's areas. These are physical upgrading of some areas, the city extension areas, specific areas planning[13] like industrial and commercial areas, as well as the re-planning of deteriorated areas and margin areas surrounding the slum areas. These are in addition to private projects called "land division projects", which are submitted by private owners, who own land with an area equal or more than one fadan[14]. As these owners should

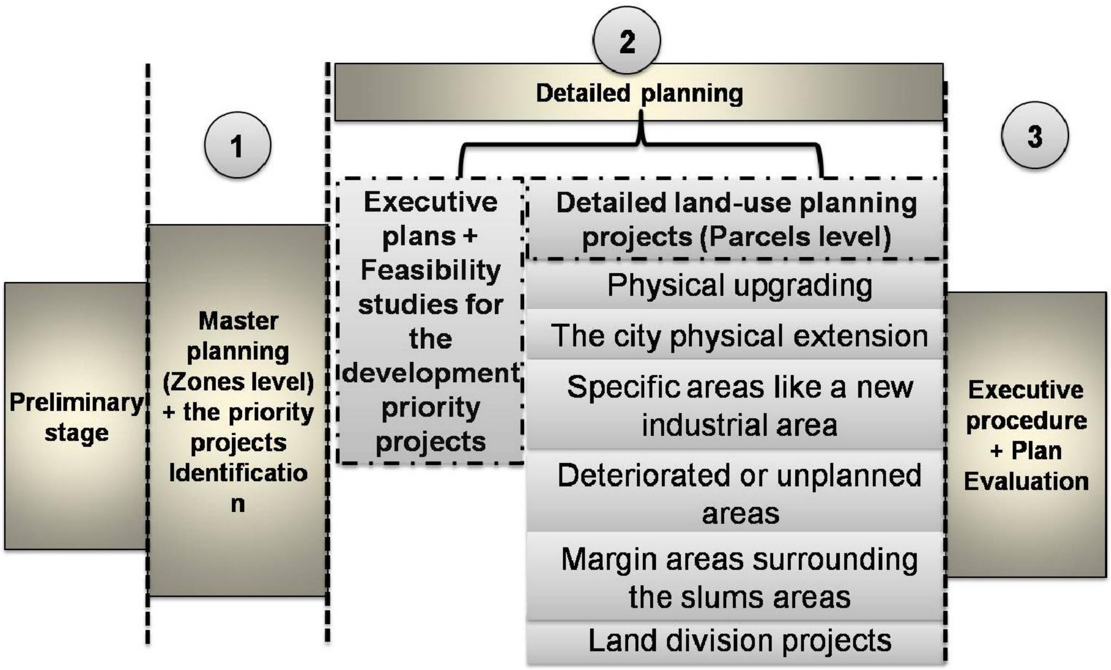
11 Each stage includes some steps, and each step contains some tasks.
12 The assessment of the sustainability attainment in the detailed land-use plans is the focus of empirical part of this dissertation.
13 The specific areas types:
- The new industrial areas (articles 42-45, executive regulations- Law 119/2009, p. 43-46). These areas are established in cities that have industrial potentials like vacant area (on the city margin within its legal construction boundary) or raw materials and capitals.
- Commercial areas (articles 31-32, executive regulations- Law 119/2009, p. 36-37).
- The general services areas (articles 33-34, executive regulations- Law 119/2009, p. 37-38). The multi-purposes areas “economic, commercial, and services areas” (articles 35-37, executive regulations- Law 119/2009, p. 38-39).
- The workshops areas (articles 38-41, executive regulations- Law 119/2009, p. 39-42) .
14 Fadan is an Egyptian area unit = 4200 m^2.

submit a land division project[15] before establishing any building in it (Articles 20-22 Law 119/2008, p.17,18).

The third stage is the executive procedure and the plan evaluation, in which the plan is implemented. The plan’s implementation is followed up by evaluating the attainment of the plan's main and secondary goals, as well as the execution of the priority projects according to their feasibility studies and time plans.

The GOPP and its regional centers are mainly responsible for the master plan. However, the detailed planning is done through the cooperation between the governorate and the expert team under the GOPP supervision and its regional centers. The detailed plans is the responsibility of the governorate with the local administration unit in the city proposed to re-planning.

Fig.(7.7) The stages of re-planning process for the existing Egyptian cities



Source: by own based on Terms of Reference-TOR, GOPP 2010.

The next table illustrates in details the steps of each stage of these stages and the outputs of each step according to the Terms of Reference-TOR booklet of the GOPP for the preparation of the strategic master and detailed plans for the Egyptian cities. Most of these steps are performed by the expert team or the engineering consulting office that has signed a contract with the GOPP to prepare the plan studies under the supervision of the GOPP represented by its regional planning center. This is with the cooperation of the general administration for planning and development in the governorate and the institutions in the city proposed to re-planning like the local popular and the executive councils, as well as the local administration unit[16]. These are in addition to the stakeholders (or what are called related partners) like the citizens, the NGOs, the civil society, and the private sector organizations in the city.

15 The official procedure for the land division projects is stated in articles 51-63, executive regulations- Law 119/2009, p. 50-65 .
16 The role of these institutions is illustrated later in this chapter.

Table (7.1) Steps and tasks in each stage of the re-planning process of cities and the outputs of each step:

Stage	Step	Task	The output
The preliminary stage	The plan project preparation.	The physical planning administration in the governorate cooperates with some other entities to prepare a report about the city proposed to planning. This should be after the agreement of the defense ministry on the boundaries of the study area of the city proposed to planning.	A report concerning the needs, the priorities, and suggestions for projects for developing the city.
First stage: The master strategic plan and the identification of the priority projects	Step.1: The preparation for the strategic master plan	1.The preparation for the plan’s beginning is done.	A time table for the meetings in the city along the plan project.
		2. The meeting of the experts team and the GOPP representatives with governor takes place, then the public meeting in the city for introducing the project. (figure 7.8)	A signed list by the governor for the names and contact details for “the main team-work” or what are called “the city's development partners (stakeholders)”, which are members from the city’s residents and employers in various fields.
		3. The public meetings with the stakeholder take place for discussing main problems and suggested projects by the residents. These meeting are announced in the whole city, and are opened to any resident in the city to attend and share. During these meetings, four questionnaires categories are distributed on four groups (the social services, shelter and slum areas issues, local economy, and infrastructure networks) (figure 7.9)	The answers of the questionnaires concerning the important problems in the city and their suggestion for important projects by the stakeholders.
		4. The field survey is performed for the city based on the satellite image, cartographic maps (CAD), and the geographic database using GIS (figure 7.10)	The field survey results for the city, (e.g. the land-uses types and the buildings state).
		5. The previous studies concerning the city and its region are collected.	An abstracted report for the previous studies concerning the city and the extracted conclusions from these sources.
		6. The main features of the city are identified, which are the regional location relationships of the city, history of the city’s mass development, urban governance or institutional framework, demographic study, state of the physical mass and informal settlements in it, and provision with services and infrastructure.	The main city features.
		7. The city indicators[17] are applied for assessing the current state for main and secondary sectors in the city (figure 7.11) (appendix no. 1 states the list of these indicators)	The results of the city indicators.

[17] The indicators assess six development sectors, which are “shelter issues” 17 indicators, “local economy issues” 6 indicators , “local governance issues” 3 indicators, “the infrastructure and environmental issues” (two sectors) 13 indicators, as well as “the social development, poverty, and marginalized people issues” 12 indicators.

Stage	Step	Task	The output
First stage: The master strategic plan and the identification of the priority projects	Step 2: The identification of the basic features and the future vision	1.The SWOT (Strengths, Weakness, Opportunities, Threatens) analysis is done for main and secondary sectors.	The results of the SWOT analysis of the main and secondary sectors.
		2. The city's future vision in a public meeting is identified, which is a definite short statement that identifies how the residents want to see their city. It should be based on actual potentials in the city to be actually attained[18]. As according to this vision the main and secondary goals, and the priority development projects will be also decided.	The city vision with the main and secondary goals.
		3. The city consulting presentation is prepared for presenting all the previous outputs for public, as well as some workshops for discussing the suggested development priority projects and selecting the priority projects according to the expected costs of these projects. These priority projects should be within the six development sectors.(appendix no. 2 states a list of the decided priority projects within the master strategic plan of Asyut city - the Upper Egypt- as examples for the priority projects).	The initial description for the priority projects. (figure 7.12).
		4. The information map of the city (geographic database for the city) and the analysis maps are prepared. In this step the documents of the field survey including a map for the current land-uses should be assigned by the city local administration unit because they are the base for the master and detailed plans.	The assignment of the field survey works, geographic database, and analysis maps for the city.
		5. The results of urban indicators of the city are revised.	The rates and evaluation of the city's sectors based on the urban indicators results.
		6. The “ development report for the city” is prepared. It includes the city background, current status of the development sectors, the city future vision, the identification of general goals that attain this vision, and the identification of secondary goals on the sectors' level, as well as challenges facing this vision and the suggested projects that can attain these goals. And so, the final list of priority projects are selected.	The city development report.
	Step no. 3: the preparation of the master strategic plan for the city	1. The logical framework approach (LFA) methodology is applied for identifying the activities that should be executed to attain the overall development goal of the city with definite expected results from the city development process through the strategic plan. Firstly, the overall goal is divided into main and secondary goals, then the indicators that measure their attainment are determined. Afterwards, the activities for attaining these goals and the assumptions that guarantees the execution of these activities are identified.	The Logic Framework Approach (LFA) table.
		2. The strategic board lines for the city development or "the main development strategy for the city" till the plan's target year are formulated, which is 20 years later, to fill the gap between their current state and their targeted state. This strategy is based on the SWOT analysis and the identified future vision with the stakeholders (e.g. supporting the public transportation network, suitable method for the solid wastes disposal, supporting the tourism activities, etc.). Also in this task, the most probable future population number (in the plan's target year) is identified according to the economic view and the physical capacity of the city. And according to this population number, all the required services can be identified. This is in order to suggest the mechanisms for efficiently attaining the future vision of the city.	The main development strategy for the city till the plan's target year.

18 For example, if the vision for Asyut city is “Asyut is an educational administrative commercial city”. This means that there are already educational, administrative, and commercial potentials in Asyut.

Stage	Step	Task	The output
First stage: The master strategic plan and the identification of the priority projects	Step no. 3: the preparation of the master strategic plan for the city	3. The consulting of “the main team work” of the city on the main development strategy for the city takes place, and the new legal construction activities’ boundary is discussed for occupying the increase of the city population till the plan’s target year without exceeding the Egyptian population density standard (150 person/fadan). This is a very critical confidential task, as the price of any land parcel after including in the new boundary will be multiple its previous price. So, the physical planning expert firstly puts a draft for the coordinates for the new boundary (see figure 7.13), then negotiations with the land owners begin. For instance, they may have the option that their land can be included in the new boundary with the advantage of increasing its price and the permission for constructing buildings on it, provided that these owners should donate with one third of its area for allocated services or infrastructure.	Criteria specialized for the identification of the new legal boundary of the city.
		4. The investment plan for executing of the priority projects in the strategic plan is prepared according to the development strategy. In this plan, each of the projects locations, their execution programs time tables on four intervals (each interval is 5 years)[19], and their funding plans are identified according to their priority degree.	The investment plan of the city for funding the priority projects.
		5. The suggested land-uses map within the new legal construction boundary and the construction rules for the city (e.g. maximum height in various city areas) are prepared. These rules (especially the maximum heights) are identified based on three factors. These factors are the conditions of the defense ministry for heights in definite parts of cities for security reasons, the streets widths (as in most cases the heights should not exceed one and a half of the street widths), and the paths of the high voltage lines for preserving a buffer area around them. The suggested land-use map with the new legal city boundary and the construction rules are presented to each of the city local administration unit and the local popular council, then to the governor[20]. All of these are the proceeding process for presenting this new boundary to "the legal construction boundary committee" on the national level that is responsible for studying and assigning the new legal boundary for any city. Then, the agreements of the defense ministry on the new legal boundary and the construction rules for the city are taken.	The assigned new legal construction boundary, the constructions rules for various city areas, and the suggested land use plan on zone level (not on the parcel level). N.b.: These constructions rules are applied in the detailed planning stage.
		6. The final report for strategic planning and the geo-database for the city are prepared.	The master strategic plan (maps and report) and the geo-database of the plan’s maps.
		7. The city development perspective is prepared, which is a brief study for all the previous outputs (appendix no. 3 states the items included in the city development perspective)	The city development perspective.
	Step no. 4: the presentation and the assignment of the master strategic plan for the city	1.The final draft of the master strategic plan is presented to the main team work (delegated from the city) and the representatives of the related partners.	The assignment of the plan by the governor, the housing and urban development minister, and the ministry of defense.
		2.The master strategic plan is presented to the local popular council and the concerning executive partners on the city and the governorate levels.	
		3.The final draft from the master strategic plan is submitted for the assignment.	

19 As the plan’s target year is 20 years later.

20 Most of governors prefer to assign each of the legal construction boundaries and master plans after the assignment of the local popular councils as a political attitude, see figure (7.14). In spite that the law conditions only the presentation and the approval on the plans by these councils, and does not condition their assignment on the plans by these councils. (Article 18, executive regulations- Law 119/2009, p.27).

<table>
<tr><th>Stage</th><th>Step</th><th>Task</th><th>The output</th></tr>
<tr><td rowspan="4">Second stage: The preparation of the detailed land-use plans, the executive work plans, and the feasibility studies of the priority projects</td><td rowspan="4">Step no. 1: the preparation of the detailed plans for existing and added areas in the city (the target year for the detailed plans is after 20 years like the master plan)</td><td>1.The detailed planning for land-use plans (on the parcel level) within the framework of the strategic master plan is performed. As aforementioned, the detailed land-use planning includes several types, the most prominent are the detailed re-planning for each of existing areas (the physical upgrading projects), the added areas as city extension, and the margin areas surrounding the slums areas for limiting these slum areas. The procedure used in the three types is almost the same:
- The collection of all detailed information on these areas (e.g. types and areas of lands' ownerships and the method of facilities supply).
- Establishing a workshop with groups of stakeholders.
- The detailed field survey and the soil guide tests.
- The preparation of a detailed report on these areas that includes the expected population, activities, construction regulations for each area, and others.
- The preparation of the roads network that identifies the new borders of the buildings in these areas[21] and the other infrastructure networks (e.g. water, sewage, etc.).
- The division of land into parcels and the services allocations.
- The services centers design including each of the identification of the land-uses distribution within them, the number of residents that will benefit from them, the street network for accessing them, and others.
- The urban design works that include trees and shrubs appropriate for open areas, parks , playgrounds, footpaths, and green areas on the edges of roads with determining the estimated cost of them.[22]</td><td>The detailed plans for existing areas (the physical upgrading projects), the city extension areas, and the margin areas surrounding the slums areas (limiting the slum areas).</td></tr>
<tr><td>2.The work plans for the priority projects are prepared by identifying the following: The requirements of these projects' in details- the responsibility of all the cooperated entities in the projects execution- the financial commitments of each of these entities towards these projects- the mechanisms for the coordination among these entities- the time table for executing these projects- the weak points in these projects' plans- alternatives in case of the implementation failure. Then, these plans are translated into the investment program for explaining the implementation and financing process of the projects to be included in the whole capital investment plan for the city because after the approval of the stakeholders on the suggested priority projects, these projects should be considered in the next five years of the city's agenda provided that the annual reviewing of projects' budget.</td><td>The executive work plans.</td></tr>
<tr><td>3.The economic feasibility studies are prepared for the priority projects[23] according to studying each of the state of the market and its actual needs, the purchasing capacity of the population, as well as the movement of the capital in general in the city, the contributions of the private sector in the priority projects, and the implementation stages of them. The results of these studies should be presented in successive workshops for the city's development partners and executives members from various city's sectors.</td><td>The economic feasibility studies for the priority projects.</td></tr>
<tr><td>4.The geo-information database for the city is updated .</td><td>The detailed geo-database (after updating) .</td></tr>
</table>

21 As establishing new roads or streets or widening old ones requires the identification of the border lines for the buildings' constructions, which will be established or re-established on new the roads network.
22 The details urban design works are stated in appendix no.41 of the TOR, GOPP, 2010.
23 This task is done in parallel with the preparation of detailed plans for various areas.

Stage	Step	Task	The output
Second stage: The preparation of the detailed land-use plans, the executive work plans, and the feasibility studies of the priority projects	Step no. 1: the preparation of the detailed plans for existing and added areas in the city	5.The detailed plans are assigned. The expert team is committed to present the outputs of these plans to the GOPP for the technical revision to check that the detailed plans match with the master strategic plan of the city and according to the TOR . Then, these plans are presented to the stakeholders group and the local popular council before the Governor’s assignment on these plans.	The assigned detailed plans by the governor.
	Step no. 2: the preparation of the executive plans and the tender documents for priority projects	1.The documents of the executive works and the tender are prepared with the calculation of the primary costs for all the planned infrastructure networks (roads, water, sewage, solid wastes, electricity, and communication), as well as the executive time table that should be according to the master and the detailed strategic plan.	-The documents of the tender including the quantities, specification and conditions of each project. -The final executive documents for the priority projects. -The detailed feasibility studies for the priority projects.
		2.The executive program of the strategic plan is prepared, which is the guide for clarifying the required activities in each time interval in the plan’s execution. This program includes the plan’s execution intervals or stages and the executive steps and tasks (on the quick, moderate, and long ranges) according to the degree of priority and feasibility of each executive step. And so, the responsible actors on each step are identified (i.e. civil society, private, and governmental sectors) with each of the degree of responsibility of each actor, the type and the quantity of the contribution, as well as the probable obstacles for the execution and how to overcome them.	The executive program for all the strategic plan components.
Third stage: The executive procedure, the plan evaluation, the following up of the physical development of the city, and the priority projects execution.		This stage is the responsibility of the governorate with the local administration unit in the city proposed to planning with the consulting office, (if the governorate perform a contract with this office for this stage). So, there are no specific steps and tasks or “terms of references” identified by the GOPP for this stage. However, each governorate and the local administration unit are supposed to implement the plan and the priority projects according to the available financial recourses.	

Source: by own based on TOR preparing strategic master and detailed plans for the Egyptian cities, GOPP (2010), and Law (119/2008), with its executive regulations rules (2009).

Figures that were referred to the previous table:

Fig. (7.8) Meetings of the expert team and the regional planning center (GOPP) representatives with Asyut’s governor, the physical development administration members, and the head of Asyut city for launching its strategic plan project in 2006

Source: Presentations of Asyut strategic master plan project, GOPP 2008

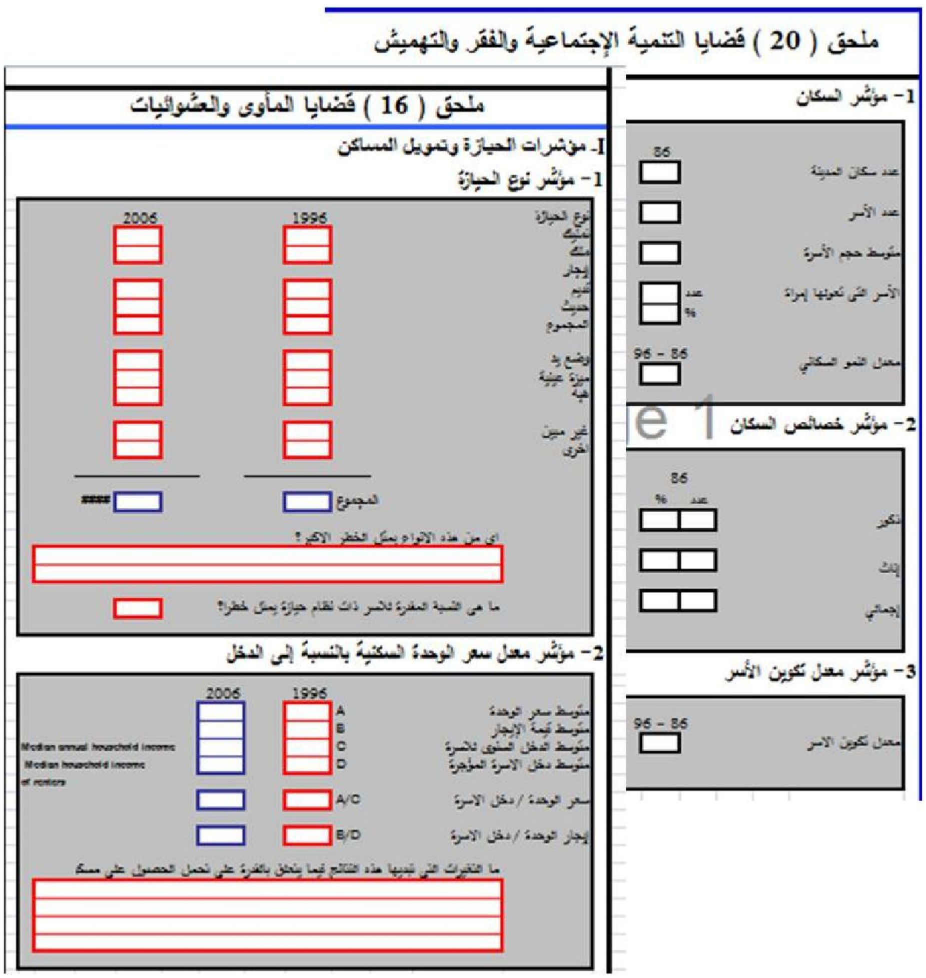
Fig. (7.9) The stakeholders groups answering the questionnaire regarding the main problems and suggestion for “El-Fateh” city (a small city near Asyut city) in the beginning of its strategic plan project in 2009

Source: Presentations of El-Fateh city strategic master plan project, GOPP 2010

Fig. (7.10) The field survey in the upgrading project for the deteriorated areas in “Moot” city, the New-Valley governorate in 2007

Source: Presentation of the upgrading project for the deteriorated areas in “Moot” city, GOPP 2007

Fig. (7.11) Examples for forms of urban indicators assessing various aspects in the city



Source: appendices no. 16 and 20 of TOR for preparing strategic master and detailed plans for the Egyptian cities, GOPP 2010.

Fig. (7.12) The template of the initial description of a priority development project

مركـــــز الدراســـــات
التخطيطيـــة والمعماريـــة
(أ.د. عبد الباقي إبراهيم وشركاه)
CPAS

محافظة أسيوط

وزارة الإسكان والمرافـق
والتنميـــة العمرانيـــة
الهيئة العامة للتخطيط العمراني

مشــــروع إعــــداد المخــــطط الأستراتيجــــي العــــام والتفصيــــلي لمدينــــة أسيــــوط

إســـم المشـــروع	....
القطاع	....
الموقع	....
نوع المشروع	(دراسة أو مسح – تنموي – تطوير مؤسسي – آخر يذكر..............)
ملخص الأهداف	....
الفئات المستهدفة	....
وصف المشروع	....
النتائج والفوائد المتوقعة	....
الافتراضات الرئيسية	....
الروابط مع المشروعات الأخرى	....
التكلفة المتوقعة	(لتنفيذ المشروع: .... – للصيانة والإدارة..............)
المؤسسة المنفذة	....
المؤسسات المتعاونة	....
المؤسسات المالية الداعمة	(حكومة محلية – حكومة مركزية – مؤسسات مالية دولية – قطاع خاص – صناديق خاصة – أخرى تكر..............)
مشاركة القطاع الخاص	....
الإجراءات	
إجراءات فنية	(دراسات – حماية – تنفيذ مشروعات بيئية – تقييم الموقع وحجم المشروع– أخرى ذكر ....)
إجراءات إدارية	(تعديل استعمالات أراضي – تنسيق مع الإرشادات البيئية – المتابعة البيئية – تدريب فريق المشروع على إدارة المشروعات – الاتفاق مع السكان – أخرى تذكر.............. ....)
الأولوية	(ملح – عاجل – هام – قصير الأجل – متوسط الأجل – طويل الأجل)

Source: Presentations of Asyut strategic master plan project, GOPP 2008

Fig. (7.13) The meeting of the expert team and the regional planning center representatives (GOPP) with the physical development administration members in Asyut governorate for discussing the initial draft of the new legal construction boundary for Asyut city in 2007(before presenting it to the stakeholders in a public meeting)

Source: Presentations of Asyut strategic master plan project, GOPP 2008

Fig. (7.14) The assignment of the regional planning center’s manager (GOPP) on the master strategic plan of “El-Fateh” city (in a public meeting in the city administration unit) after the assignment of the city head and the local popular council head in the presence of the stakeholders and before the governor meeting in 2009.

Source: Presentations of El-Fateh city strategic master plan project, GOPP 2010

(7.3.6) Critiques on the Procedure of Performing Plans for Cities (Positive and Negative Aspects in Adopting the Strategic Planning Approach in Egypt):

According to the author’s point of view that was formed through her professional experience[24], there are some shortages in the procedure of performing plans for cities. These shortages may have been resulted from the direct application of the strategic planning approach in the Egyptian cities since 2006 without considering the difference in the circumstances and potentials in the Egyptian cities and other cities in developed countries that have adopted this approach. The main difference is the centralization policy impact on the development process in Egypt as will be illustrated later. These critiques are:

- The application of urban indicators (first stage, step 1, task 7) requires data that is sometimes unavailable in some cities. An example is the indicator of “the changes in the family income”, which is one of the six indicators of “the local economy issue” (appendix no.17, TOR, GOPP 2010). In this indicator, an information on the family income is required that is very difficult to be available in the small cities, as it is only available on the whole country level. Even on the country level, the value of the family income may not be accurate, as many families’ incomes are from private activities, which cannot be monitored by the Central Agency for Public Mobilization and Statistics-(CAMPAS) [25].

  Also, some of the required information in the tasks of the city development report preparation or the city development prospective is not available in many Egyptian cities like the state of the resource mobilization.

  In task 3, step no. 1 in the second stage regarding “preparing the feasibility studies of the priority projects”, there is a study for “the state of the market and its actual needs”. This study includes an item concerning the movement of the capitals in general in the city,

24 The author has worked as a planning engineer for more than 12 years in the Asyut regional planning center (office) related to GOPP.

25 CAPMAS is the organization responsible on the statistics in Egypt, which performs the census in Egypt every ten years, for example census 1976, 1986, 1996, 2006, and recently 2016.

which is difficult to be accurately studied through the actual available data in most of the small cities. As this needs a lot of data, money, and a well studied methodology to be accurately performed.

- Despite the logical framework approach-LFA is successful as a methodology, it is performed as a theoretical task (in the first stage, step 3, task 1). The LFA includes indicators that are supposed to be applied for following up the efficiency of implementing the activities decided within this framework. However, what practically happens is that these indicators are just stated in the LFA without actually applying them during the implementation of the plan.

- The repetition of some studies’ content in many tasks. For example, the city background and its historical emergence are done in the first stage, task 6, step 2 for “the city development report preparation” and the same in task 7, step 3 of the same stage for “the preparation of the city development perspective” (see appendix no. 3).
  Another example, the sectoral studies for the six development sectors are repeated in the previously mentioned two tasks, in addition to other two tasks, which are task 6, step 1 in the first stage regarding “the main features for the city” and task 1, step 2 in the same stage regarding “SWOT Analysis”. These are in addition to evaluating these sectors in the task of “urban indicators” task 7, step 1 of the same stage. All these repetitions increase the time, costs, and efforts spent in performing these studies.

- There are tasks with outputs, which are most likely will not be totally used like the task for the “preparation of the work plans of the priority projects” (second stage, step 1, task 2). These work plans include the identification of each of the priority projects’ requirements in details, the time table for executing the projects, the role of all the cooperated entities, the financial commitments of these entities towards these projects, the mechanisms for the coordination, and others. It is expected that these plans will be changed due to the continuous changes in the economic state as whole. This means that a lot of efforts, costs, and time may be spent in these work plans without an actual benefit. Also, this task is (in most cases) done as a routine task by the consulting office to fulfill the required TOR instructions.
  Moreover, this task contradicts with the actual adopted financial policy in Egypt. As this task requires the translation of the work plans into an investment program to be included in the whole capital investment plan for the city. Moreover, (as will be illustrated later) the financial resources are managed in a centralized way in Egypt, so that the local authorities of the cities cannot decide funding any project without the agreement of the central authority of the government.
  However, this does not mean the total infeasibility of the work plans of the priority projects, as there should be a detailed planning for the priority projects, but this confirms the need for focusing on the identification of more important aspects within these work plans (like the role of the cooperated entities) to be studied. And the other aspects can be postponed to be studied just before the actual execution of the projects like the financial commitments of various entities towards the projects implementations.

- The most pressing problem in the procedure of performing plans for cities is the long time period for this procedure, (especially if there are insecurity circumstances like what happened during the revolution time between 2011 and 2013). People (in many cases) badly exploit this long period and break the construction rules and built illegal buildings despite this being forbidden by law. They expect that they will be just punished by paying some fees to obtain legality for their illegal buildings in the next parliament election.

However, all the previous do not mean the failure of the strategic planning approach. As there are many strong points that show its success in applying in the re-planning process of the existing Egyptian cities. These points include:

- The selection of a group from the cities’ citizens and persons working in various sectors in the city to form what is called the “city's development partners” facilitates the consulting office’s mission in performing the plan. These group members are aware of many details and problems in the city, and can present beneficial suggestions.
- The field survey for the city is based on satellite images beside the cartographic maps (CAD), which helps in establishing accurate base maps for the cities’ masses.
- The usage of GIS analyses in the urban studies for the city[26] supports the identifications of many directions for the development intervention. For example, if there are slum areas that need limitation. As GIS act as a planning support system in the physical development field.
- The meetings with stakeholders in various planning stages give the opportunity for the expert team to know about all the problems and all the aspects in the city. Before the strategic planning approach, a “blueprint style” planning process was adopted in Egypt. This was a kind of top-down planning approach, by which the planner plans the city from office and cannot estimate all the actual needs in the city. However, there is still a centralization attitude in many of the strategic planning procedure in Egypt in managing the planning and development processes as it will be illustrated later. So, these processes need to move towards actual decentralization, as the centralization is the general political attitude in Egypt in all fields not in the physical planning field only.
- The importance of the agreement of the stakeholders and the local popular council on each of the legal construction boundary and the master plan helps in the plan’s success. The plan should be presented and illustrated in a public meeting in the city. And the consulting office is committed to perform all the modifications in the plan according to the stakeholders requests (under the supervision of the regional planning center of the GOPP), as long as these requests are reasonable and applicable. (Articles 14, 15, 16, and 18, executive regulations- Law 119/2009, p. 26, 27).
- The negotiations with the land owners for identifying the coordinates of the new legal construction boundary for the city (first stage, step 3, task 3) are considered very beneficial despite their difficulties. As most of the lands ownerships inside the cities are private ownerships, and at the same time there is a need for allocating new facilities

[26] E.g. the percentage of vacant lands, the percentage of informal areas, the directions of the previous city’s mass extensions, and the various lands’ tenure types.

inside the new city’s boundary. So, this requires the donation of some lands by their owners. And so, these negotiations give the opportunity for a mutual benefit for the city to allocate the needed facilities and for the landowners, who donate parts of their lands with the advantage that these lands will be included in the new legal construction boundary. Or, in case that the landowner donates all the area of his/her land, he/she can be compensated with another land in another location.

- The task of the preparation of the economic feasibility study for the priority projects (second stage, step 1, task 3) is done parallel to the preparation of detailed plans for various areas. This allows considering the purchasing capacity of the population in these detailed plans for various areas. Despite it is a bit difficult to accurately grab the purchasing capacity of the population, it is very important to consider the land and housing market in planning or re-planning various areas.

(7.4) Problems within the Local Administration System in Egypt Facing the Physical Development and How to Deal with Them through Adopting a SPSS:

After illustrating the planning system's elements of the Egyptian cities and the way of plans’ formulation, it is important to study the managing or the administrative aspects that directly affect the planning process and hinder the sustainable urban development. This is achieved by comprehensively identifying all the gaps in the local administration system (in this section), as well as in managing the physical planning and development process in Egypt (in the next section). These gaps (as it is possible) are taken into account in designing the administrative framework for applying the proposed SPSS.

(7.4.1) The Gaps in the Local Administration System in Egypt:

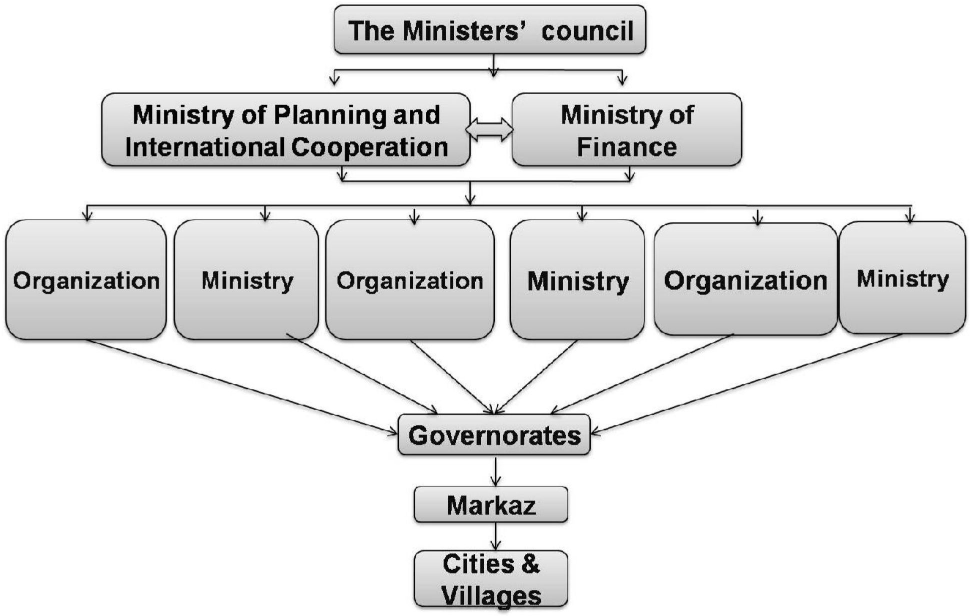
The local administration system is managed according to the local administration law (act 43, 1979). This system is represented in three administrative levels (governorate, markaz, and city/village)[27]. Because the local administration system directly affects the planning procedure of the existing cities, so it is important to illustrate each of gaps from outside and inside this system.

(7.4.1.1) Gaps from Outside the Local Administration System:

The financial relations between the central and local authorities are the main problem affecting the physical development process from outside the local administration system. The next figure clarifies these financial relations, and how the annual budget distribution (state general plan) is managed in Egypt.

27 There are exceptions in these administrative levels as it is illustrated before.

Fig.(7.15) The financial relations between the central and local authorities in Egypt



Source: Nada 2011.

The "Ministry of Planning and International Cooperation-MoP" is responsible for setting the annual state plan for attaining the socioeconomic development, as well as preparing the investments programs of sectors for achieving the short and long development goals. (Moustafa 2015, p.40). This is through studying and following up the execution of the national budget distribution on the whole country. Firstly, MoP receives the suggestions and needs for the projects of each ministry or national entity (e.g. youth council) for the next finance year to evaluate these projects from the economic point of view. Then, the MoP selects the appropriate projects to be considered in an integrated way within the draft state general budget, which is prepared by the Ministry of Finance-MoF. The selected projects’ plan with the draft state general budget are submitted to the ministers’ council (Cabinet), then to the parliament. After the parliament approves this general budget, various governmental entities or institutions can work according to it in the next finance year. (Nada 2012, p.1).

So, each institution provides each governorate with its portion from the budget according its needs and volume. And each governorate distributes on each markaz in it, and each markaz distributes on each city and village in it [28].

In order to practically illustrate how the centralized way in distributing the annual budget represents the main obstacle facing the physical planning process, a following practical example is stated:

If there is a suggestion for establishing a regional road to connect a city with other cities. So, the city's head should present this project to the markaz's head, and the markaz's head should

28 According to the finance planning law (act 70, 1973), the role of the local authorities is just to provide the required data for the financial planning for any project execution to the central authorities. As all the local projects (like schools) are centrally decided as sectors because each ministry has its own projects' plans.

present it to the governor. And the governor presents it to the concerning minister with the specific type of the project (transport and roads minister). And so, this minister presents this project to the ministers' council represented in each of MoP and the MoF to receive the agreement on funding this project from the budget of the next finance year.

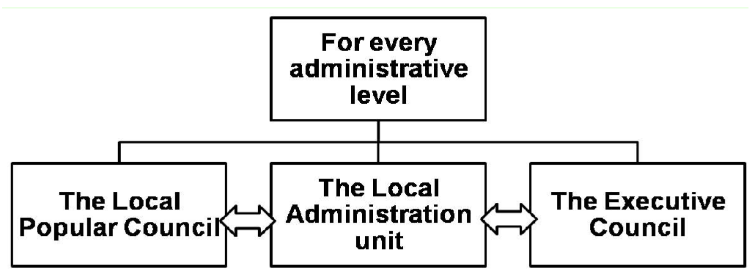
The previous example shows how the financial relations between the central and local authorities in Egypt are complicated and time consuming. This makes the financial recourses of the local authorities dependent on the central authorities[29]. Therefore, it negatively affects the local decision making process through the weak response of the local leaders for the needs of the citizens, who feel that their suggestions may not be executed.

The problem of financial centralization hinders the physical development process in the Egyptian cities. This has led to infeasibility of the strategic planning despite that it is based on the public contribution as illustrated before. Therefore, it is recommended to change this centralized financial policy[30], so that each governorate identifies its portion from the national annual budget based on the outputs of the strategic planning process for cities and villages in each governorate.

(7.4.1.2) Gaps Inside the Local Administration System :

As previously illustrated in the administration division in Egypt, the components of the local administration system of the governorates in Egypt differ according to the governorate type. And each item of the items (forming the local administration system of the governorates in Egypt) is considered "a local administration level". For every administrative level, there are three entities, which are the local administration unit, the executive council, and the local popular council as shown in the next figure:

Fig.(7.16) The three entities composing every administrative level in the Egyptian governorates



Source: by own, according to Nada, 2011.

First: the local administration unit is represented in the head of the local administrative level[31] (i.e. the head of markaz, city /village, and district in mixed or urban governorates). This head manages a group of administrations like construction activities control and cleaning administrations.

29 Except small budget which is specialized for each governorate to spend it on small projects that are decided locally (according to the local administration law).

30 No expectations from the SPSS to deal with the financial centralization, as the centralization is a general policy adopted by the Egyptian government that cannot be solved through PSSs.

31 The governorate as a local administrative level has no local administration unit, but consists of a group of administrations that manage all the local administration units on the administrative levels lower than the governorate level.

With regards to the physical development process, each local administration unit is responsible for the execution of the detailed physical plans. This unit also manages the local development projects according to the local annual budget for this unit, in addition to the construction control activities.

Second: the local popular council (as previously mentioned) is represented in elected people from the citizens. It is responsible for the public contribution in the local projects and following up each of the execution of these projects and the local annual budget. However, this council can just present suggestions for ideas for local development projects like utilities and services establishment, but cannot decide them.

With regards to the physical development, each local popular council has the right to accept or refuse any suggested plan before assigning it from the governor and the minister (as previously mentioned).

Third: the executive council is represented in the governor, (if this council on the governorate level), or the head of the Markaz, city/ village, and district (in mixed or urban governorates). This council also includes the managers of the branches or administrations that are related to some central services and infrastructure authorities or ministries[32] .

This council is responsible for providing consultation to the local popular council with regards to the legal, administrative, and technical aspects of various issues. (Nada 2011)

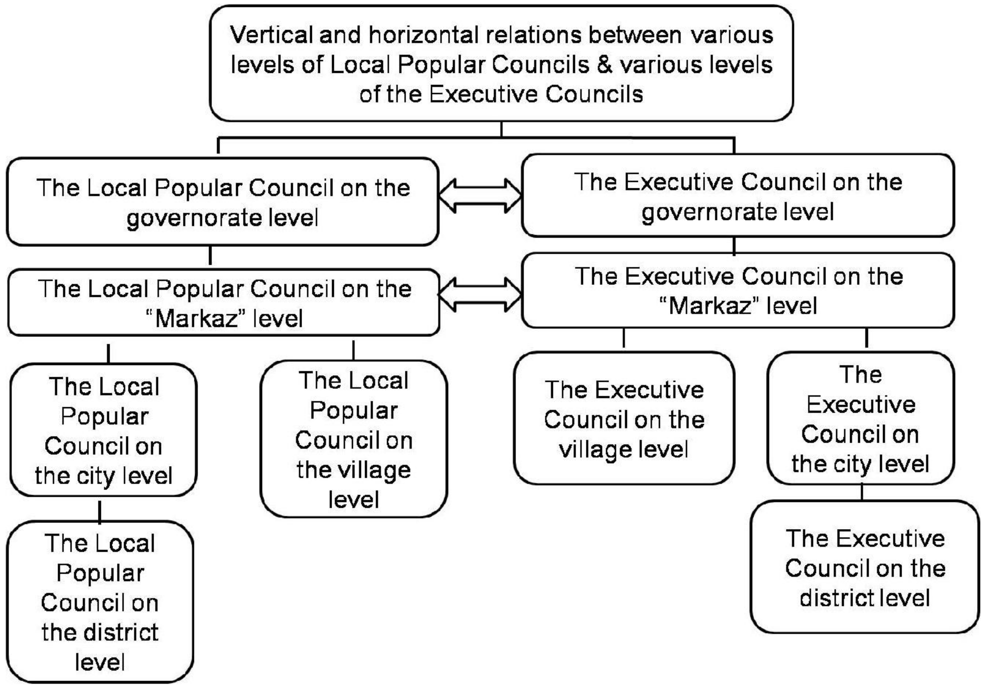
With regards to the physical development, each executive council is also responsible for preparing various projects' plans (e.g. services). It studies and suggests common projects that serve more than administration unit and performs the local development plan according to the local annual budget. (Nada 2011)

The articles no. 9 and 11 in the unified construction law (119/2008, p.10,11) and article no. 10 in the executive regulations (2009) of this law (p.20) support the involvement of each of the executive councils and the local popular councils in identifying the polices and needs in the physical development process. However, this law does not condition the assignment of these councils on the physical plans.

There is a big administrative gap or problem that is resulted from the nature of the vertical and horizontal relations between the local popular councils and executive councils on various administrative levels. As it is shown in the next figure, the local popular council on the governorate level has a direct horizontal relation with the executive council on the same level and the same case on the markaz level. However, these two councils have no direct horizontal relations on the city or village or district level, but they just have vertical relations with the related councils on the higher level. (Nada 2011)

32 Depending on the level of each executive council.

Fig.(7.17) The vertical and horizontal relations between the local popular councils and the executive councils on various administrative levels



Source: Nada 2011.

There is a problem within these relations, which can be clarified through the following practical example: If a member in the local popular council of the district wants to present a suggestion for a development project in the district. This requires that the local popular council of the district should presents this suggestion to the local popular council of the city. And the local popular council of the city presents this suggestion to local popular council of the Markaz, or in case of large projects this suggestion should be presented to local popular council of the governorate. Then, the last local council presents this suggestion to its equivalent executive council, which gives the opinion in this suggestion (with regards to the legal, administrative, and technical aspects). And so, this opinion will be passed back with the same procedure to the executive councils on the lower levels down to the district level.

As it is clear, it is a long and time consuming procedure caused by the nature of the relations between the local popular councils and the executive councils. This is due to gaps in the previously mentioned local administration law (act no. 43, 1979).

(7.4.2) General Recommendations and Expectations from the Proposed SPSS to Deal with the Gaps in the Local Administration System in Egypt:

The next table summarizes the most pressing gaps inside the local administrative system that directly affect the urban development attainment in the Egyptian cities. General recommendations to how to alleviate these gaps on the managing level of the urban development process are presented. The expectations from the proposed SPSS to deal with these gaps are also identified. This is in order to take these expectations into consideration in designing the administrative framework for applying this SPSS in the Egyptian cities:

Table (7.2) The important gaps inside the Egyptian local administrative system and general recommendations , as well as the expectations from the SPSS to deal with them:

<table>
<tr><th>Gaps</th><th>General Recommendations</th><th>Expectations from the SPSS</th></tr>
<tr><td>Despite that the presentation of the cities' plans to the local popular councils is obligatory before assigning these plans, these councils can only suggest development projects (according to the local administration law).</td><td>The local popular councils should have the authority to suggest and decide executing projects.</td><td>Involving the local popular councils in the assessment process.</td></tr>
<tr><td>In most cases, the executive councils have no members working in physical planning institutions (i.e. GOPP or the general planning and physical development administration in the governorate).</td><td>Assigning members working in the physical planning institutions in the executive councils.</td><td rowspan="2">Involving the executive councils in the assessment process.</td></tr>
<tr><td>Despite that the executive council includes members from various institutions, its role in the planning process is just in the preliminary stage. As it is one of the institutions that prepare the aforementioned report concerning the needs of the city proposed to planning.</td><td>Involving the executive councils in an effective way in the all the planning procedure stages.</td></tr>
</table>

Source: by own

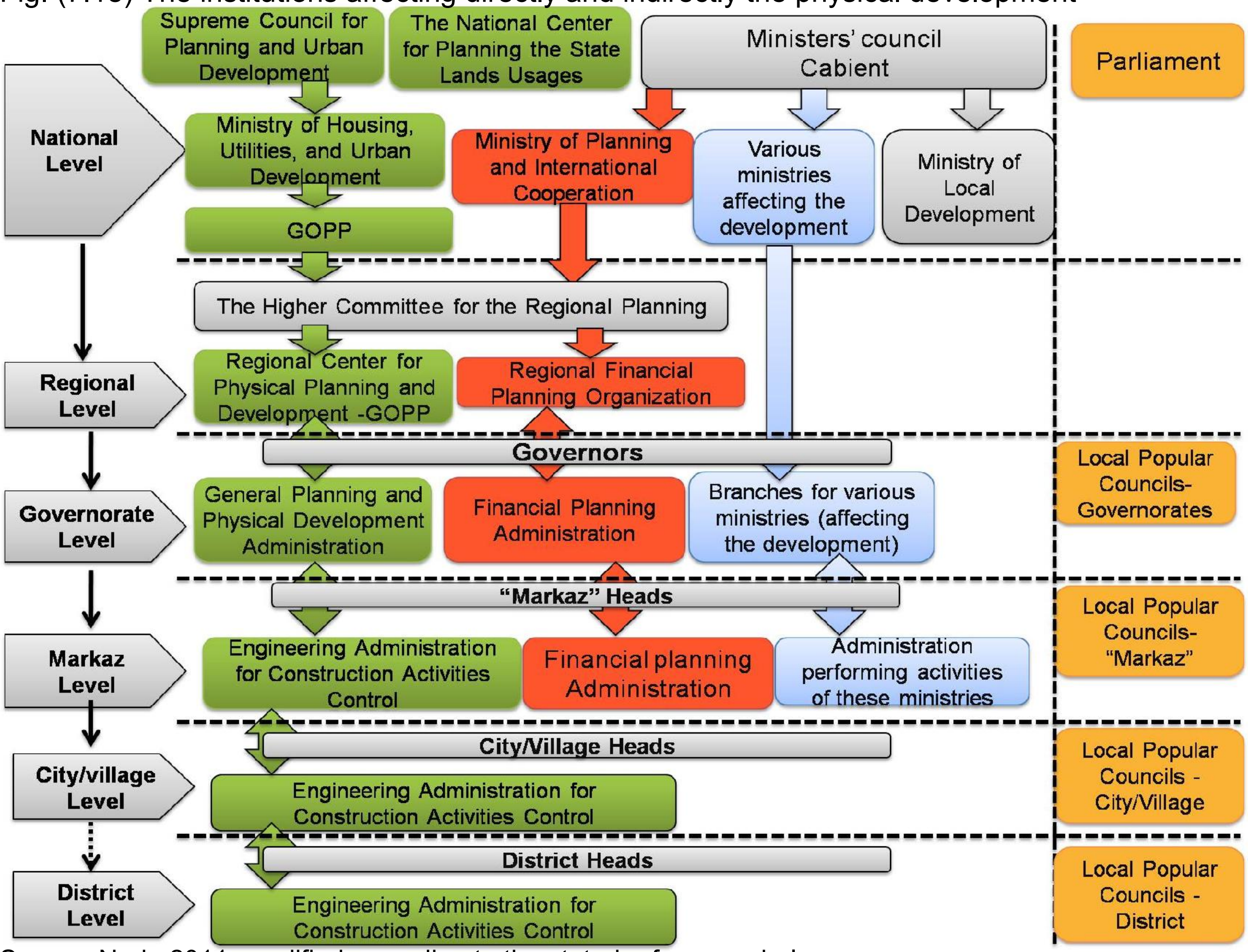
(7.5) Gaps in Managing the Physical Planning and Development Processes in Egypt and how to Deal with Them through Adopting a SPSS:

After illustrating the problems within the local administrative system that affect the physical development in the Egypt, this section focuses on the managing gaps in the way of how the physical planning and development processes are performed in Egypt. So first, the gaps in managing the physical planning and development process in Egypt in general are illustrated. Then, the gaps in managing the land-use planning process in the existing Egyptian cities in particular are identified. And so, the general recommendations and expectations from the proposed SPSS for dealing with all these gaps are deduced. This is to take these gaps (as far as it is possible) into account in designing the administrative framework for applying the proposed SPSS.

(7.5.1) Gaps in Managing the Physical Planning and Development Processes in Egypt in General:

The gaps in the Egyptian planning system are mainly caused from the relations among the institutions affecting the physical development on various levels in direct and indirect ways. The following figure clarifies these entities or institutions. These include institutions that perform physical planning activities (green shapes), institutions that perform the financial planning (red shapes), institutions that perform activities that serve the physical planning purposes (blue shapes), and institutions of public sharing in the decision making processes (orange shapes). This is in addition to the ministers’ council and the ministry of local development that manages the authorities of the local administration system.

Fig. (7.18) The institutions affecting directly and indirectly the physical development[33]



Source: Nada 2011, modified according to the stated references below.

Figure (7.18) shows how the physical planning and development processes are supposed to be managed in Egypt. The comprehensive planning for all the country's sectors (stated by the planning law- Act 70/1973) supports the horizontal integration and coordination on the national level between these sectors through the ministry of planning-MoP. This coordination is supposed to be based on the spatial locations of various development projects, which are implemented by various ministries. (Nada 2012, p.2). However, there are actual vertical relations among each type of aforementioned institutions. However, (in most cases) there are no actual horizontal relations among these institutions, which could guarantee the physical development process success.

For the geographical levels that are lower than the national level, some constitutional amendments in 2007 have supported the decentralization in the planning and monitoring processes, which are used to be centralized in Egypt, but these have not actually been applied in the practical experience (Nada 2012, p.2). As all these institutions are centrally managed (including the GOPP). And all the related branches or administrations of these institutions in the lower geographical levels are just executors for their central visions and polices. This is the centralization attitude in Egypt.

33 Only in the mixed and urban governorates, the district is considered an administration level.

The following points illustrate what actually happens in managing the physical planning and development processes on various geographical levels in Egypt:

On the national level:

- As aforementioned, the planning law (Act 70/1973) supports the coordinating role of the MoP to perform a comprehensive planning on the moderate and the long run among all the country’s sectors. However, Nada confirms that on the applicable level the comprehensive planning has been converted to a group of very sectoral (specified) plans, by which MoP role is limited on discussing these sectoral plans with very limited opportunities for coordination and integration among these plans. (Nada 2012, p.2).
- There is no coordination between the GOPP and MoP (either supported by the planning law or the unified construction law) to plan the funding for the execution of the plans done by the GOPP. It was aimed that the strategic planning approach adoption (supported by the unified construction law) would deal with the inapplicability of comprehensive planning (supported by the planning law), but there are no connecting points between these two laws. This has led to the lack of coordination in the process of performing strategic plans on various levels. As there is no synchronization between this process and the process of performing sectoral plans within the national socioeconomic plan performed by the MoP. Therefore, there is no consideration for the suggested development projects suggested by the strategic plans in the sectoral plans and in the national annual budget. And so, there are weak opportunities for the strategic plans execution. (Nada 2012, p.2).
- As a result for the previous point, there is no actual coordination between the GOPP and various ministries affecting the physical development like the transportation ministry. As what happens is that these ministries plan independently for projects that affect the development. And the GOPP just takes these projects into consideration when performing any city plan. Because there are no obligatory articles in the unified construction law for involving these ministries in the planning process on the cities' planning level[34].
- Despite that the aforementioned "legal construction boundaries- Haiez committee" includes various institutions' members, this does not lead to coordination among these institutions in managing the development process.
- There is no actual coordination between the GOPP in performing the strategic plans (on levels higher than the local planning level) and the National Center for Planning the State Lands Usages-NCPSLU in identifying uses for governmental lands located outside the legal construction boundaries of cities and villages. As Nada mentions that this leads to conflict in identification of the central governmental entity, which is responsible for the uses of these lands. (Nada 2012, p.2). Despite the unified construction law is clear is this issue, as article 7 (executive regulations- Law 119/2009, p.19) states that the Supreme

34 These ministries are involved in the cities' planning process only as stakeholders or development partners, who share in the public meetings, (established in various steps of the master strategic plan for the cities). Examples for these stakeholders are employers in their branches or in administrations performing their tasks on the markaz level. However, this does-not lead to commitment from these ministries to execute projects suggested in that plan.

Council for Planning and Urban Development- SCPUD receives suggestions for development projects on these lands to study them only with the NCPSLU and the defense ministry, there is still a conflict regarding the authorities of GOPP in identifying the uses of the governmental lands within the national, regional, and governorate strategic plans.

On the regional level:

- The regional planning centers related to the GOPP and the regional financial planning organizations (related to the MoP) just execute what is already decided by the GOPP and MoP. There is a committee called “ the higher committee of the regional planning”, which supervises the regional planning center and the regional financial planning organization (Nada 2011). However, it is not activated in the practical experience.
- The regional planning centers are not involved in the regional strategic planning process, as it is the responsibility of the previously mentioned “regional planning administration” within the head office of the GOPP.
- In contrast to most developed countries, the regional institutions have weak influence in Egypt. As the regional planning in these developed countries works as the intermediate connection between each of the national planning (that adopts a top-down approach) and the local planning (that adopts a bottom-up approach). This is not the case in Egypt. (Nada 2012, p.2).

On the governorate and markaz levels:

- There is no actual coordination between each of the physical planning administration of the governorate, the financial planning administration (related to the MoP), and branches and the administrations related the aforementioned ministries, which are responsible for performing the tasks of their central organizations or ministries like the education ministry[35].
- The weak capacity in the GIS of the engineers in the physical planning administrations of the governorates and the construction activities control administrations negatively affects the physical development management. As the geo-databases are important in the physical development management.

On the local levels (city/village and districts):

- Despite that sharing as stakeholders in the strategic plans is considered a step towards the bottom-up approach in the planning process, but still the polices that direct the planning process are decided on the national level.
- There are no definite strategies for encouraging the civil society, NGOs, and private sector to be effectively involved in the planning and development processes. Their sharing as stakeholders in the meetings during the plans formulation is optional. So, in most times their contribution in implementing the suggested development projects in the plans is nothing.

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35 Some central organizations or ministries do not delegate their tasks to local branches (like industry, tourism, and investment ministries), as they totally work in a very centralized way.

- There is no article in the unified construction law that defines a maximum period for the plans assignment. The assignment of the master and detailed strategic plans can take a long time. This may lead that some changes happen in the current state of the city (proposed to planning), which are not be taken into account. However, the law states the revision and update of the assigned plans every 5 years (Article 13 Law 119/2008, p. 13).
- The experts and consulting offices (registered by GOPP) are responsible for performing most tasks of the master and detailed strategic plans under the supervision of the GOPP’s engineers studies (Article 11, executive regulations- Law 119/2009, p.21). This leads in some cases to the conversion of the planning process into a kind of profit-business process more than a serving process for the public benefit.

The next figure illustrates the two core managing gaps of the physical planning and development processes in Egypt. These are the lack of horizontal coordination among institutions directly and indirectly affecting the physical development, as well as the centralization attitude within the vertical relations within each type of these institutions.

Fig. (7.19) The two core managing gaps of the physical planning and development processes in Egypt

Source: by own.

However, still the professionalism of the planner in managing the physical planning and development processes can positively affect these processes especially on the local levels. The planner can motivate the involvement of all the actors affected and affecting the process of performing the plans in an effective way. This is through the communication with the executive councils, which include members from various institutions like the financial planning and the services provision institutions. These are in addition to the active involvement of the local popular councils, which represent the citizens. The articles 9 and 11 in the unified construction law (Law 119/2008, p.10,11) and the article 10 in the executive regulations of the same law (executive regulations Law 119/2009, p.20) support the involvement of each of the executive and local popular councils in identifying the polices and needs of the physical development.

(7.5.2) General Recommendations and Expectations from the Proposed SPSS to Deal with the Gaps in Managing the Physical Planning and Development Processes in Egypt:

The way to a more successful physical planning and development processes is to the reformation of the legal and institutional framework managing planning in Egypt. There is also a need for specific principles and features suitable for the Egyptian circumstances that can direct the planning process in Egypt. And modifications of the roles of each of the central, regional, and local governments are needed as well. These are in addition to formulation of strategies for attaining the decentralization in the financial, administrative, and political systems. The effective involvement of the private sector and NGOs in planning process is a must for solving the funding problem. There should be also an evaluation procedure for the plans, (which is the target of this research). Mechanisms are required for motivating the citizens and raising the awareness about the social responsibility for the city or village they live in. (Nada 2012, p.2)

The next table summarizes the most pressing gaps in managing the physical planning and development processes in Egypt in general and general recommendations to how to alleviate these gaps on the managing level. The expectations from the proposed SPSS to deal with these gaps are also identified to be taken into consideration in designing the administrative framework for applying this SPSS in the Egyptian cities:

Table (7.3) The gaps in managing the development process among the planning levels and general recommendations and expectations from the SPSS to deal with these gaps:

<table>
<tr><th colspan="2">Gaps on various geographical levels</th><th>General recommendations</th><th>Expectations from the SPSS</th></tr>
<tr><td rowspan="4">General</td><td>No coordination between the GOPP and MoP (either supported by the planning law or the unified construction law) for funding the execution of the plans done by the GOPP .</td><td>Enacting connecting rules between the planning law and the unified construction law</td><td>Involving MoP (represented by the financial planning administration of the governorate) in the assessment process in the SPSS (especially in the final results stage).</td></tr>
<tr><td>No common work framework for the institutions affecting directly and indirectly the physical development process</td><td>A mechanism (supported by the planning and unified construction laws) for horizontal coordination among these institutions.</td><td rowspan="2">Involving local branches or administrations of these institutions in the assessment process in the SPSS (especially in the data input stage).</td></tr>
<tr><td>Centralization attitude within the vertical relations within each type of the institutions affecting directly and indirectly the physical development</td><td>It is a general attitude and should change as a political reformation.</td></tr>
<tr><td>Centralization in managing the planning process by the GOPP's head office.</td><td>The regional planning centers and the planning and physical development administrations in the governorates should be the main supervisor in the performing of cities' plans.[36]</td><td>The regional planning centers and the planning and physical development administrations in the governorates should be the managing actor of the SPSS</td></tr>
<tr><td rowspan="2">National Level</td><td>Contradiction in the legal and institutional framework regarding the role of the NCPSLU and GOPP in managing the land-uses of governmental lands located outside the legal construction boundaries of cities and villages (Nada 2012, p.2).</td><td>Adding an article in the unified construction law for identifying a definite role of each of GOPP and NCPSLU in dealing with the governmental lands within the national, regional, and governorate plans under the supervision of SCPUD and the defense ministry.</td><td rowspan="2">The SPSS deals with the land-use planning processes on the cities local level</td></tr>
<tr><td>The role of the SCPUD as a coordinator between MoP, GOPP, and NCPSLU is not defined within the institutional framework (Nada 2012, p.2).</td><td>Adding an article in the planning law for the coordination regulation of the SCPUD and MoP from one side, with the GOPP and NCPSLU from the other side.</td></tr>
</table>

36 This is already supported by the executive regulations of unified construction law 119/2009 (articles 11,14,15,and16, p.21,26,& 27), but needs to be actually applied.

Gaps on various geographical levels		General recommendations	Expectations from the SPSS
Regional Level	The regional planning institutions have weak influence.	Adding articles in the unified construction law that empower the regional institutions.	The SPSS deals with the land-use planning processes on the cities local level
Governorate Level	No actual coordination between the planning and physical development administrations, the financial planning administration (related to MoP), and branches related the ministries presenting services projects.	The aforementioned mechanism (supported by the planning law and the unified construction law) for horizontal coordination among the institutions affecting the physical development.	
Local Levels	The weak capacity in the GIS of engineers in the planning and physical development administrations of the governorates and the construction activities control administrations in the local administration units.	Training programs for these engineers.	-
	The experts and consulting offices (registered by GOPP) are responsible for performing most of tasks of the master and detailed strategic plans. This may lead sometimes to inaccuracy in performing the plans, as the planning process become a kind of business.	Minimizing the role of experts for definite tasks and more dependence on the engineers of GOPP and physical planning administrations of the governorates.	-
	No article in the unified construction law defining a maximum period for the plans assignment.	Adding an article for identifying a maximum period for performing the plans by law.	A recent satellite image for the study area should be one of the inputs data.
	No definite strategies for encouraging the civil society, NGOs, and private sector to be effectively involved in the planning and development processes.	Strategies for motivating the civil society, NGOs, and private sector to be effectively involved in the planning and development processes (supported by law).	Involving representatives of the civil society, NGOs, and private sector in the assessment process in the SPSS (especially in the data input and the final results stages).
	The Environmental law (act 9, 2009) is one of the laws affecting indirectly the planning process, which this is considered a gap in attaining sustainability in planning process.	Modifications in the unified construction law for considering the regulations in this law as obligatory conditions in the planning procedure[37].	Involvement these regulations in this law in the assessment criteria in the SPSS.

Source: by own, according to the stated references.

<u>(7.5.3) Gaps in Managing the Land-use Planning Process in the Existing Egyptian Cities in particular :</u>

The management procedure of the cities’ planning in Egypt is complicated. The next figure is the best way to illustrate how complicated this procedure is. This figure shows the relations between various institutions that are involved in managing the planning process on city level. Each relation of these relations is labelled by a number in this figure. And table (7.4) states (for

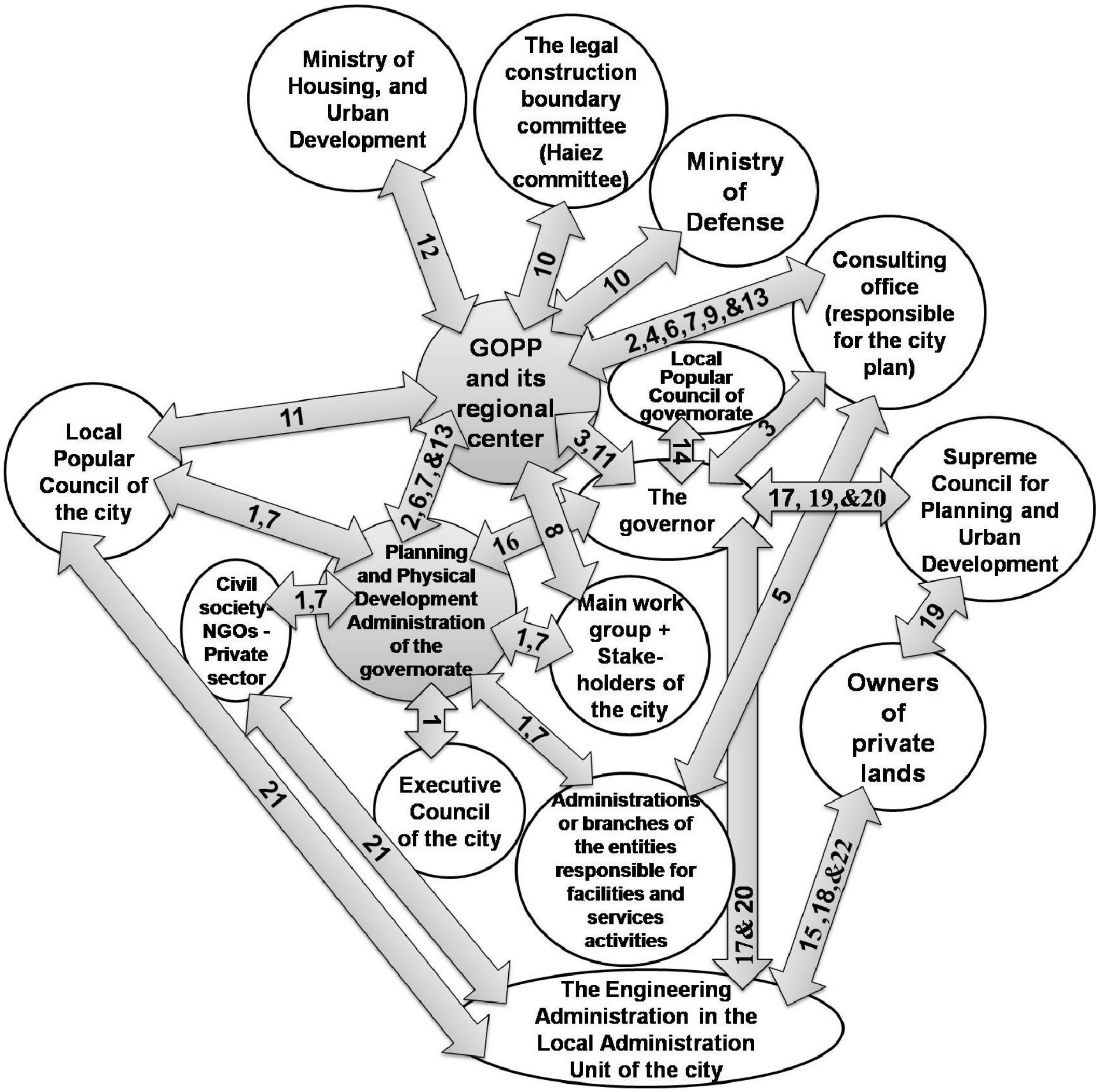
37 Only the article 42, the executive regulations of the unified construction law (2009,p.43), has stated that any air populating industrial activity should be surrounded with dense forestation buffer area.

each number) each of the actors or entities within each relation, the task performed within it, and the reference articles of the unified construction law and its executive regulations. Worth to be mentioned that the tasks are arranged in an ascending order according to the steps of the procedure of performing the cities’ plans as previously illustrated.

It is clear from the figure that there are two main entities, which affect the managing of the land-use planning process in the existing Egyptian cities. They have the two largest numbers of relations with respect to all the other actors in the figure. These are the GOPP with its regional planning centers and the planning and physical development administration of the governorate. As the GOPP is the main organization responsible for the physical development strategies on all levels in general. It is also responsible for performing the physical plans on the local level (master strategic plans for cities and villages) in particular within the framework of these strategies for attaining the sustainable development (Articles 5-7 Law 119/2008, p. 9-11).

The planning and physical development administration of the governorate is the main responsible entity for the detailed plans (on the parcel level) for cities and villages. This is through the cooperation of the consulting offices (registered in GOPP) under the supervision of the regional planning center of the GOPP. These plans should be according to the construction regulations that are identified within the master plan for the city or the village. (Articles 8, 14 Law119/ 2008, p.11,14).

Fig. (7.20) The relations between various entities involved in managing the planning process on the city level[38]



Source: by own

38 Almost the same relations in performing plans for the villages.

Table (7.4) The relations between various entities involved in managing the planning process on city level:

	The actor/s (entities)	Task	Article/Law
		Master Plan Stage	
1	The administration of the planning and physical development of the governorate - administrations or branches of the entities responsible for facilities and services activities (e.g. transport, medical and educational) - executive council of the city- Local popular council of the city- Civil society representatives.	A report concerning the needs and priorities of the physical development in the city and suggestions for the required projects for this development is prepared to be assigned by the city’s head, and presented to the regional planning center -GOPP.	Article 10, executive regulations- Law 119/2009, p.20
2	The regional planning center (GOPP)- experts of the consulting office (responsible for the city plan)- the administration of the planning and physical development of the governorate	The regional planning center and the consulting office study the report presented from the planning and physical development administration for the preparation for the beginning of the master strategic plan of the city. As this report is considered one of the important documents in the contract between the GOPP and consulting office.	Article 11, executive regulations- Law 119/2009, p.21
3	GOPP - the governor- the consulting office	GOPP issues an official letter for the governor asking for facilitating the mission of the experts group from the consulting office by providing them with the required data and maps to begin in the plan project[39].	The first paragraph in the first point in article 13, executive regulations- Law 119/2009, p.21
4	The consulting office - the regional planning center -GOPP.	The consulting office sends the time table for the strategic plan to the regional planning center according to each of the contract period of the consulting office with the GOPP and the terms of reference-TOR for preparing the strategic plans. [40]	The second paragraph in the first point in article 13, executive regulations- Law 119/2009, p.22
5	The consulting office- administrations or branches of the entities responsible for developing and serving activities.	The consulting office presents the suggested touristic or industrial or commercial areas to the responsible entity for each activity to confirm on the appropriateness of the projects.	The forth point in article 13, executive regulations- Law 119/2009, p.24
6	The regional planning center- the consulting office- the planning and physical development administration of the governorate	The regional planning center receives the master strategic plan of the city from the consulting office, and reviews it. Then, the regional planning center sends this plan to the planning and physical development administration of the governorate.	The first point in article 14, executive regulations- Law 119/2009, p.26
7	The planning and physical development administration of the governorate- main team group - stakeholders - local popular council of the city- the representatives of civil society, NGOs, and the private sector - administrations or branches of the entities responsible for facilities and services activities - the consulting office - the regional planning center	The planning and physical development administration of the governorate presents the master plan to each of the citizens, stakeholders, local popular council, representatives of civil society , NGOs, and the private sector, as well as all the concerning entities for developing and serving activities. This presentation is within a public meeting in the city hall in the local administration unit in the presence the consulting office to respond to queries from the audience and representative of the regional planning center of GOPP to record notes from the audience.	The second paragraph in article 14, executive regulations- Law 119/2009, p.26, and the first paragraph in article 12 - Law 119/2008, p.13

39 In this step, the governor assigns an official list of the main work group from the city, who will cooperate with the team from the consulting office.
40 This time table is also sent to the planning and physical development administration of the governorate, as well as the administration unit of the city.

	The actor/s (entities)	Task	Article/Law
		Master Plan Stage	
8	The regional planning center - the main work group from the city.	The regional planning center follows-up the consulting office to make sure that the notes and the requited modifications by the main work group from the city are done in the master plan.	Article 15, executive regulations- Law 119/2009, p.26
9	The regional planning center - the consulting office.	The regional planning center reviews the plan after being modified by the consulting office, and so it issues a letter of the validity of the procedure and the steps taken in preparing this plan in accordance with the executive regulations of the unified construction law.	Article 16, executive regulations- Law 119/2009, p.27, and article 12 - Law 119/2008, p.13
10	GOPP- legal construction boundary committee (Haiez committee)- ministry of defense	GOPP sends the master plan after modifications including the new legal construction boundary to the legal construction boundary committee and ministry of defense.	Article 17, executive regulations- Law 119/2009, p.27
11	GOPP- the governor- the local popular council of the city.	After the approval of both the legal construction boundary committee and ministry of defense, GOPP sends the modified plan to the governor for presenting it to the local popular council of the city. And after the approval of this council, GOPP makes the final revision for the plan as a preliminary step for the assignment of the minister of housing, utilities, and physical development.	Article 18, executive regulations- Law 119/2009, p.27
12	GOPP- the ministry of housing, utilities, and urban development.	GOPP sends the plan to be assigned later by the minister of housing, utilities, and urban development.	The third paragraph in article 12 -Law 119/2008, p.13
		Detailed Plan Stage	
13	The planning and physical development administration of the governorate- the consulting office-GOPP	The planning and physical development administration and GOPP supervise the consulting office in preparing the detailed plans for the city’s areas based on the requirements of the special construction rules for each area in the city that are decided within the master plan according to the executive regulations of the unified construction law.	Article 14 Law 119/2008, p.14
14	The governor - the local popular council of the governorate.	The governor issues the assignment decision of the detailed plans for each of re-planned existing areas, unplanned areas, new industrial zones, craft areas, urban extension areas of the city mass, and areas with distinctive architectural value, as well as the fees of the improvement and provision with the required facilities fees for division projects. This is after the agreement of the local popular council of the governorate on all these plans.	Article 16 and the first point in article 19 -Law 119/2008, p.15,16
		Division Lands Projects[41]	
15	The engineering administration in the local administration unit of the city[42] - the land owners.	The engineering administration studies the requests presented from land owners, whose lands' areas are more than one fadan for performing land division projects for these lands.	Article 22 -Law 119/2008, p.18

41 The division project for any land cannot be assigned without the assignment of a detailed plan for its area according to the article 17-Law 119/2008, p.15

42 This engineering administration is responsible for extracting the buildings permissions and the lines (identifying the boarders of the buildings within the streets according to the detailed planning).

	The actor/s (entities)	Task	Article/Law
		Division Lands Projects	
16	The governor - the planning and physical development administration of the governorate	The planning and physical development administration of the governorate presents all the division projects to the governor. And so, the governor assigns these projects with their specified conditions and the required implementation of the internal public utilities for each. The governor also decides any required modifications in the detailed plans of various areas of the city conditioned that these modifications are within the regulations decided in the master plan for these areas .	Article 20 -Law 119/2008, p.17
		Re-planned areas Projects	
17	The governor - the supreme council for planning and physical development (SCPUD)- the engineering administration in the local administration unit of the city	The areas that need to be re-planned in the city are identified according to a report presented to the governor from the engineering administration in the local administration unit of the city. This report is based on what are decided in the master and the detailed plans. The governor presents the areas that need to be re-planned in the city to SCPUD to be assigned and validated. Then, the governor issues a list of these areas with the identification of the official procedure for re-planning them and the priorities of the renewal projects for various sites in these areas.	The first point in article 24 - Law 119/2008, p.18,19
18	The engineering administration in the local administration unit of the city - the land owners.	The engineering administration negotiates with the owners, who own lands or buildings within the re-planning areas regarding the re-division of these areas and the redistribution of the boundaries of the land ownerships or properties in these areas. This is for the purpose of allocating the required facilities in these areas.	The second point in article 24 - Law 119/2008, p.19
19	The supreme council for planning and physical development (SCPUD)- the land owners- the governor.	In case that any of the owners (within the re-planning areas) refuses to negotiate on the re-division or re-distribution of the ownerships, the governor presents this refuse to the SCPUD, which has the right to issue a decision to expropriate the property for the public benefit and the purpose of re-planning. As the SCPUD identifies the appropriate financial compensation for the owner according to the proposed land-use for the expropriated property[43].	The third point in article 24 - Law 119/2008, p.19
		Un-planned areas Projects	
20	The engineering administration in the local administration unit of the city- the governor- the supreme council for planning and physical development (SCPUD)	A report is presented to the governor from the engineering administration in the local administration unit of the city stating the location of un-planned areas in the city. This report is based on what are decided in the master and the detailed plans. So, the governor presents these un-planned areas to the SCPUD to be assigned and validated as development and upgrading areas.	The first point in article 25 - Law 119/2008, p.20

43 The owners (in this case) have the choice between two options: The first is to obtain a financial compensation according to the value of their shares in the area’s lands on the base of the current estimated value of the land, before the implementation of the project of the re-planning. The second is to obtain a financial compensation after the implementation of the project of the re-planning and the sale of the new land lots in the new distribution or land division. This is through calculating the percentage of the area of the expropriated lands from the total area of the re-planned area according to the new estimated value of the land after the re-planning provided the subtraction of the lands, which are allocated for roads and public services, as well as the costs of the re-planning project execution.

	The actor/s (entities)	Task	Article/Law
		Un-planned areas Projects	
21	The engineering administration in the local administration unit of the city- the local popular council - the civil society representatives	The engineering administration in the local administration unit of the city, the local popular council and the civil society representatives identify the most important projects required for the development and the upgrading of the un-planned areas and their priorities in the light of the available governmental resources for these purposes, as well as the resources available from the civil society or any other non-governmental or private resources.	The second point in article 25 - Law 119/2008, p.20
22	The engineering administration in the local administration unit of the city - the land owners.	The engineering administration negotiates with the owners, who own lands or buildings within the unplanned areas regarding the re-division of these areas and the redistribution of the boundaries of the land ownerships or properties in these areas. This is for the purpose of allocating the required facilities in these areas.	The fourth point in article 25 - Law 119/2008, p.20

Source: by own according to the stated references.

(7.5.4) General Recommendations and Expectations from the Proposed SPSS to Deal with the Gaps in Managing the Land-use Planning Process in the Existing Egyptian Cities in Particular:

The procedure of performing the land-use planning process in the existing Egyptian cities is considered successful to a great extent. However, there are only a few gaps in this process as shown in the next table:

Table (7.5) The gaps in managing the land-use planning process in the existing Egyptian cities, the general recommendations, and expectations from the proposed SPSS to deal with these gaps:

Gaps	General recommendations	Expectations from the SPSS
Master Plan Stage		
The unified construction law states that the regional planning center reviews the plan after being modified by the consulting office (Article 12 Law 119/2008, p.13). However, what actually happens is that the plan is reviewed in the central office of GOPP in Cairo.	The regional planning offices should be the main supervisor on the cities' plans.[44]	The regional planning offices should be one of the managing actors of the SPSS (as stated before).
Detailed Plan Stage		
The governor is responsible for the assignment of the division projects, which leads to time loss. As each governorate has many cities, so this is considered a type of partial centralization inside the governorates. (Article 20 -Law 119/2008, p.17)	The assignment of the division projects through a committee composed from members from the engineering administration in the local administration unit of the city and a planning expert.	-
The governor presents the areas that need to be re-planned and the un-planned areas in the city to the SCPUD to be assigned and validated, which is the centralization attitude in managing the cities’ planning. (The first point in article 24 -Law 119/2008, p.18, and the first point in article 25 -Law 119/2008, p.20)	The governor should have the authority for the assignment of re-planned and the un-planned areas in the cities through a validation study done through the cooperation between planning and physical development administration of the governorate, and the engineering administration in the local administration unit of the city.	-
The SCPUD has the right to put or decrease the restrictions on the use of any building or land or area in any city for the national benefit. (The second point in article 17 20 -Law 119/2008, p.16)	The restrictions on the use of buildings or lands or areas should be decided within the governorate with the agreement of the city local popular council of the city.	-

Source: by own according to the stated references.

Despite there are differences between the scales of the management of the physical development process in Egypt and the land-use planning process in the cities, there are resembling recommendations and expectations from the SPSS to deal with the gaps in all scales. This is due to the same major problem, which is the centralization policy in managing all the fields in Egypt including the planning system and local administration systems, and so the land-use planning process of cities.

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44 As previously mentioned, the regional planning center’s authority in managing the plans is supported by the executive regulations of unified construction law 119/2009 (articles 11,14,15,&16, p.21,26,& 27), but this needs to be actually applied.

(7.6) Spatial Problems Facing Sustainable Urban Land-use Planning and Directions to Alleviate Them:

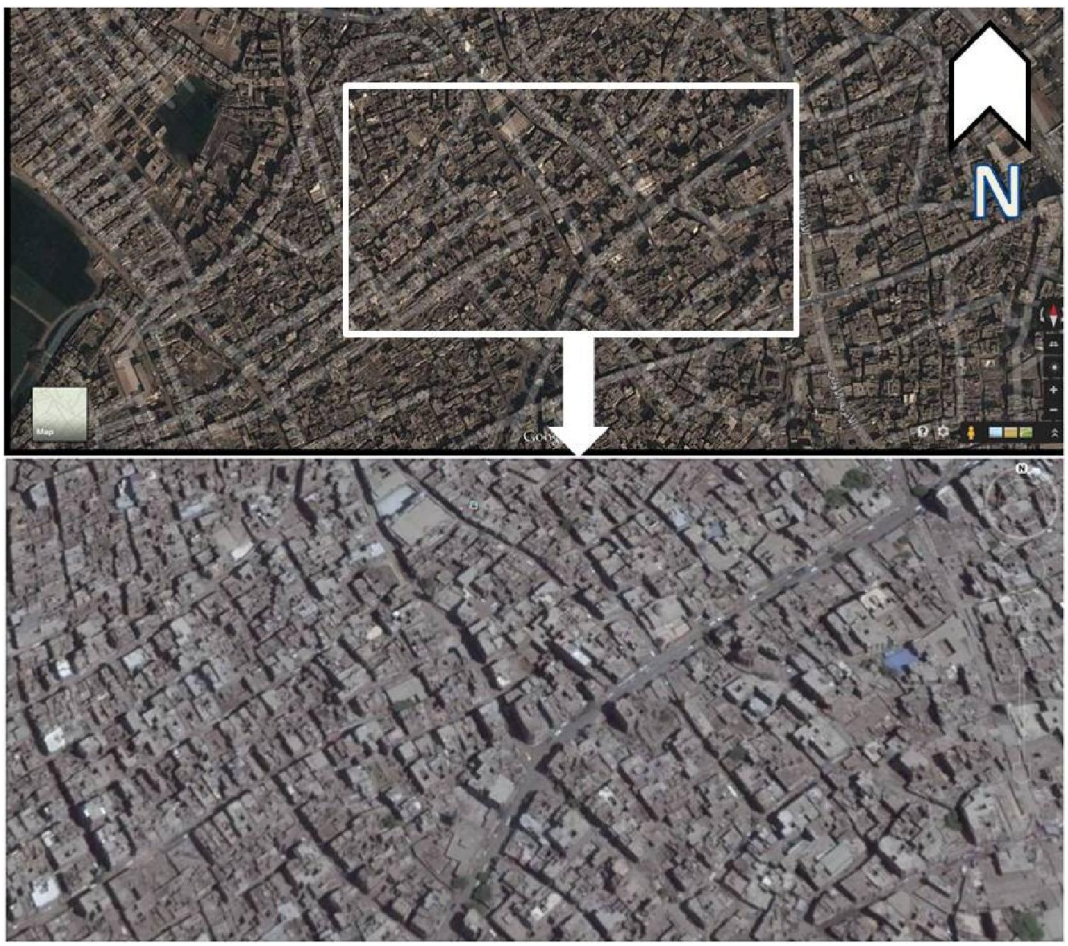
In addition to the managing and administrative problems, there are spatial problems facing sustainable urban land use planning for cities.

(7.6.1) Spatial Problems Facing Sustainable Urban Land-use Planning:

The most common spatial problems in the existing Egyptian cities are:

- There is a difficulty in dealing with the current state of some areas due to the organic pattern of these areas and the narrowness of the streets. The next figure shows an example for an area in the old part of existing Asyut city (capital of Asyut governorate in the Upper Egypt). It is clear how difficult the re-planning process and the provision or the extension of the infrastructure networks in areas with this pattern will be.

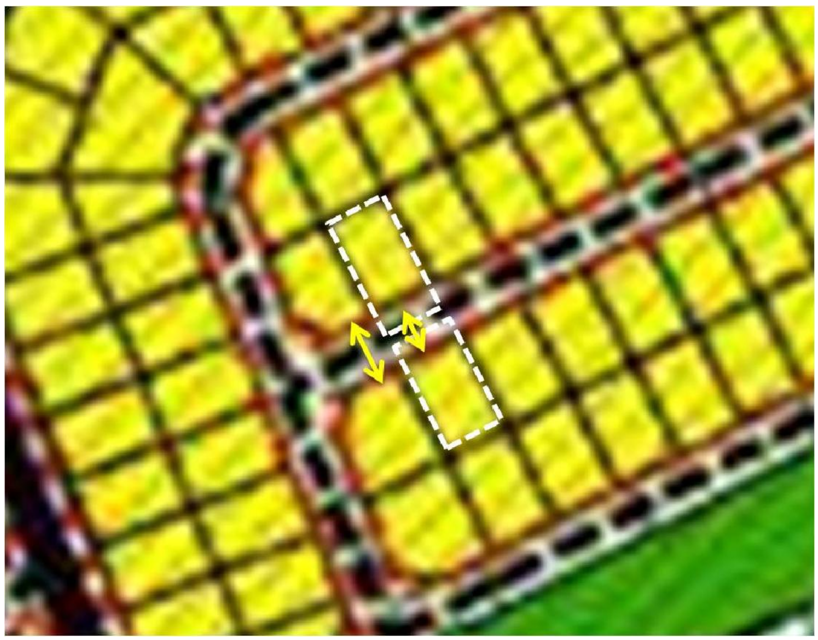
Fig. (7.21) An example for the organic urban pattern of "El-Sadat" area in the old part of existing Asyut city



Source: Google maps, 2017

- The second common spatial problem is connected to the law. There is no obligation in the unified construction that the existing buildings should respect the new suggested street lines (identifying the buildings' boarders within streets) according to the detailed planning and the same for the new uses for their lands. So, these existing buildings or land-uses can remain as they are in the current state for a permission period ranging from 5 to 10 from the plan assignment[45], unless the owners need to demolish and re-construct, or extend these buildings. (Article 24, executive regulations- Law 119/2009, p.31). Only in the case that an owner needs to perform any changes in the building, the owner should respect the new street lines by returning back with the building’s boundary with a distance equal to half the difference between the old narrow street width and the new wider street width as shown in the next figure. Also, the owner should respect the suggested land-use type in the detailed land-use plan, in case that the old land-use type is different than the new one. This gap in the law leads to irregular street lines for a long time due to various buildings’ boundaries.

Fig.(7.22) A sketch clarifying the new and the old buildings’ boundaries and the difference between the old narrow street width and the new wider street width



Source: Detailed plans report of Asyut areas, GOPP 2015

- Most of the ownerships types inside the legal construction boundaries of the existing cities are private ownerships. This leads to difficulties in allocating new services and utilities.
- The current state of the existing infrastructure networks may not afford the increasing in their capacities, unless these network are re-constructed from scratch. Moreover, as previously mentioned, the state of the old parts in the existing cities will not facilitate the process of extending or re-constructing these networks.
- There is a disharmony between the new areas in the cities extension and the current old existing. The next figure shows an example for two neighboring areas in the south of the existing Asyut city, which are separated by a canal called “El-Mallah canal”. The first area is a part of the old city, its urban pattern is organic with narrow curved streets, whereas the second is a recent added area, its urban pattern is wide straight streets.

45 This is through obtaining an approval from the planning and physical development administration of the governorate.

Fig. (7.23) An example for the disharmony among the new (added) and the old (existing) parts in an area in the south of the existing Asyut city

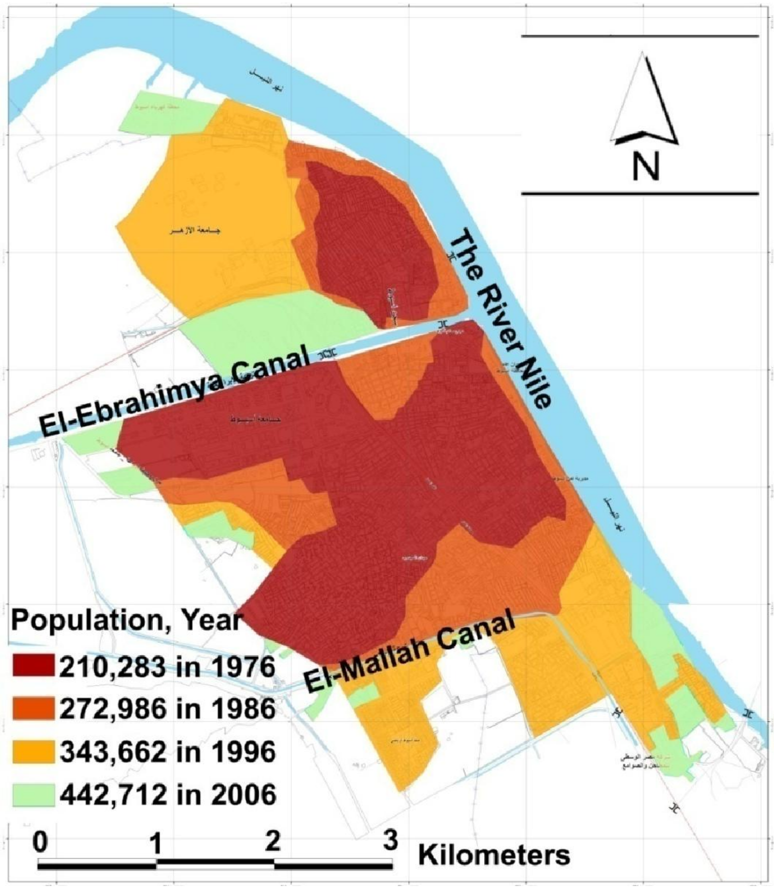
Source: Google maps, 2017

- There is a continuous increase in the physical masses of the cities due to immigration from the rural areas to urban areas. This leads to the informal settlements in the margins areas especially during the plan preparation[46] to the degree that the situation may totally

46 The unified construction law states that it is totally forbidden that the engineering administration in the local administration unit issues any construction permission for any area. This is till the assignment of the master strategic plan with the specifications of the construction regulations for all the city’s areas and the detailed plan for this area, (if this area will be planned in detailed) (article 17 Law 119/2008, p.15). However, people sometimes illegally construct buildings in the margin areas that are expected to be included in the

differ at the end of the plan project from its beginning. This means the possibility of not considering recent informal extensions in any city’s plan. The next figure shows how quick Asyut city’s mass and population have increased during 30 years.

Fig. (7.24) The historical development in Asyut urban mass and population



Source: Asyut master strategic planning report, GOPP 2014

- As a result of the previous point, there is loss in agricultural lands. As many cities expanded on agricultural lands in the form of informal areas. These were converted latter to formal areas and were included within the legal construction boundaries.
- The massive investment activities within the housing market in the existing Egyptian cities leads to the continuous expansion of the cities’ masses. This is accompanied with a lot of commercial activities especially within the cities’ centers. All of these lead to the rapid increase of the land prices, as well as the increase of the traffic congestions and parking problems due to the mixed land-uses. For example, in the existing Asyut city, the city center was limited by two streets in the middle of the city (called “23th July” and “26th July” streets) till the 90s in the last century. Now, the commercial activities have extended to reach double the area of the previous city center with a big traffic congestion problem,

new construction boundary of the city. These buildings are totally illegal, as they do not follow the construction regulations that will be identified in the master plan. Also, these buildings are not located in the locations that will be identified in the detailed plan according to the parcels boundaries on the streets network.

as the capacity of the streets in the city center is not enough for the high rate of vehicles ownerships in Asyut.

- There are many workshops and small industrial polluting uses inside the residential areas.
- The attitude of many of the Egyptian people of not willing to live outside the old existing cities leads to spatial congestion problems in the Egyptian cities. Many Egyptians buy residential units in the new cities, but they stay in the old existing cities. This is due to many reasons like the culture concept that the big family should live beside each other, the weak transport system to the new cities, as well as the low availability of job opportunities and services in these cities.

(7.6.2) Directions to Alleviate the Spatial Problems Facing Sustainable Urban Land-use Planning:

(7.6.2.1) Directions for Dealing with Old Areas:

All the previous do not imply the impossibility of upgrading the existing cities (especially their old parts), but they stress the need to identify the most optimal solutions for these parts, as far as it is possible. For example:

- Ways for the supply with the fire emergency services to the old areas that have an organic compact urban pattern should be studied. According to the degree of the spatial location difficulty, the most appropriate solution to provide with these important services can be identified. For example, if the streets are too narrow for a fire or ambulance vehicle to pass or enter, the old area should be divided into some parts, and definite entrance points should be identified for each part. These points will be the access from the outside to the inside of the area, and so the locations of these points should be evacuated from buildings, so that these services can approach, as near as it is possible to all the areas’ parts through long spouts.
- The illegal floors from buildings[47] should be demolished to improve the environmental circumstances (light and ventilation) especially in the areas with narrow streets.
- The air and noise pollutants should be transferred outside the cities especially the old areas, as the effects of the pollution caused by these pollutants are more harmful in the old areas with organic compact urban pattern than in other areas.
- With regards to the utilities, the main obstacle for their provision is the state of the streets and the buildings. This requires special engineering procedures and specifications for the materials of the networks’ components.
- The main paths should be identified for facilitating the traffic flow in the old area, so that the streets locating through these paths (not all the streets) should be widened, as far as it is possible.

[47] According to the unified construction law, the maximum height for a building should not exceed one and a half times from the street width with maximum height 30 meters in all cases. (the last point in article 15 - Law 119/2008, p.15).

- The old buildings should be upgraded, as much as it is possible, through improvement of the construction state, the facades, and the pipes connections.
- Carbon dioxide absorbers like small trees are needed to be planted.
- The solid wastes disposal should depend on small vehicles that can pass in the narrow streets.
- There is a need for organizing programs by NGOs to increase the awareness of the residents in the old areas about the environment preservation and its importance for their health.

In some cases, the appropriate solution is the total demolishing and the re-constructing of the old area, if this area is considered dangerous for its residents. So, definite restrictions should be decided for evacuating this areas to protect the residents.

(7.6.2.2) Expectations from the Proposed SPSS to Deal with the Spatial Problems:

Adopting a SPSS in planning assessment cannot provide many solutions for dealing with the spatial problems like the case of the administrative problems. However, having a recent satellite image for the study area (that its plan is proposed to assessment) as one of the inputs to the SPSS helps to detect any increase in the physical mass of the city during the time of the plan preparation.

Also, the coordination with the petroleum ministry is required to obtain the planned natural gas network[48] in the city proposed to re-planning[49] to be included in the data entry for SPSS, so that the paths of this future network is taken into account. This is to avoid future spatial problems resulted from the contradiction of the land-use plan with the path of natural gas network.

It is also recommended to consider the tenure type of the lands within the data input as illustrated in the next point.

(7.6.2.3) General Recommendations to Deal with the Spatial Problems:

There is a need for modifications in the unified construction law and its executive regulations, in the following:

- The article that allows the existing buildings to remain for a permission period (5-10 from the plan assignment) should be modified by decreasing this permission period to be not exceeding 5 years. (Article 24, executive regulations- Law 119/2009, p.31).
- An article should be added for the obligation on the immediate transfer of all the polluting activities outside the residential areas. This is already stated in the environmental law (Act 9/2009). However, the application of the environmental impacts assessment -EIA in the planning procedure should be supported by legalizations.

There are other recommendations:

- The transport system between the existing old cities to the new cities is needed to be supported to encourage the people to live in the new cities.

[48] The strategic plan procedure (master and detailed stages) includes plans for various infrastructure networks, which are the provision with water, sewage, solid waste disposal, electricity, communication and roads, but it does not include the natural gas network.

[49] The natural gas network is still not supplied in many existing small cities.

- Most of the ownership types within the current legal construction boundaries of the existing cities are private ownerships. So it will be beneficial, if the land owners in any city are invited to be members in the work group of this city or at least representatives for them. This is in order to involve them from the beginning in the plan preparation. Some of the land owners may then cooperate by donating parts of their lands to be used as public services and facilities.

However, this may not be applied for the land owners, whose lands are located on the margins but outside the current legal construction boundaries. These owners may orient the plan to their personal benefit by trying to include their lands into the new legal construction boundary. So, it is better to involve these land owners in the negotiations process after identifying the primary draft for the new legal construction boundary.

Therefore, it is recommended that (during the process of including lands within the new legal construction boundary) the tenure type of lands is considered. This is to prioritize governmental lands, as far as it is possible. Also, the negotiation process with the private land owners should be regulated by law.

(7.7) The Funding Problem Facing the Physical Planning and Development Processes in Egypt :

All the previously stated problems are considered obstacles, but the real obstacle in front of the physical development process is the lack of funds that are required for this process. For instance, there are no obligatory articles in the unified construction law for expropriation of the private ownership of lands for using them as services except in case of roads. This confirms that the funds provision (for buying lands from owners to allocate public services) is a more pressing need than solving the management and spatial problems. The following points state some reasons for the funding problem:

- The national plan of the MoP does not focus on the physical development, but there are other priorities. And so, there is a lack of coordination between various ministries and GOPP in funding distribution, which leads to suggesting projects within strategic plans without funds (as previously mentioned).
- Egypt is now in a transition period after two consecutive revolutions (2011 and 2013).
- There is mismanagement in investing the huge resources in Egypt. Egypt owns many economic resources like natural gas, petrol, two seas, metals like gold, several kind of tourism, (medical, Pharaonic, Christian, Islamic, safari, etc.), Suez Canal, one third of all the monuments all of over the world, large human resource, large country area, and other. So, the problem is mainly how to integrate all these resources to provide funding.
- People inhabit in only 5% of all the country area as previously mentioned in the beginning of this chapter.
- Like many developing countries, there is corruption in many country sectors that leads to loss of funding.
- There is no enough awareness that the physical development is the core of all development aspects.

However, the improvements in the management process of the physical development can alleviate a part from the funding problem. For example, the success in involving the private sector in the planning of the cities will contribute in funding some of the suggested development projects.

(7.8) The Positive and Negative Effects of the 25th January Revolution on the Physical Development Process in Egypt:

In the 25th of January 2011, a huge revolution took place in most of the Egyptian governorates with main request “Bread- Freedom -Social Justice”. The Egyptian people were seeking for a better life standard, more freedom in the political field, and equity among various society categories. The revolution was mainly emerged in Cairo in a very famous and the biggest square in Egypt “El-Tahrir square”, which means “liberation” in Arabic. This revolution was against Mubarak Regime, and many people were killed in it. So, this square is now called “El-Shohadaa square”, which means “martyrs” in Arabic.

This revolution was accompanied by a massive mobilization in various sectors in Egypt including the physical development process and mainly concentrated in the cities. The revolution brought some positive, but also negative effects for this process. The positive effects include:

- There are positive changes in the relationships between experts, practitioners, and citizens of the cities. This was in a form of common dialogue regarding the cities, their actual situations, and their futures. This dialogue has become no more limited to the academic and professional circles, but it has included, who are called “community activists”. These were the key actors of the new social movements emerged in the revolution time. The local residents in various areas are now the new active actors in forming their cities. (Ibrahim 2014, p.237).
- Stadnicki sees the revolution as a “turning point in urban planning in Egypt”, which caused a fight within the spatial planning field. The government decided to give up what is called “Cairo 2050”. This was a vision of the old system regarding Cairo region, which mainly focuses on the capital area and supports the centralization attitude more. And so, what is called “Egypt 2052 master plan” is adopted now, in which the decentralization is the main attitude. Also, the stakeholders from the civil society representatives have become the main actors in forming development documents like “Egypt Vision 2030” and “Egypt 712” through a participative ideology. (Stadnicki 2014, p. 29).
- A concept called “Right to the City” emerged in the academic and professional circles. This demands more consideration of the social justice principle in formulating the urban development policies and in the planning practices. (Ibrahim 2014, p.238).
- The revolution encouraged the citizens to criticize any project done by the government. This is with the emergence of “street activism”, which motivates the diversity within the society. Also, a large number of organizations calling for the preservation of heritage and environment and housing rights were established, despite that there is no discourse for a comprehensive policy for urban areas since 2011 till now. However, the “urban activists” succeeded to involve the planning issues within the debates between the citizens and state. They use specific websites and blogs for transfer the citizens’ criticism regarding the planning projects. This motivates people to evaluate the planning practices. (Stadnicki 2014, p. 27).

- Some local decisions were taken in some governorates to alleviate a part of the financial burdens on the citizens because of the unemployment and economic inflation caused by the revolution. For example, Cairo governorate decided the exemption of property owners from the betterment levy[50] according to their complaints (Nada 2014, p.160).

Unfortunately the researches refer to more negative effects resulting from the revolution on the physical development process than the positive ones. These negative effects include:

- There was a delay in performing and assigning strategic plans for many cities, which resulted that the data, on which these plans are based, is not up-to-date anymore.
- The lack of security and the government control during the revolution time led to the appearance of a lot of informal areas and illegal buildings on agricultural lands "informal urbanism". The ministry of agriculture mentions that about 29,486 fedans (approx. 118,000 square kilometers) of good quality agriculture lands were built without permission in the period from the beginning of the revolution in January 2011 till March 2013. To the degree that the annual number of new constructions from 2011 to 2012 in certain sub-urban areas within Giza governorate is equal to 4.5 times the same number from 2003 to 2011 in these areas. (Stadnicki 2014, p. 25,26).
- Despite the aforementioned "urban activists" ask for better living standards by focusing on the planning issues, and motivate citizens to criticize the urban planning practices, the urbanization issue itself has gained a secondary priority within the presidential campaigns that happened in 2011 and 2012. (Stadnicki 2014, p. 24)
- The revolution caused a kind of obstacles towards the government to execute the previously mentioned planning policies for dealing with urban growth[51]. The protest attitude made the land owners less interested in these policies, because the land owners just focus on acquiring rights from the government. They are not aware that in order the government attains the social justice and equity in distributing investments, they should support the government policies in limiting urban growth. (Nada 2014, p.145, 161).
- The revolution made the government seeks more the short-term results in order to return the people's trust in the government (Nada 2014, p.161)

We can conclude from all the previous that the revolution is considered a two-sided weapon. However, Egypt is generally still within a transition period, in which we cannot thoroughly judge, whether the planning field is positively affected by the revolution, or not. This requires more time to figure out the actual impacts.

(7.9)The Requirements and Challenges of Adopting SPSS in the Planning Process for the Egyptian Cities:

In this chapter each of the administrative, spatial, and funding problems are illustrated. However, the focus here is on the administrative framework for adopting SPSS in the planning

50 As previously mentioned, the betterment levy is a kind of specific taxes over selected properties to support infrastructure provision on the local level.

51 As previously mentioned in the point of "the official boundaries for Egyptian cities" in this chapter, there are three main Egyptian policies to manage the physical expansion for cities. These policies are applying limits for cities growth, the betterment levy, and performing detailed plans for extension areas of cities.

process for Egyptian cities. Many administrative problems in managing the planning process in the Egyptian cities can be taken into account in designing this framework. Chapter 6 focuses on the technical framework that can help in dealing with a main problem of the spatial problems, which is the increase in the cities’ masses during the planning process.

This section deduces the requirements and challenges of adopting SPSS in the planning process for Egyptian cities according to the studied administrative gaps and expectations from the SPSS to deal with these gaps.

(7.9.1) The Requirements for Adopting a SPSS in the Planning Process

- Each of MoP, various ministries providing services and utilities, public sharing institutions, and local authorities in cities should be committed to be a part of the assessment process using the SPSS especially in the data input stage.
- Channels for motivating the private sector and civil society to share in the assessment process are needed.
- The GOPP should begin to adopt a decentralized attitude in managing the planning process, so that the regional planning centers (cooperated with the physical planning administrations in the governorates) are the managers of the assessment process.
- There is a need for a technical support from experts in PSSs for training each of the regional planning centers and physical planning administrations of the governorates on using the SPSS.
- Financial resources for collecting data and obtaining satellite images are required for the assessment process.
- Experts in various sustainability aspects should be mainly involved in the formulation of the predefined criteria for the SPSS.
- The engineers in local administration units and physical planning administrations in the governorates are in need of training programs in GIS software.

(7.9.2) The Challenges of Adopting a SPSS in the Planning Process:

- Modifications within each of the unified construction law, planning law, and local administration law are required.
- Some of the members in the local popular and executive councils are not aware of importance of sustainability.
- The assessment process should include the roads and infrastructure networks' plans beside the land-use plans. This requires attaining balance among various plans, which is difficult in the modeling process for establishing the SPSS.
- Even with the success of the assessment process using the SPSS, still the financial centralization in the Egyptian system is the main obstacle facing the success of the cities' plans.
- The centralization within the institutions affecting the physical development and the weak horizontal cooperation among them impede the success of the SPSS.
- The spatial problems in the existing cities cannot be totally solved by the SPSS.

(7.10)The Administrative Framework for Applying the SPSS in Planning Process of the Egyptian Cities:

The participation process is very important for any successful sustainability assessment process (as previously mentioned in chapter 3). So, the assessment process should include conversations among all the development partners within the planning process, who are affected by the assessment results. These conversations should have the style of negotiations more than just sharing in the assessment process. (Sharifi and Murayama 2013, p.81).

Sharifi and Murayama present an experience for developing what are called “Neighbourhood Sustainability Assessment- NSA tools”. All the stages in these tools are based on the stakeholders participation. This confirms the importance of involving the actors (affected by the planning process) in the sustainability assessment. These actors can share in three stages for the assessment process (Sharifi and Murayama 2013, p.81):

- First. identifying the sustainability goals in definite points and the specialized criteria for the city: The stakeholders (especially if they are from the city that its planning is proposed to assessment) have sufficient knowledge about the city. So, they are able to provide the assessment process with accurate and reliable data, which will support the decision-making process.
- Second. identifying weights for the various criteria: These weights are the relative importance of these criteria according to the point of view of the stakeholders.
- Third. providing the feedback on the assessment results: These feedback can support the updating of the assessing tool. The planners can also identify the development changes, which are required to attain the balance among the economic development activities with environmental limits and social needs through the feedback.

The administrative framework for the proposed SPSS was designed according to the perspective of Sharifi and Murayama in how the stakeholders should be involved in the sustainability assessment process. It is also based on the analysis of the gaps in both the local administration and planning systems in the Egypt. These are in addition to the identified expectations from the SPSS to deal with these gaps.

But before illustrating the suggested administrative framework, it is important to identify the institutions (entities) that should be involved in the assessment process using the proposed SPSS. The next table states these institutions and the importance of each one of them in the assessment process:

Table (7.6) Institutions/entities that should be involved in the assessment process and their role:

Institution/s		Its/their importance in the assessment process
Managing actors of the SPSS	The regional planning centers of the GOPP	The regional planning centers should be involved as a managing actor in the plans’ assessment using the proposed SPSS. The decentralization in managing the cities plans is supported by the unified construction law. Article 7 (Law119/ 2008, p.11) states that the regional planning centers are responsible for all the GOPP’s tasks within their planning region’s limits.
	The planning and physical development administration of the governorate	This administration cooperates with GOPP from the preliminary stage for the cities strategic plan (Article 10, executive regulations- Law 119/2009, p.20). Also, this administration (with the cooperation of the consulting office) prepare the detailed plans for the city’s areas under the GOPP’s supervision. (Articles 8, 14 Law119/ 2008, p.11,14). So, the involvement of this administration should be as a managing actor in the plans’ assessment using the proposed SPSS.

Institution/s		Its/their importance in the assessment process
The local administration system of the city	The local popular councils.	The local popular council includes elected people from the city’s residents, so it represents to some extent the public interest. Therefore, the involvement of this council in the assessment process through the proposed system will be effective in the plan attainment for the public needs.
	The executive councils.	The contribution of executive council in the planning process is mainly within the preliminary stage for preparing the report concerning the needs of the city proposed to planning. The involvement of this council in the assessment process will be beneficial. Because this council includes members from various institutions, which will support the successful coordination among various development sectors (education, health, transport, etc.).
	The local administration unit	The local administration unit is responsible for the execution of the detailed physical plans. This is in addition to the construction control activities according to the regulations identified within plans. So, the involvement of this unit in the assessment process is important as it is the main executor for the assessed plan.
Experts	Sustainability Experts	As sustainability in land-use planning has many aspects that differ according to the city circumstances. This requires experts to be involved in assessing plans.
	Experts in PSSs	As the proposed SPSS is based on the self learning process and extracting specialized criteria for each study area, so the assessment process needs to be guided by experts in PSSs.
The MoP, (represented by its financial planning administration of the governorate[52])		Due to the weak possibility for the plans execution resulting from the absence of obligatory articles in the unified construction or planning law for coordination between the GOPP and MoP, so it is important to involve the MoP (represented by its financial planning administration of the governorate) in the assessment process using the SPSS. This is in order to guarantee the availability of the funds required for executing the projects within the assessed plans.
The administrations or branches of the entities responsible for developing and serving activities		The entities affecting the development process do-not work together in the same framework. Their contributions in the cities' planning process is only as stakeholders, who share in the public meetings like the employers in the branches performing their tasks on the local level. So, their involvement (especially in the data input stage) in the assessment process will lead to actual coordination in the cities’ plans, as well as the increase the opportunity for executing the suggested projects for services and utilities in the plans.
Representatives of the civil society, NGOs, and private sector		The civil society organizations, NOGs, and the private sector affect the planning process on the local level for cities. This is through funding and other contributions. So, their involvement in the assessment process may allow better opportunities for their contributions in the execution of the projects within the assessed plans.

Source: by own

Figure (7.25) shows the suggested administrative framework for applying the SPSS for assessing the planning process of the Egyptian cities. As previously mentioned in chapter 6, the

52 Despite that there is a financial planning administration on the markaz level, it is better here to cooperate with the financial planning administration on the governorate level. As the financial planning administration of the governorate has more authority than that on the markaz level. Also, it is more easier and flexible to make coordination between administrations on the same level (governorate level) within the assessment process than coordination between administrations on different levels.

technical framework of the SPSS consists of seven sections, each section performs a stage in the assessment process. Therefore, the administrative framework of the SPSS is also composed of seven sections. Each section includes the actors (or development partners) that are involved in each assessment process stage. These are in addition to the managing actors for the assessment process, which are the regional planning center and the planning and physical development administration of the governorate, who will be supported by PSSs experts. These managing actors share in all sections with the other actors stated below:

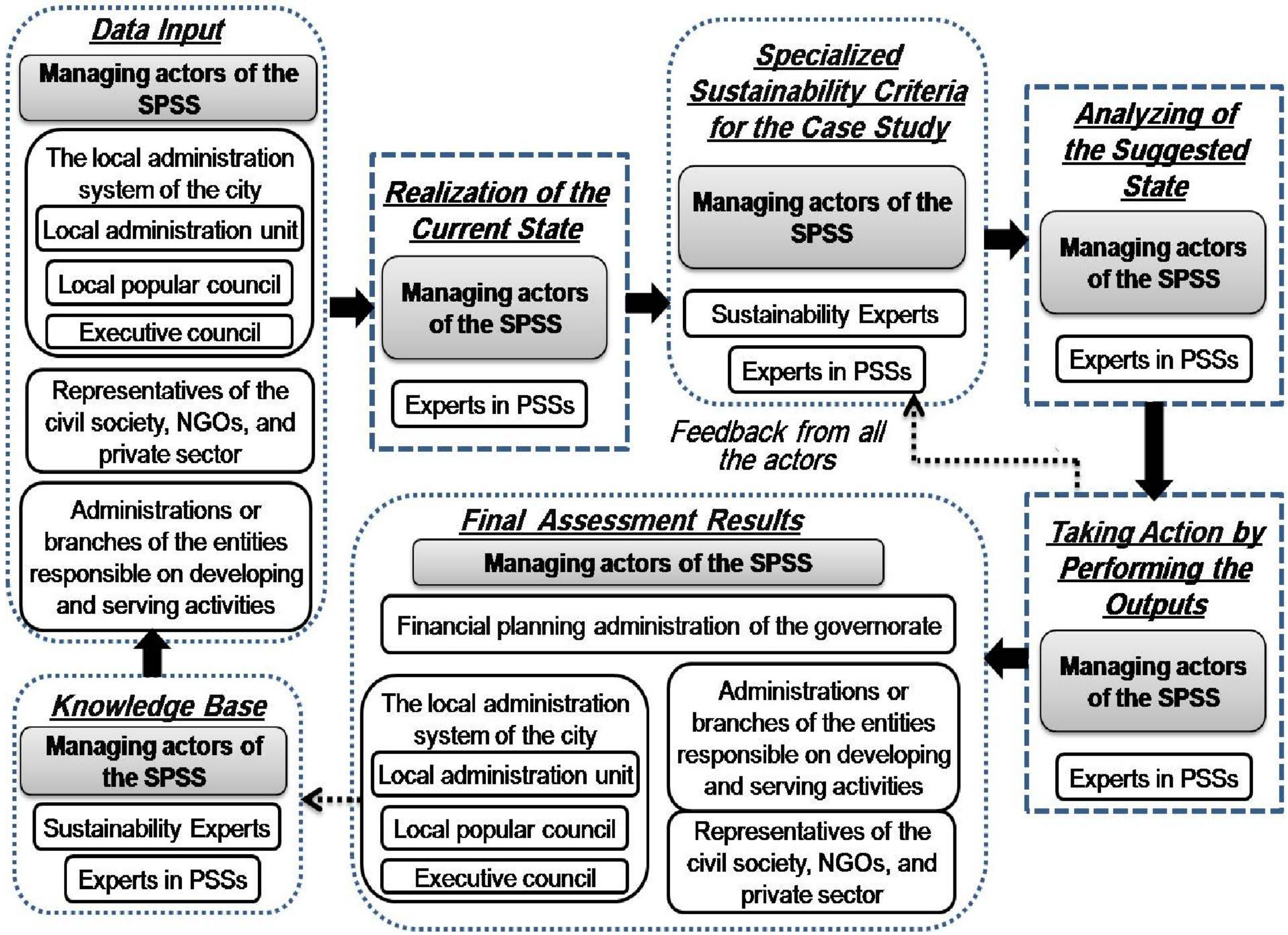
- The data input section: includes actors that can provide the information, which is beneficial for the assessment process. These are the entities forming the local administration system for the city (i.e. its administration unit, executive council, and local popular council), administrations or branches of the entities responsible for developing and serving activities, as well as representatives of the civil society, NGOs, and private sector. These actors are in addition to the managing actors.
- The realization section: includes the managing actors and PSSs experts.
- The section of the formulation of the specialized criteria for the study area: includes sustainability and PSSs experts in addition to the managing actors. The experts can guide the SPSS during the process of identifying the specialized criteria to the most appropriate criteria for the study area. However, (as previously mentioned) these criteria can be modified after the feedback on the suggestions regarding modifying the plan. This feedback is according to all the actors involved in the assessment process (table 7.6). As each actor should agree on the plan for various causes.

This confirms the concept that the PSSs should support and facilitate the planning process, but not replace the planner’s role in this process. As previously mentioned in the introduction of this research, the proposed SPSS willl not replace the planner’s role or make the planner totally dependent on technology.

The managing actors and the experts are the coordinators within the feedback process.

- The analyzing and action sections: include the managing actors and PSSs experts.
- The final results section: includes the same actors of the data input section with the cooperation of the financial planning administration of the governorate. As the assessment results directly affect their work (especially the financial planning administration). These actors are in addition to the managing actors.
- The knowledge base section: includes sustainability and PSSs experts, who can guide the SPSS through the self-learning potential in it to update the general predefined criteria within the knowledge base of the SPSS. These actors are in addition to the managing actors.

Fig.(7.25) The administrative framework for applying the SPSS



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It is clear that the sections identifying the efficiency degree of the SPSS (i.e. realization, specialized sustainability criteria, analyzing, action, and knowledge base sections) are mainly dependent on the regional planning office, the planning and physical development administration of the governorate, and experts. As these sections require definite backgrounds in sustainable land-use planning. While, the actors in the other two sections are actors, who have necessary information for a comprehensive assessment process or concern with the outcomes of the final results' section.

(7.11) Reflections:

This chapter thoroughly presents the Egyptian context regarding the local administration system and planning system. The physical development process in general and the cities’ planning in particular are illustrated. The managing problems within the physical planning and development processes and the land-use planning process in the existing Egyptian cities are also identified. And the spatial problems resulting from the spontaneous generation of most of the existing Egyptian cities and the funding problem are stated as well.

So, the expectations from the proposed SPSS to deal with the administrative and spatial problems in the Egyptian cities are deduced. And so, the requirements, challenges, and the design of the administrative framework for applying the SPSS in the Egyptian context are identified.

For the 25th January revolution, it is clear that there are positive and negative effects for it on the physical development process especially for the cities. However, Egypt is still in a transition period, so not all the actual impacts for the revolution can be deduced.

THE EMPIRICAL PART

Chapter 8
The Establishment of an Assessment Model from the Proposed System

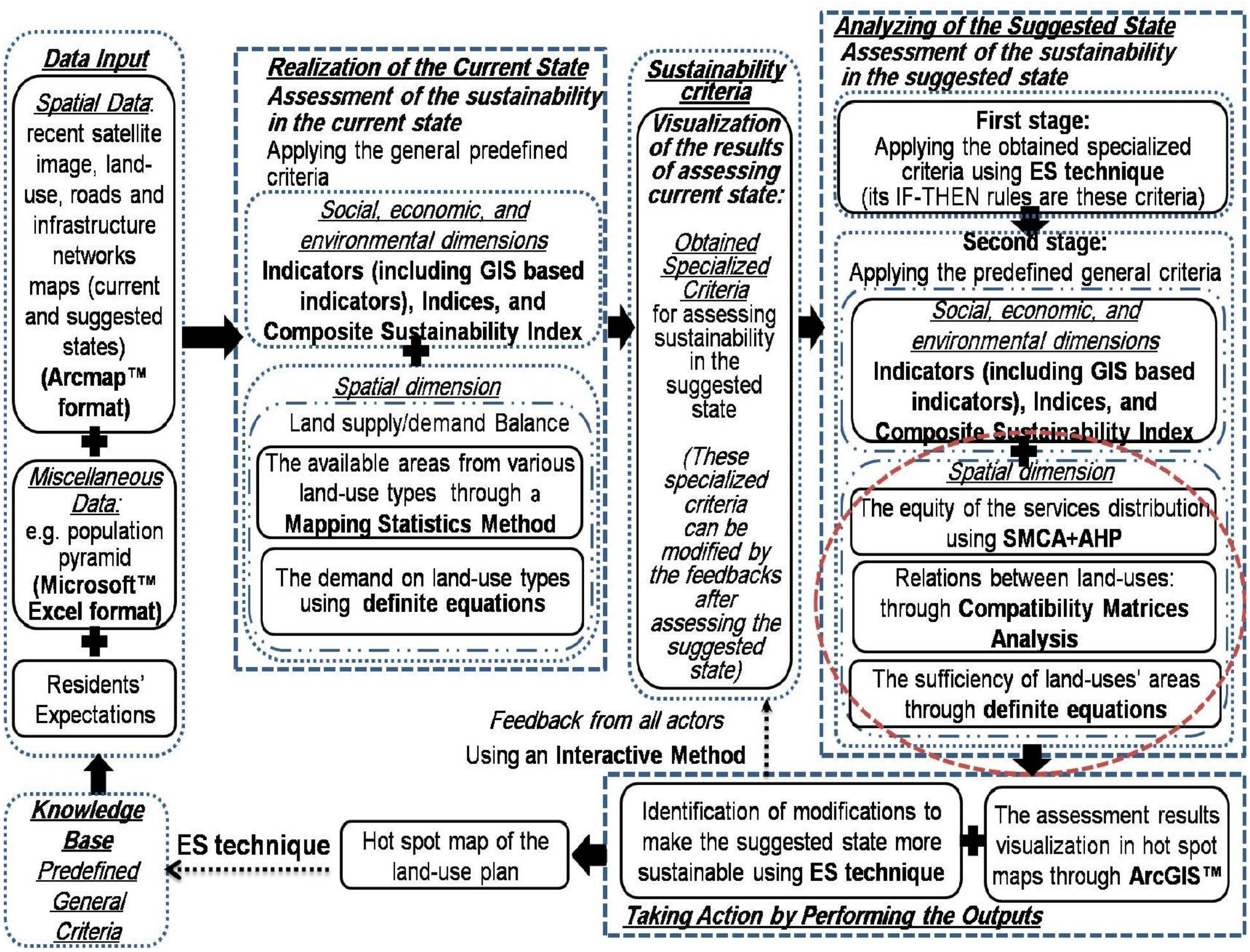
(8.1) Introduction:

In this chapter, the main focus is on introducing the selection and the establishment of an assessment model from the proposed comprehensive SPSS in this dissertation. This assessment model is in the form of a new toolbox within the ArcGIS™ software. This chapter illustrates each of the purpose and design concept for the tools in this toolbox, input and output data of them, the predefined criteria, the detailed description for all tools within the toolbox, the modeling charts for the tools’ designs, and finally the advantages of the toolbox.

(8.2) Identification of the Assessment Model to be implemented within the Empirical Part of the Research in the PhD Dissertation

Figure (8.1) shows the comprehensive framework for the proposed SPSS and the selected assessment model from it. For establishing this system, a multi-partner research project is needed. This research project aims at raising the efficiency of the land-use planning process in the existing Egyptian cities for attaining the sustainable development and growth for these cities. This SPSS is previously illustrated in details in Chapter 6.

Fig. (8.1) The comprehensive technical framework of the SPSS for raising the efficiency of the land-use planning process in the existing Egyptian cities and the selected assessment model



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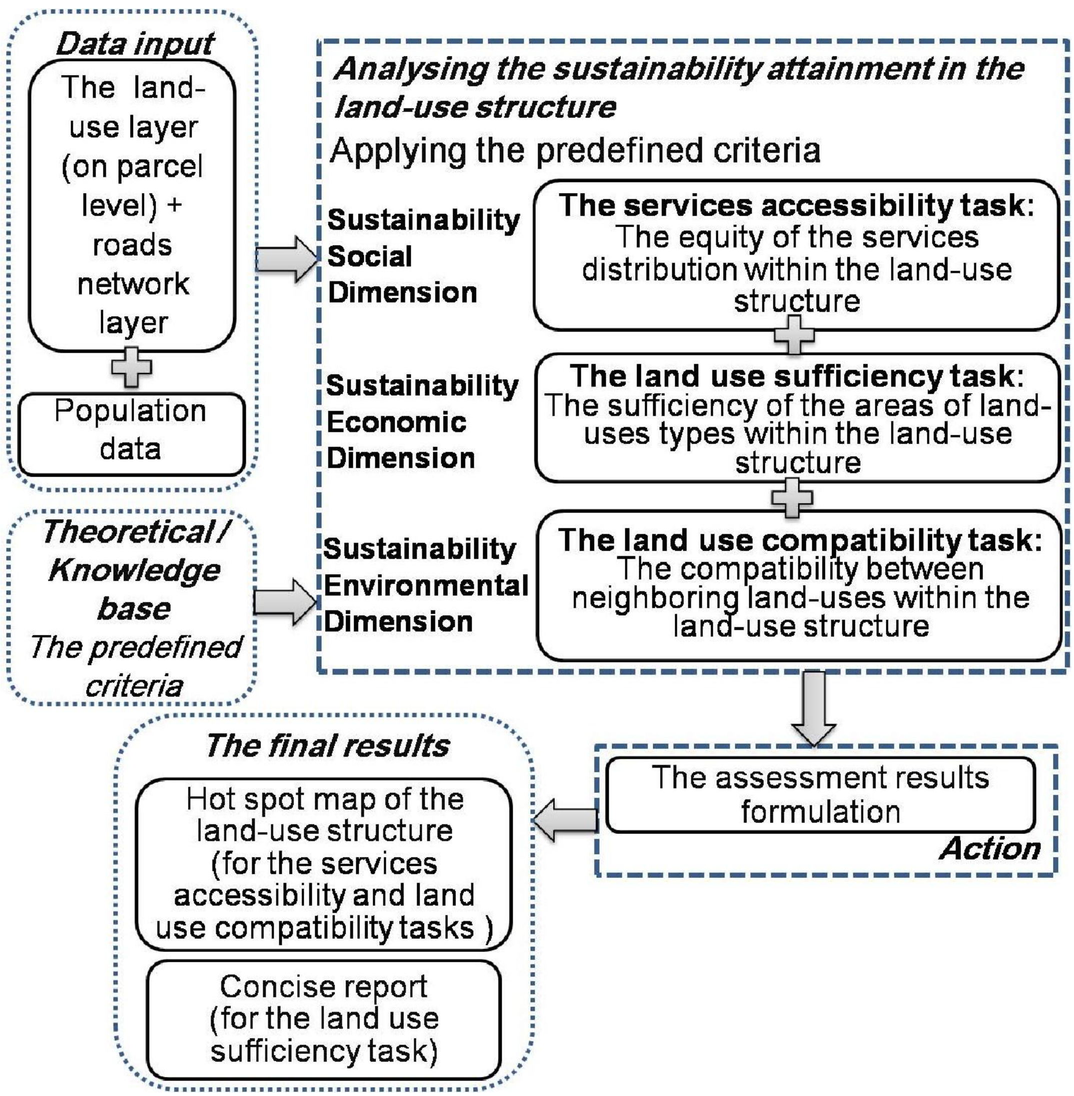
The next figure presents the identified assessment model from the comprehensive framework of the SPSS, which was implemented within the empirical part of the research project. As this comprehensive SPSS is considered a large research project, which requires a big team work and a lot of time to be modeled. And so, it can be implemented through a multiple cooperation. This assessment model was established in the form of a new toolbox called “Land-use Sustainability Analysis”. This toolbox was developed through geo-scripting within the ArcGIS™ software using Python language. (Fig. 8.3).

(8.2.1) The Assessment Model Description:

This dissertation aims at assessing the sustainability in land use planning process in the Egyptian Cities. The assessment model, as a part from the previously illustrated system, also focuses on assessing the sustainability attainment in the land-use structure of urban areas. As clarified in the following framework for the model (that is the theoretical base for the toolbox’s design), this model includes five sections as follows:

Fig. (8.2) The assessment model that was implemented from the comprehensive framework of the suggested SPSS



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1.The data input section:

In this section the detailed land-use map[1] (on the parcel level[2]) is entered to the model in the form of ArcGIS™ format either as current or planned state for the study area, as well as the population data according to the assessed state of the study area.

2.The analyzing section:

This section analyses or evaluates the land-use structure sustainability by performing three main tasks:

- The services accessibility evaluation task assesses the equity of the essential services distribution among the residents of an urban area. This is through evaluating to what extent the residential parcels have access to the essential services based on the walking distance to the recreational service, commercial service of daily-required products, primary educational service (elementary schools), and pre-educational services (nurseries). Or, it is based on the required time to transfer from the service locations to the residential parcel using vehicles, which are mainly emergency services (the fire stations and the medical service).
- The land-use compatibility analysis task evaluates the compatibility between the neighboring land use types within the land use structure for an urban area. This is through the identification of the compatibility between the neighboring land uses based on the importance degree of locating each land use type near or far from other types.
- The land-use sufficiency evaluation task checks the sufficiency of the areas specialized for the essential land-uses. This is in addition to identifying the required areas, which should be added to fulfill the study area’s needs from the essential land-uses types that have shortages.

Each task is responsible for one axis of the three sustainability axes based on predefined criteria that are adjustable according to the country in which the study area is located.

3.The action section:

This section is responsible for taking action of calculating and forming the assessment results.

4.The final results section:

This section provides the visualization of the land-use structure assessment results. These results are provided in the form of hot spot maps for the service accessibility and land-use compatibility and concise report for land-use sufficiency.

5.The theoretical base:

This is the knowledge base for the model. This base is represented in predefined criteria regarding each of the minimum required area per person from the essential land-use types in residential areas and the ideal and maximum distance or time for accessing the essential services, as well as the compatibility degrees among each two probable land-use types.

(8.2.2) The “Land-use Sustainability Analysis” Toolbox:

The assessment model was developed in the form of a new toolbox including group of script tools[3]. These tools were developed using the Python language to work through the software

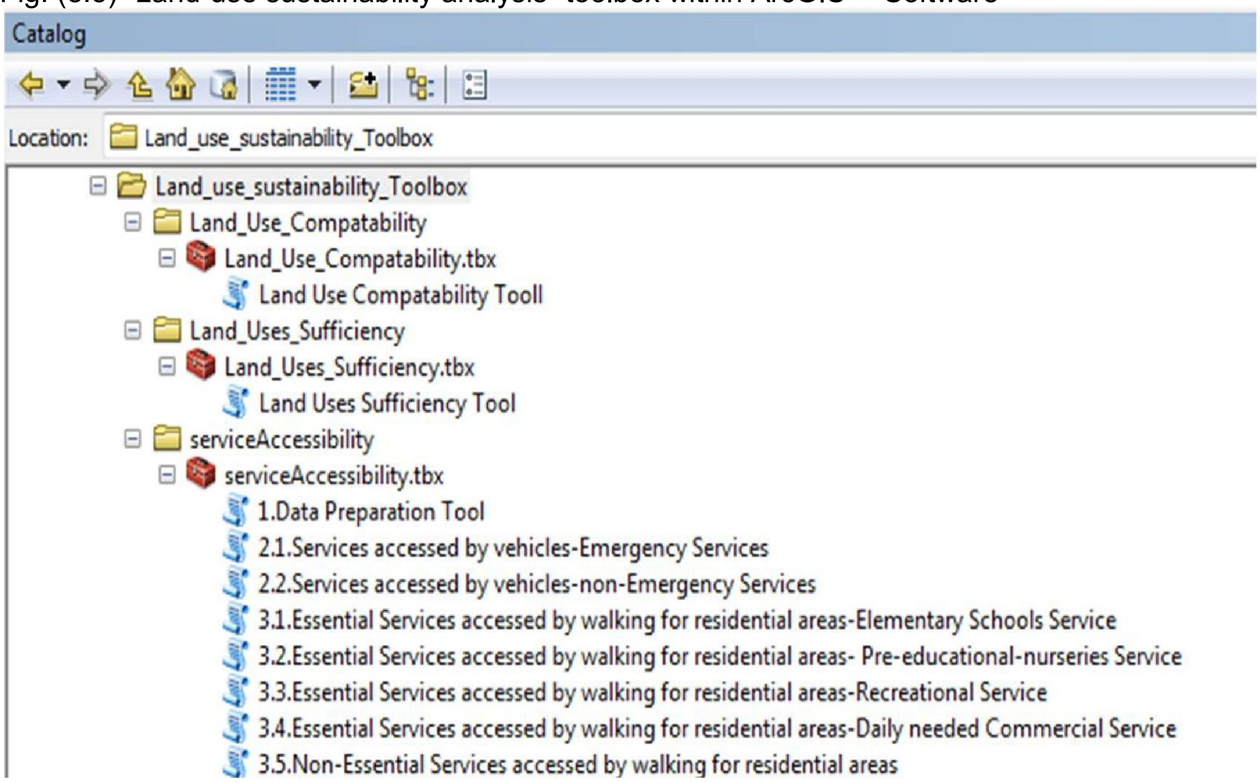
[1] The detailed map includes the land-use and the roads network maps.

[2] The model can also deal with zones level.

ArcGIS™10.3 or higher versions (Fig.8.3). The tools are adjusted according to the German standards as default values, but at the same time, they can easily be re-adjusted by the users to any country standards. The main requirements for the toolbox are advanced ArcGIS™10.3 version or higher versions with the Network Analyst Extension license. Also, the input land-use and roads layers should be according to a projected coordinate system.

The “Land-use sustainability analysis” toolbox[4] is mainly designed for assessing the sustainability attainment in the land-use structure of urban areas (neighborhood or small district). These areas are characterized by mainly including residential and mixed-residential land-uses and the minimum daily-required services as well. These services are the emergency services, recreational services (for children and adults), the daily commercial service, and the educational services (nurseries and elementary schools).

Fig. (8.3) “Land-use sustainability analysis” toolbox within ArcGIS™ Software



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The “Land-use sustainability analysis” toolbox can mainly deal with simple roads network (i.e. pedestrians and vehicles[5] roads), which is the most probable case in residential urban areas. As the target services can be accessed through the pedestrians and vehicles roads. So, this toolbox is not applicable in the case of complicated roads networks for the large cities that includes several types of roads networks or transport modes (e.g. tram, and under-ground networks). However, it can be upgraded in the future to be able to deal with the complicated roads networks in urban areas of large cities.

3 ‘Script Tool’ is an ArcGIS™ structure within a custom toolbox, which works through a Python script (Tateosian 2015, p.449).

4 The “Land-use Sustainability Analysis” toolbox is a Patent pending.

5 Including bridges and tunnels.

(8.2.3) Comparison between the Proposed Comprehensive Spatial Planning Support System-SPSS and the “Land-use Sustainability Analysis” Toolbox:

The model or the established toolbox is like a minimized version or a prototype from the proposed comprehensive SPSS in this dissertation. However, the model is based on different methods from those stated in the identified part from the comprehensive SPSS framework (the spatial part within the analyzing section of the SPSS). The following table presents a comparison between the comprehensive SPSS and the established assessment model from it.

Table (8.1) A comparison between the comprehensive SPSS and the established assessment model (the “land-use sustainability analysis” toolbox):

	The SPSS	The “Land-use Sustainability Analysis” Toolbox
1.Purpose	The SPSS aims at assessing of all the sustainability aspects in urban planning process for cities including the infrastructure, the roads networks, and the land-use planning, as well as to provide suggestions for modifying the evaluated plan to be more sustainable, if it does not attain sustainability.	The toolbox aims at assessing the sustainability attainment in the land-use structure of an area or a total small or medium city with regards to the residential circumstances. This assessment includes the land-use types compatibility, the accessibility to the essential services for the residents, and the land use-areas sufficiency. The toolbox also aims at providing a guidance for the planner for what should be changed in the land-use structure regarding each of the land-use compatibility and the services accessibility, whereas the land-use sufficiency results identify exactly the areas needed to be added to fulfill the residents need.
2.The state being assessed	The SPSS assesses the current state to extract specialized criteria for the study city that should be fulfilled by the suggested (planned) state. Then, it assesses the planned state based on both the general predefined and extracted specialized criteria.	The toolbox can assess each of the current and suggested (planned) state based on general predefined criteria.
3.Flexibility	It is adjustable to be applied on other cities from other countries.	It is adjustable to be applied on any area in any country.
4.Inputs	The main inputs are spatial data (a recent satellite image, land-use, roads and infrastructure networks maps for the city in the current and planned suggested states) (GIS format), as well as miscellaneous data like current and expected population, age categories, residents’ needs, and expectations.	The main inputs are land-use and roads maps[6] for the area (GIS format) on parcel level and the population number of the study area with the population number of residents in the age of nursery and elementary schools, if it is available.

6 N.b.: The toolbox is designed to mainly deal with maps on the parcel level. However, it can also deal with zones level.

	The SPSS	The “Land-use Sustainability Analysis” Toolbox
5.Outputs	The main outputs are hot spot colored maps of the land-use plan and suggested modifications for the plan to be more sustainable, which are in the form of maps and concise reports. These are in addition to other numerical assessments results.	The main outputs are hot spot colored maps (for service accessibility and land-use compatibility) and concise report (for land-use sufficiency).
6.Participation	It is based on an interactive process for various stakeholders’ participation.	It depends on the planner or the planning organization only.
7.Scale of Application	It can be applied on a whole city.	It can be applied on an area, and on a whole city as well in case that it is a medium or small city with uncomplicated transport modes.
8.Techniques/ Methods Used	It is established through Expert System techniques, Spatial Multi-Criteria Analysis (SMCA), Analytical Hierarchy Process (AHP), compatibility matrices analysis, and an interactive method like "the digital Charrette".	It is established through geo-scripting using Python language.
9.Required knowledge/ theoretical base	It requires: - Three groups of urban indicators including GIS-based indicators (regarding the roads and infrastructure networks) that forms three sustainability indices (economic, social, and environmental) and the composite sustainability index. -The spatial planning criteria regarding the balance between the land supply and demand, services accessibility, as well as values for all probable land-use combinations within the compatibility matrices.	It requires criteria of the sustainable land-use structure according to the country of the study area location: - The minimum required area per each person from the essential land use types in a residential areas (land-use sufficiency). - The ideal and maximum distance or time for accessing the essential services (services accessibility). - The compatibility degrees among each two probable land-use types (land-use compatibility).
10.Type of software	It is a whole independent spatial planning support system software with a user interface.	It is a toolbox within the ArcGIS™ Software.
11.Potentials	It is based on artificial intelligence techniques (i.e. the SPSS can realize, analyze, and take actions towards planning problems), so that it can formulate the specialized criteria for each study city. It is based on self learning potential, as the knowledge base can be modified through feedback from several resembling cases assessed by the SPSS.	It is based on ordinary programming potential.

	The SPSS	The “Land-use Sustainability Analysis” Toolbox
12.Developers	The developers should be a research group with various specifications, (economics, social, environmental studies, urban planning , infrastructure, and roads networks planning, as well as AI and geo-scripting programmers).	The developer is the researcher.
13.Time required	It requires 3-5 Years for establishing , trial, and application.	It took only 9 months for establishing , trial, and application.
14.Steps forward	It can be upgraded to be applied in the assessment of the regional planning level.	It can be upgraded in the future to be able to assess areas with the complicated roads networks (e.g. tram and under-ground networks) for the large cities like cities commercial centers, and various types of non-residential areas as well.

Source: by own

(8.2.4)The Design Concepts, Input, Output Data, and Guide for Tools within the Toolbox:

As it is clear in figure (8.3), the “Land-use sustainability analysis” toolbox includes three sub-toolboxes, each sub-toolbox performs one of the three tasks:

(8.2.4.1)The Services Accessibility Task [7]

This task assesses the social dimension of the sustainability attainment in the land-use structure of urban areas by assessing the social equity among the residential parcels in accessing the six daily-required essential services. These are the primary educational, nurseries, recreational, emergency medical and fire station services, as well as commercial services for daily-needed products. However, this task includes eight tools that are classified into three groups as shown in figure (8.3):

-The first group is the “*1.Data Preparation tool*” for preparing the roads network layer. This tool is used as a preliminary step before any other tool from the other seven tools.

-The second group is for evaluating the accessibility by vehicles to services. It includes two tools. One is for the emergency services (medical and fire stations) “*2.1.Services accessed by vehicles-Emergency Services*” that does not depend with the roads directions. And the other is for the non-emergency services “*2.2.Services accessed by vehicles-non-Emergency Services*”[8] that depends on the roads directions, and flexible to be applied to any service accessed by vehicles like gas stations.

-The third group is for evaluating the accessibility by walking to services that includes five tools. Four tools are specialized for the daily-required services in the residential areas, which are “*3.1. Elementary Schools Service*”, “*3.2. Pre-educational-nurseries Service*”, “*3.3.Recreational Service*”, and “*3.4.Daily needed Commercial Service*”. The fifth is for “*3.5.Non-Essential*

[7] This is the only task that includes more than one tool.

[8] This tool has not been applied in the two selected case studies (illustrated in chapter 9). As the focus in evaluating the services accessed by vehicles is on the emergency services only.

Services accessed by walking for residential areas” [9], which is flexible to be applied on any service that is accessed by walking like post offices.

The design concept of this task is finding the routes for the closest services. And so, it analyzes these routes to find how far or how much time is required for transferring from the residential parcels to the service parcel for some services types, or vice versa for other services types. This is the degree of the residential parcels’ accessibility to services.

The routes analysis depends (in some services) on their lengths in meters as “cost attribute” from the residential parcels to these services (e.g. nurseries). For the other services, the routes analysis depends on the time taken in minutes by vehicles as “cost attribute” in these routes from these services to the residential parcels, which are the emergency services.

Example, the degree of accessibility to the primary educational services (elementary schools) according to the German standards is identified by the distance that the elementary schools’ pupil should not walk more than it, which is called “cutoff value”, so:

- If the route between a residential parcel to the elementary school parcel is less or equal 700 meters, then the elementary school parcel is totally accessible by this residential parcel. (Schoening and Borchard 1992, p.52).
- If it is more than 700, but less or equal 900[10] meters, then the school parcel is partially accessible by this residential parcel.
- If it is more than 900 meters, then the school parcel is not accessible by this residential parcel.

In order to assess the accessibility to a services through this task, the three following steps should be done:

A. Data Preparation Step/Tool:

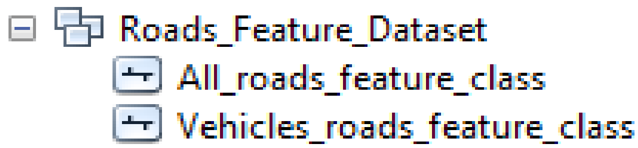
This is the step within the services accessibility task that greatly helps the users, who do not have a big background in the network analyst extension. In this step, the roads layer is prepared for building the network datasets by preparing a roads dataset that includes two features classes as shown in the next figure. The first is a feature class for vehicles roads, (i.e. all the roads excluding the pedestrian roads or roads that cannot be accessed by vehicles). This is for building a network analysis dataset specialized for evaluating the accessibility to services via vehicles based on this vehicles road feature class.

The second is a feature class for all roads, (i.e. all the roads including the pedestrian roads or roads that can be only accessed by walking). This is for building another network analysis dataset specialized for evaluating the accessibility to services via walking based on this comprehensive road feature class.

[9] This tool has not been applied in the two selected case studies (illustrated in chapter 9). As the focus in evaluating the services accessed by walking is only on the daily-required services for residential areas.

[10] This value is more than the maximum standard value with about 200 meters.

Fig. (8.4) The output roads feature dataset from the data preparation tool with two feature classes (vehicles and comprehensive roads)



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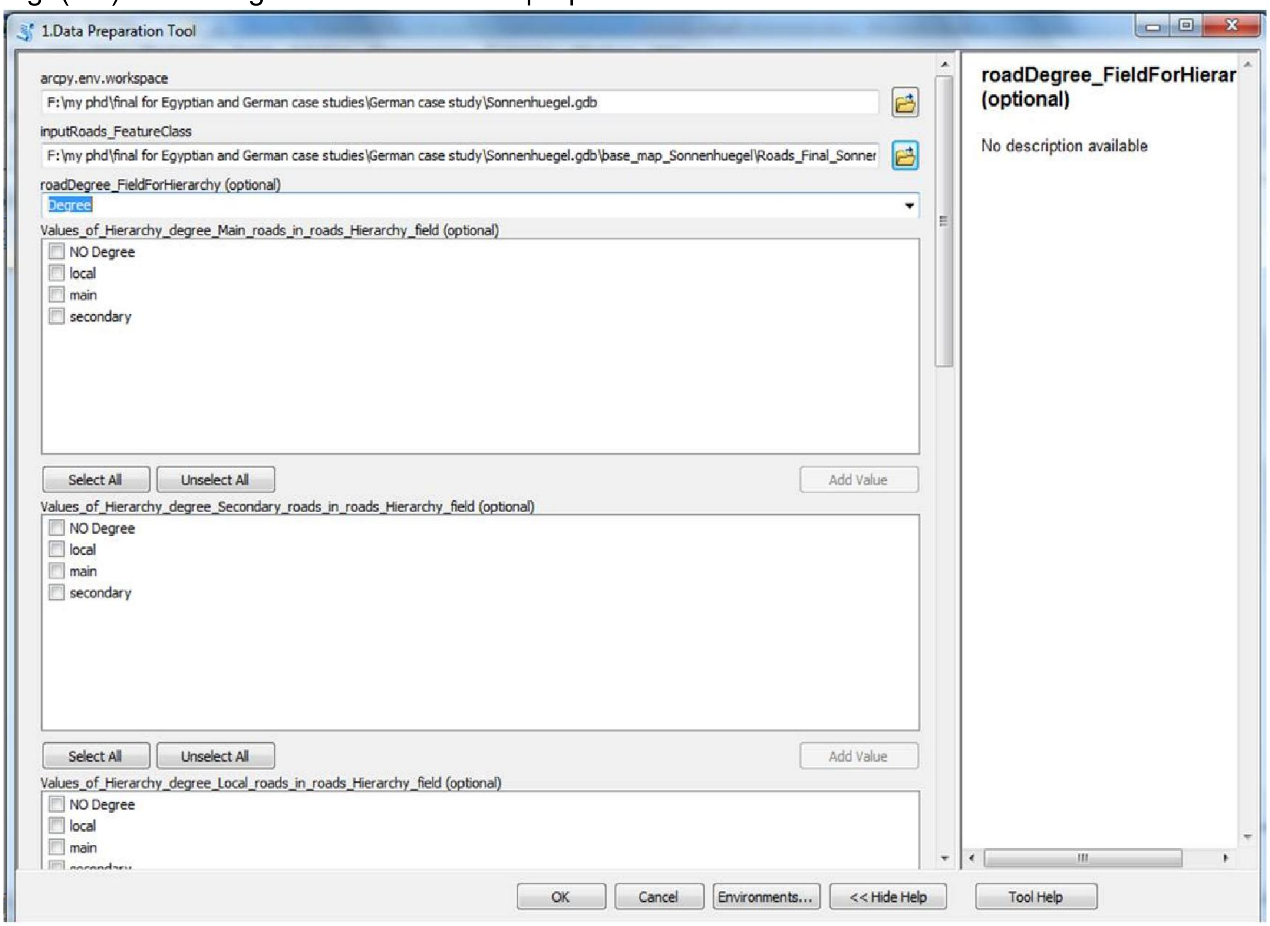
Then, the tool checks the presence of the important fields that should be in the roads feature classes for building the two network datasets. And so, it adds the required fields for this purpose with the appropriate names for these fields, and adds data with definite format to them, which is required for the evaluation of the services accessibility.

Fig. (8.5) The dialog window of the data preparation tool



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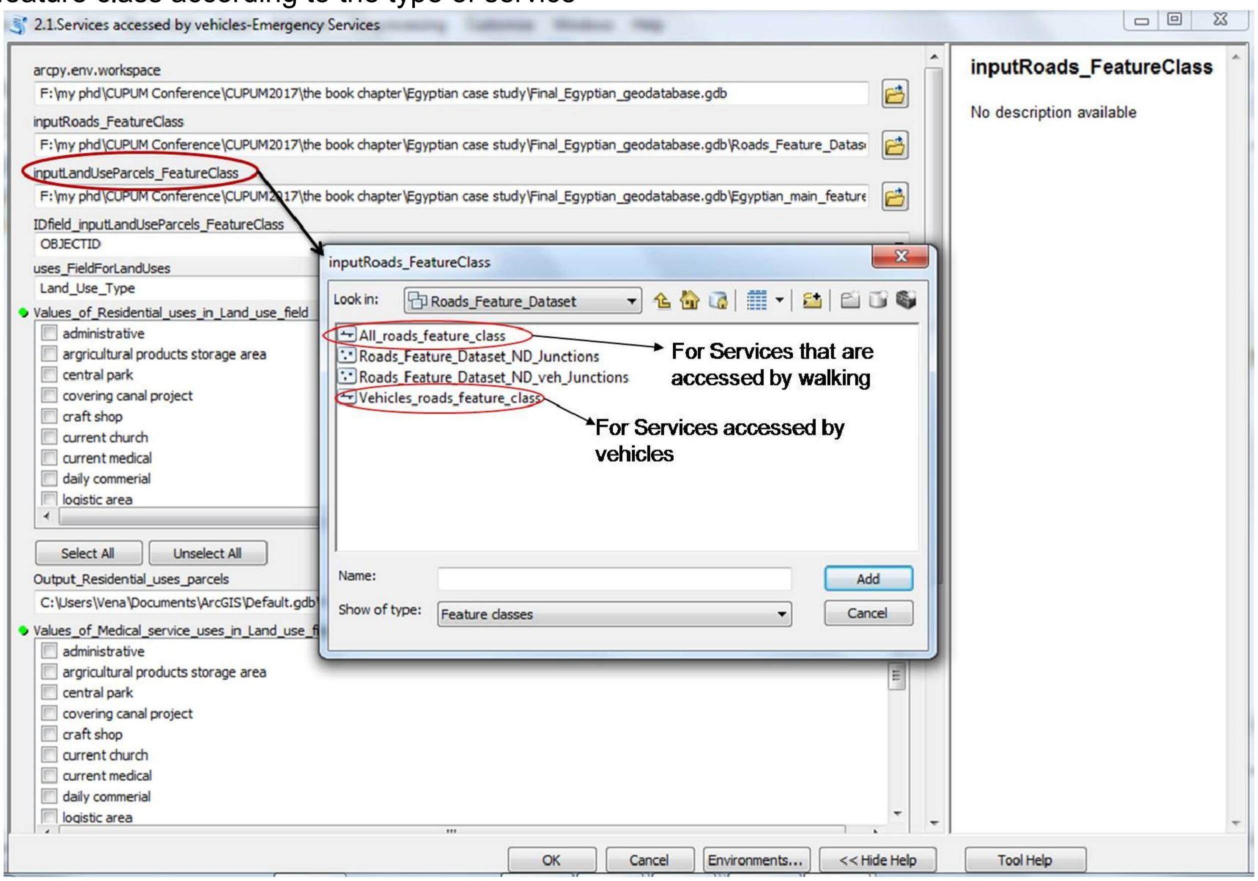
B. Building the Network analysis Datasets Step:

In order to analyze the service accessibility, a network analysis dataset should be built. As a network dataset is one of the input parameters in any tool of the services accessibility tools. Unfortunately, there is no possibility that the building of the network analysis dataset is automatically done through the scripting of the tool. So, this step should be done by the user (unlike the first and the third steps). The two feature classes within the feature dataset that are prepared by the data preparation tool in the previous step are the bases for building two network datasets. The first network dataset is based on the feature class of all the roads including pedestrians’ paths (comprehensive roads). The second network dataset is based on the feature class of vehicles roads including the bridges and tunnels[11].

C. Services Accessibility Step/Tool:

In this step, each of the input network dataset and roads feature class differ according to the type of the target service. In case of the services accessed through walking, the user should use the network dataset that is based on the comprehensive roads feature class and this comprehensive roads feature class. For the emergency services (or any service accessed by vehicles), the user should use the network dataset that is based on the vehicles roads feature class and this vehicles roads feature class as shown in the next two figures.

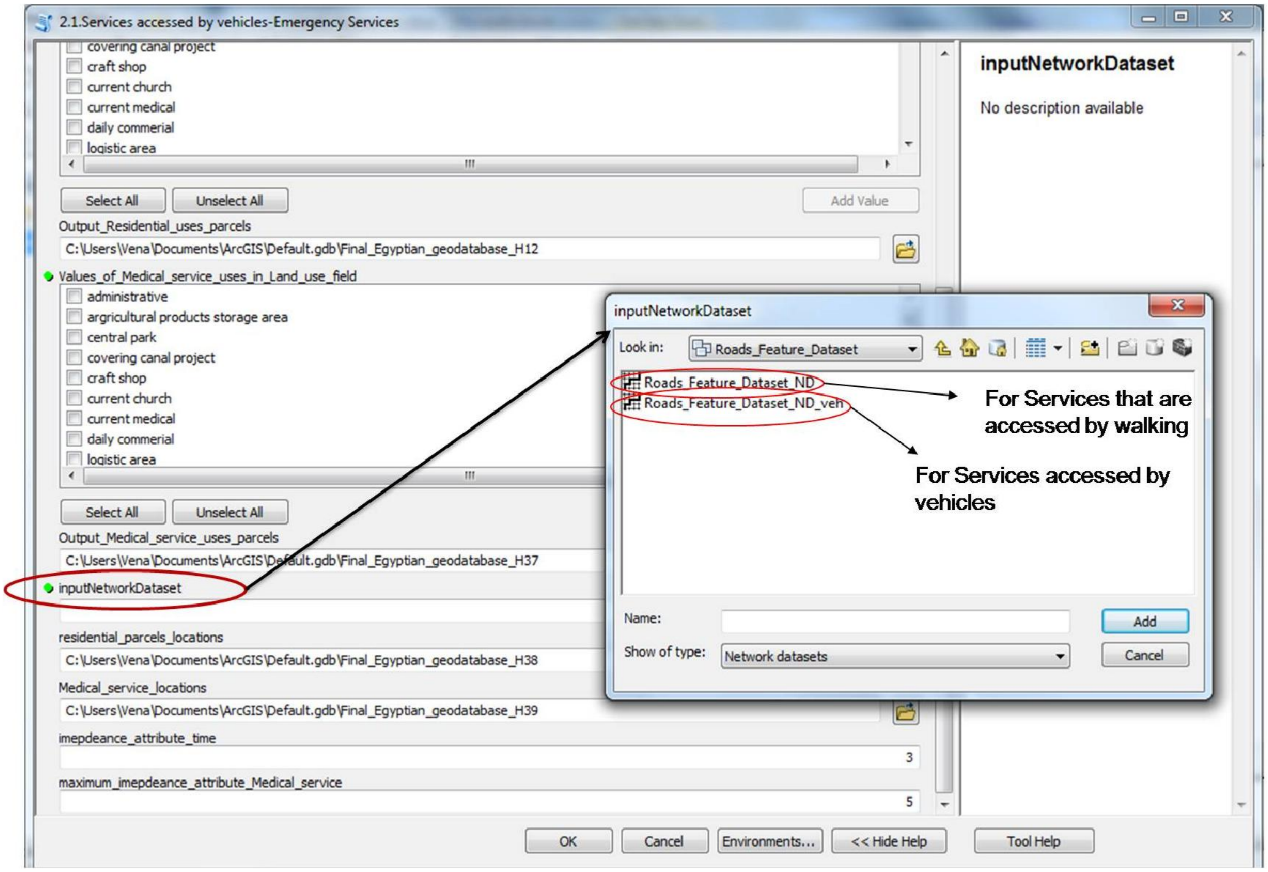
Fig. (8.6) The dialog window of one of the services accessibility tools clarifying the input roads feature class according to the type of service



Source: by own.

[11] Note: In case of the presence of other transportation mode in the study, the only transportation mode that is considered in building the network datasets is the normal streets network (with its bridges and tunnels). The other transportation modes (like the underground or metro or tram) are neglected. This is for the reason that the types of services (that are targeted to analyze the degree of the accessibility to them) depend on the normal streets network. These services are two types, the first depends on accessibility through walking. And the second type is the emergency services, which are accessed through the normal streets network, and do not depend on any other transportation mode like tram or the underground.

Fig. (8.7) The dialog window of one of the services accessibility tools clarifying the input network dataset according to the type of service



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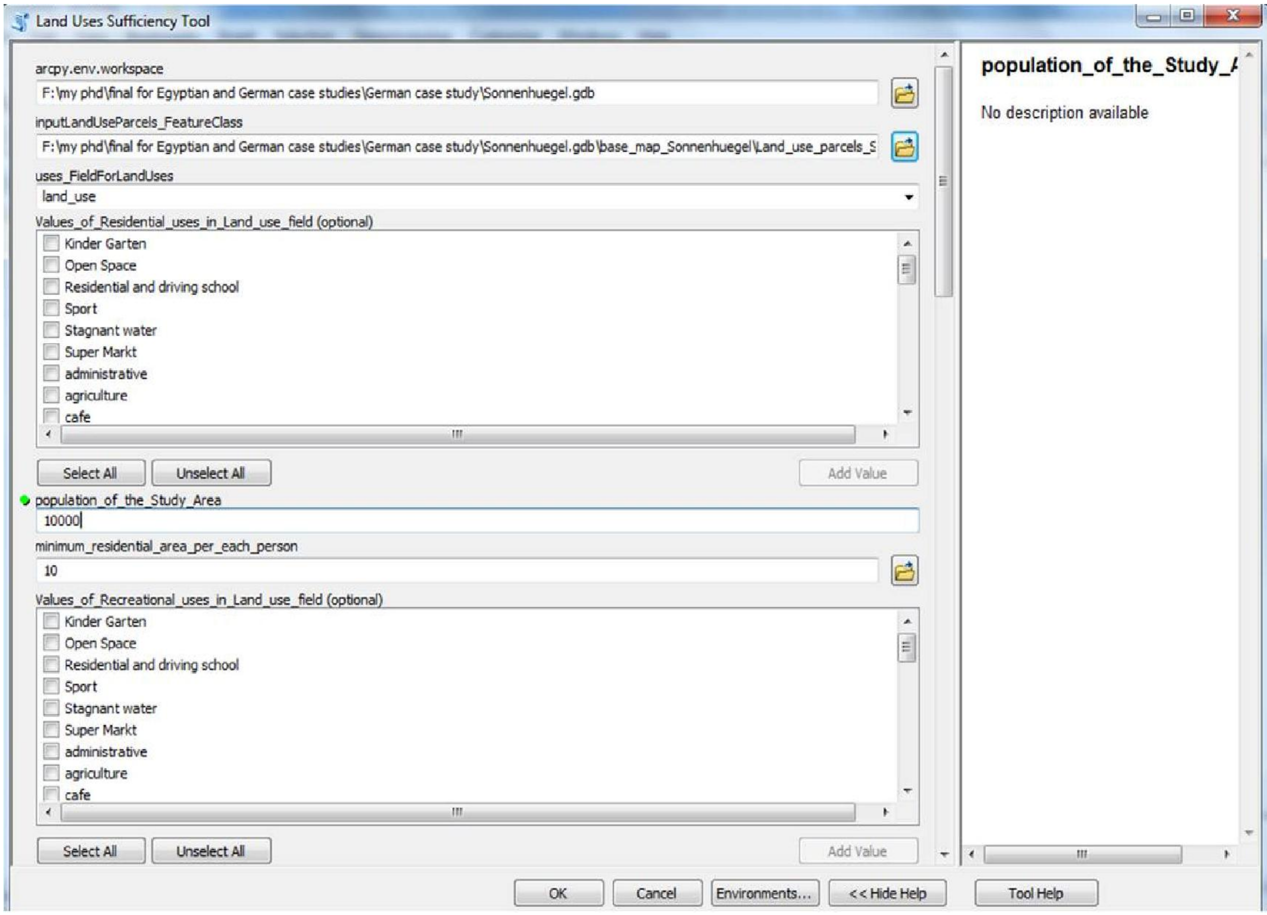
<u>(8.2.4.2)The Land-use Sufficiency Task/Tool:</u>

This task assesses the economic dimension of the sustainability attainment in the land-use structure of urban areas. This is through evaluating the economic efficiency of this structure in providing the essential land-uses types.

The design concept of this task (tool) is calculating the available areas from the essential land-uses types for any residential urban area, which are the residential use, and the six daily required services. Then, the tool compares these available areas with the needs of the population in the study area. And so, it finds whether there is a shortage in any land-use type, or not.

So, if there is a shortage in any land-use type, the tool calculates the required area recommended to be added. This is for fulfilling the population needs from the land-use type that has shortage.

Fig. (8.8) The dialog window of the land-use sufficiency tool



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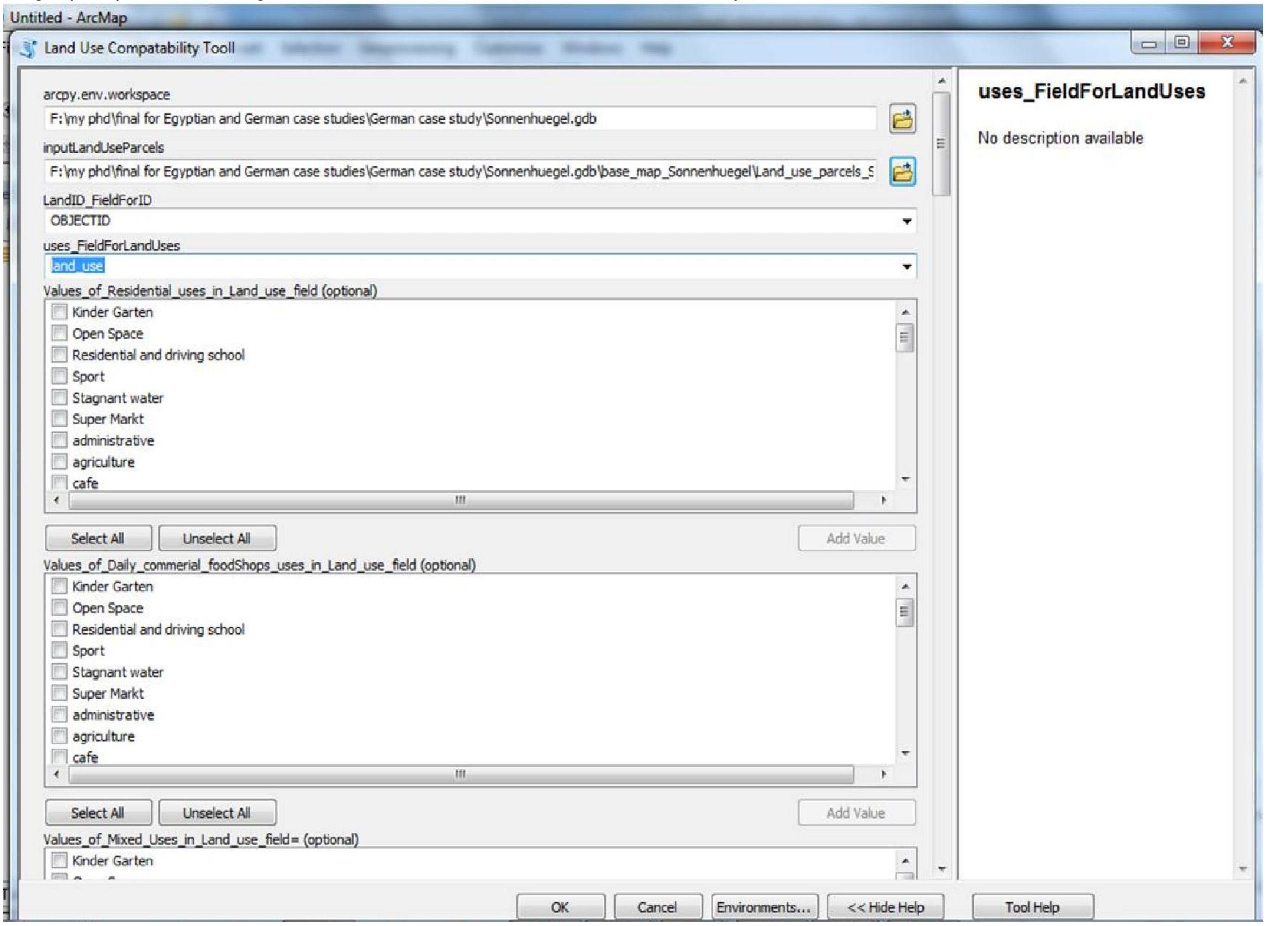
<u>(8.2.4.3)The Land-use Compatibility Task/Tool</u>

This task assesses the environmental dimension of the sustainability attainment in the land-use structure of urban areas. This is through evaluating the environmental consideration in neighboring the land-uses types within this structure.

The design concept of this task (tool) is based on identifying the compatibility degree resulting from the neighboring between each two different land-use types. The parcels of these two neighboring land-uses may have a common edge or a common node (vertex). So, the common edge or node will have a value. This value is the compatibility degree between the two different land-uses types, which occupy the two neighboring parcels (polygons) sharing this common edge or node.

The compatibility degree values are divided into three ranges, the highest range is for the highly compatible land-uses. The moderate is for the partially compatible land-uses, and the lowest is for not-compatible land-uses. The compatibility degree defines to what extent the existence of any two land-uses beside each other is beneficial and positively effective, and there is no environmental conflict between them based on degree of the importance of locating each land-use type near or away from other types. (Aminde et al. 2010, p.114).

Fig. (8.9) The dialog window of the land-use compatibility tool



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This task requires the direct attachment between the land parcels either through common edges or nodes. This means that if two land parcels are not attached or separated by a street or any space, the relations among their land-use types cannot be assessed by the land-use compatibility tool. So, this tool is applicable on the land-use layer, which includes the ownership limits of each land-use type as shown in the following figure:

Fig. (8.10) The ownership limits of the land parcels

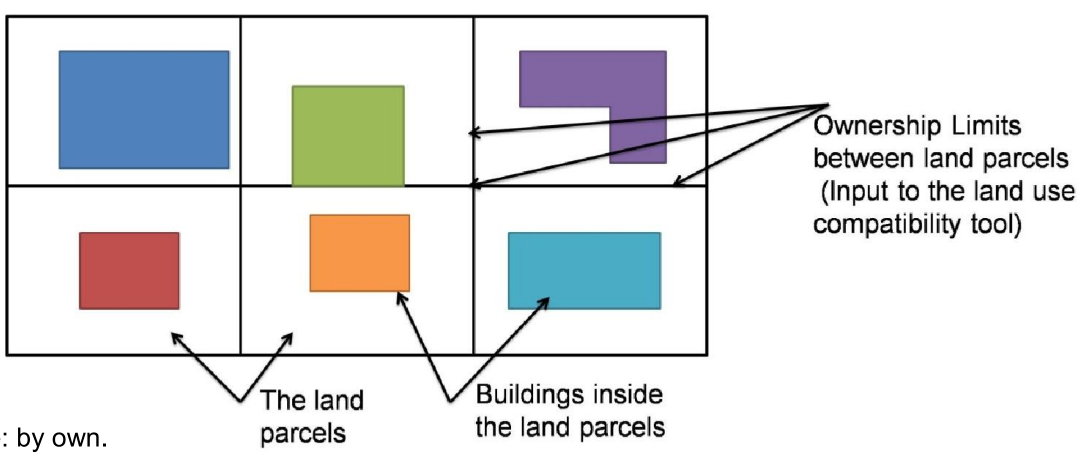

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Table (8.2) states the input and output data of the tools in the toolbox. There are two main inputs, which are the land-use layer (preferred to be on parcel level) and the roads layer**.**

Table (8.2) The input and output data of the tools in the toolbox

Task	Tool	Main Inputs	Main Outputs
Services Accessibility Task	Data preparation and services accessibility tools	1. Roads layer 2.Land-use layer. (The toolbox is designed to mainly deal with maps on the parcel level. However, it can also deal with zones level).	A colored residential parcels layer clarifying the accessibility degree of each residential parcel to the service under assessment: - Green color refers to the total accessibility. - Yellow color refers to the partial accessibility. -Red color refers to the lack of accessibility.
Land-use Sufficiency Task	Land-use sufficiency tool	1.Land-use layer 2.Population data (age categories are optional)	The available area of each entered land-use type and the area required to fulfill the shortage in any entered land-use type in case of the in-fulfillment of this type for the study area’s residents needs.
Land-use Compatibility Task	Land-use compatibility tool	Land-use layer	The land-use layer with colored edges and nodes between each two attached polygons either through common edge or vertex for clarifying the land-use compatibility degrees between the land-use types within the land-use structure of the study area. - The green color refers to the high compatibility. - The yellow color refers to the partial compatibility. - The red refers to the lack of compatibility.

Source: by own

(8.3) Identification of Predefined Criteria (the Knowledge Base) for the Assessment Model

As previously mentioned the knowledge base section of the assessment model is represented in the predefined criteria, which had to be identified before scripting the tools. These criteria include:

- The minimum required area per person from the essential land use types for residents in the urban areas: These are the residential use and the six daily required services. These services are the elementary schools, nurseries, recreational, emergency medical and fire station, and commercial services for daily-needed products. These standards are for the land-use sufficiency evaluation.
- The ideal and maximum time in minutes for the transfer by emergency vehicles from the emergency services (medical and fire station services) to the residential parcels: These standards are for the evaluation of the emergency services accessibility.
- The standard and maximum distance in meters for the transfer by walking from the residential parcels to the essential daily-required services in the residential urban areas: These services are the elementary schools, nurseries, recreational, and commercial services for daily-needed products. These standards are for the evaluation of the daily-required services accessibility.
- The land-use compatibility degrees between every two probable land-uses types out of twenty various land-uses categories, which may exist in urban areas (including polluting

activities or even rural land-uses). These values are used in performing the land-use compatibility analysis.

As the application of the toolbox was done on two study areas, one is a German area and the other is an Egyptian area (as will be illustrated in chapter 9), so these criteria were collected from both the German and the Egyptian standards. However, the criteria of the land-use compatibility degrees can be applied on any country. As these criteria consider the environmental aspect in neighboring various land-uses categories based on the importance degree of locating each land-use type near or away from other types. These are according to Aminde et al., who identified the land-uses types that should be near or far from the residential land-use. These can be applied on any study area in any country. (Aminde et al. 2010, p.114)

Regarding the assessment of the services accessibility and the land-use sufficiency of the Egyptian area, some of the services standards are not available yet in the Egyptian services standard guide. So, the German standards were used instead of these unavailable standards.

(8.3.1) Predefined Criteria for the Services Accessibility Evaluation:

As mentioned before, the time in minutes or the distance in meters for the transfer among residential parcels and the essential services within a residential urban area are the criteria for evaluating the services accessibility in the land-use structure of this area.

(8.3.1.1) Predefined Criteria for the Services Accessibility for the German Cities:

The predefined criteria for the services accessibility for the German cities are stated in the next table:

Table (8.3) The German services standards for services accessibility: [12]

Service Type		Criterion	Note	Reference
A. The daily-required services for the residential urban areas (accessed by walking)	Elementary school (primary educational service)	Standard walking distance	*700 meter (10 minutes walking)	-Borchard1974, p.105 -Schoening and Borchard 1992, p.52
	Nursery (pre-educational service)	Standard walking distance	*300 meter (5 minutes walking).	- Borchard1974, p.131. - Schoening and Borchard 1992, p.48 - Aminde et al. 2010, p. 118.
	Recreational areas	Standard walking distance	400-*500 meter	-Schoening and Borchard 1992, p.90
	Daily commercial service	Standard walking distance	*500 meter (7 minutes walking)	- Borchard1974, p.71. - Schoening and Borchard 1992, p.71

12 The underlined values with asterisk were used as default values in the application of the toolbox.

Service Type		Criterion	Note	Reference
B. The emergency services (accessed by vehicles)	Emergency Medical service	Ideal transfer time	The location should be central (*3-5 minutes by vehicles).	- Schoening and Borchard 1992, p.64
	Fire stations service	Ideal transfer time	The location should be central (*3-5 minutes by vehicles).	- Borchard1974, p.170.

Source: by own according to the stated references.

(8.3.1.2) Predefined Criteria for the Services Accessibility for the Egyptian Cities:

The next table states the predefined criteria for the services accessibility of the Egyptian cities:

Table (8.4) The Egyptian services standards for services accessibility: [13]

Service Type		Criterion	Note	Reference
A. The daily-required services for the residential urban areas (accessed by walking)	Elementary school (primary educational service)	Standard walking distance	500-*750 meter	The guide for the planning criteria and standards of services in the Arab Republic of Egypt (1st part - Educational Services), GOPP 2014, p.29
	Nursery (pre-educational service)	Standard walking distance	200-* 400 meter	The guide for the planning criteria and standards of services in the Arab Republic of Egypt (1st part - Educational Services), GOPP 2014, p.29
	Recreational areas	Standard walking distance	Not- available yet in the Egyptian services guide.	-
	Daily commercial service	Standard walking distance	Not- available yet in the Egyptian services guide.	-
B. The emergency services (accessed by vehicles)	Emergency medical service	Ideal transfer time	Maximum 5 minutes, so the ideal transfer time is (*3 minutes)	The guide for the planning criteria and standards of services in the Arab Republic of Egypt (2nd part -Medical Services), GOPP 2014, table 5, p. 29

13 The underlined values with asterisk were used as default values in the application of the toolbox.

Service Type		Criterion	Note	Reference
B. The emergency services (accessed by vehicles)	Fire stations service	Ideal transfer time	Not- available. So it is considered (*3 minutes), as the ideal transfer time for the emergency medical service.	-

Source: by own according to the stated references.

Note: The currently available Egyptian standards are the cultural, social, educational, normal medical services, youth, and sport activities. Each of the recreational, administrative, and religious services are under preparation.

The network analysis extension in the ArcGIS™ is the main element in scripting the services accessibility tools, which is mainly based on what is called “cost attribute". This is the walking distance for daily-needed services or the transfer time for the emergency services. So the next table shows the identified cost attribute (standard walking distance and ideal time) and the maximum cost attribute (maximum walking distance or maximum time):

Table (8.5) The identified cost attribute (standard and maximum) for the German and the Egyptian case studies, which are used in the services accessibility tools as default values:

Service Type	Cost Attribute		German case study	Egyptian case study
A. The daily-required services for the residential urban areas (accessed by walking)	Elementary school (primary educational service)	Standard walking distance	700 meters	750 meters
		Maximum walking distance[14]	900 meters	950 meters
	Nursery (pre-educational service)	Standard walking distance	300 meters	400 meters
		Maximum walking distance	500 meters	600 meters
	Recreational areas	Standard walking distance	500 meters	Not- available (considered 500 meters as German standards)
		Maximum walking distance	700 meters	700 meters
	Daily commercial service	Standard walking distance	500 meters	Not- available (considered 500 meters as German standards)
		Maximum walking distance	700 meters	700 meters

14 This value is more than the maximum standard value with about 200 meters.

Service Type	Cost Attribute		German case study	Egyptian case study
B. The emergency services (accessed by vehicles)	Emergency Medical service	Ideal transfer time	3 minutes	3 minutes
		Maximum transfer time	5 minutes	5 minutes
	Fire stations service	Ideal transfer time	3 minutes	3 minutes
		Maximum transfer time	5 minutes	5 minutes

Source: by own based on the two previous tables.

(8.3.2) Predefined Criteria for the Land-use Sufficiency Evaluation:

As mentioned before, the minimum required areas for each person from the essential land-uses types for a residential urban area are the criteria for evaluating the land-use sufficiency.

Note: The identification of the land-use sufficiency criterion for medical service is based on the public medical service area standards. As this service can provide each of normal (non-emergency) and emergency medical service. However, the identification of the transfer of the emergency medical service to residential parcels is not based on the ideal time for transfer to the normal medical service, but to the emergency medical service.

(8.3.2.1) Predefined Criteria for the Land-use Sufficiency for the German Cities:

The predefined criteria for the land-use sufficiency for the German cities are stated in the next table:

Table (8.6) The German services standards for land-use sufficiency: [15]

Land-use	Criterion	Note	Reference
Residential use	Required built area per each person (without considering gardens and floors number) and with considering all the required facilities (washing rooms, storage, etc.)	Min:3.5-7.5 m^2/person Max:30-50 m^2/person Average: *10-30 m^2/person	Borchard1974, p. 59
	Required area per each person (with considering gardens and floors number) and with considering all the required facilities (washing rooms, storage, etc.)	Min:14-25 m^2/person Max:40-50 m^2/person Average:30-35 m^2/person	Borchard1974, p. 61 .
Elementary school (primary educational service)	Required area with regards to the total population	Min:0.6 m^2/person Max:3.5-4 m^2/person Average: *1.6-2.8 m^2/person	Borchard1974, p.105 .

15 The underlined values with asterisk were used as default values in the application of the toolbox.

Land-use	Criterion	Note	Reference
Elementary school (primary educational service)	Required area with regards to the population in the elementary school age	*25 m^2/pupil	- Borchard1974, p.105. - Schoening and Borchard 1992, p.52 -Aminde et al. 2010, p. 118.
Nursery (pre-educational service)	Required area with regards to the total population	Average: *0.4- 0.8 m^2/person	- Borchard1974, p.131. -Aminde et al. 2010, p. 118.
	Required area with regards to the population in the nursery age	*20 m^2/pupil	- Borchard1974, p.131. - Schoening and Borchard 1992, p.48
Recreational areas	Required area per each person	Parks: *8-15 m^2/person Sports: 5-8m^2/person	- Schoening and Borchard 1992, p.89
Daily commercial service	Required area per each person	Average: *0.7-1.2m^2/person	- Borchard1974, p.71 . - Schoening and Borchard 1992, p.71 . -Aminde et al. 2010, p. 119.
Medical service	Required area per each person [16]	Average: *1-1.7 m^2/person	- Borchard1974, p.154. - Schoening and Borchard 1992, p.64 . -Aminde et al. 2010, p. 119.
Fire station	Required area per each person	Average:0.05-0.10m^2/person	- Borchard1974, p.170.
		1500-4000m^2/100,000 residents	-Aminde et al. 2010, p. 119.
		*0.015-0.04 m^2/person	

Source: by own according to the stated references

[16] Every 1000 person should have at least 7.5 beds (in case of emergency) (Schoening et al. 1992, p.64)

(8.3.2.2) The Predefined Criteria for the Land-use Sufficiency for the Egyptian Cities:

The next table states the predefined criteria for the land-use sufficiency for the Egyptian cities:

Table (8.7) The Egyptian services standards for land-use sufficiency: [17]

Service	Criterion	Note	Reference
Residential use	Required area per person	There is no definite standard residential area for each person, but there is definite general population density, which is 150 person / 4200 m^2, (i.e. each person should at least have 28 m^2). However, this is a general density, which includes all the non-residential uses and the roads.	Terms of reference for preparing the strategic planning for the Egyptian cities- TOR, GOPP 2010
Elementary school (primary educational service)	Required area with regards to the total population	Existed re-planned areas of cities: *0.6 m^2/person New added areas to cities: *1.2 m^2/person	The guide for the planning criteria and standards for services in the Arab Republic of Egypt (1st part - Educational Services)-GOPP 2014, p.30
	Required area with regards to the population in the elementary school age	The percentage of the population in the primary school age is 12-14% of the whole population. [18]	
		*4m^2/pupil	Terms of reference for preparing the strategic planning of the Egyptian cities- TOR (Services standards appendix no.32) GOPP 2010
Nursery (pre-educational service)	Required area with regards to the total population	Not- available yet in the Egyptian services guide.	-
	Required area with regards to the population in the nursery age	The percentage of the population in the Nursery age 4-5% of the whole population.	The guide for the planning criteria and standards of services in the Arab Republic of Egypt (1st part -Educational Services),GOPP 2014, p.30

[17] The underlined values with asterisk were used as default values in the application of the toolbox.

[18] If the data regarding the population in the age category of the elementary school is not available for the user, the user can calculate the population in the age category using this percentage and enter the result to the tool. Then, the user can use the default value 4m^2/pupil. Otherwise, the user use the default value for the whole population, which are 0.6 m^2/person in case of existed re-planned areas or 1.2 m^2/person in case of new added areas.

Service	Criterion	Note	Reference
Recreational areas	Required area per each person	Not- available yet in the Egyptian services guide.	-
Daily commercial service	Required area per each person	Not- available yet in the Egyptian services guide.	-
Medical service	Required area per each person	-5000-20,000 residents need a “medical unit” with ideal area 540 m^2 . As an average, each 12,500 person need 540 m^2 (each person needs 0.04 m^2) - 20,000- 40,000 need a “medical center” with ideal area 1250 m^2. As an average, each 20,000 need 1250 m^2 (each person needs 0.06 m^2). Therefore, the average of these two averages, each person needs *<u>0.05 m^2 medical service.</u>	The guide for the planning criteria and standards for services in the Arab Republic of Egypt (2nd part -Medical Services)-GOPP 2014, table 7, p. 30
Fire station	Required area per each person	Not- available yet in the Egyptian services guide.	-

Source: by own according to the stated references

The required area per person is the main element in scripting the land-use sufficiency tool. The next table shows the identified minimum required area in square meters for each essential land-use type regarding the German and the Egyptian case studies:

Table (8.8) The identified minimum required area for essential land-use types for the German and the Egyptian case studies, which are used in the land-use sufficiency tool as default values:

Required area from land-use		German case study	Egyptian case study
Residential use per each person		10m^2/person	Not- available (considered 10m^2/person as German standards)
Elementary school (primary educational service)	Required area per each person	1.6-2.8 m^2 (in applying the tool, 1.6m^2/person was considered as minimum value for the identified German standard).	0.6 m^2/person for existed re-planned areas and 1.2 m^2/person for new areas in cities.
	Required area per each pupil	25 m^2/pupil	4m^2/pupil
Nursery (pre-educational service)	Required area per each person	0.4-0.8 m^2 (in applying the tool, 0.4m^2/person was considered as minimum value for the identified German standard).	Not- available (considered 0.4m^2/person as German standards)

Required area from land-use		German case study	Egyptian case study
Nursery (pre-educational service)	Required area per each child	20 m^2/child	Not- available (considered 20m^2/child as German standards)
Recreational areas (parks) per each person		8-15 m^2 (in applying the tool, 8m^2/person was considered as minimum value for the identified German standard).	Not- available (considered 8m^2/person as German standards)
Daily commercial service per each person		0.7-1.2m^2 (in applying the tool, 0.7m^2/person was considered as minimum value for the identified German standard).	Not- available (considered 0.7 m^2/person as German standards)
Medical service per each person		1-1.7 m^2 (in applying the tool, 1m^2/person was considered as minimum value for the identified German standard).	0.05 m^2/person
Fire stations service per each person		0.015-0.04 m^2 (in applying the tool, 0.015m^2/person was considered as minimum value for the identified German standard).	Not- available (considered 0.015 m^2/person as German standards)

Source: by own based on the two previous tables.

(8.3.3) Predefined Criteria for the Land-use Compatibility Analysis:

In order to identify the criteria for land-use compatibility, it was important to firstly identify the probable land uses categories or types that may exist in urban areas. These include even unexpected land-uses within the urban areas like agriculture and polluting activities, which are:

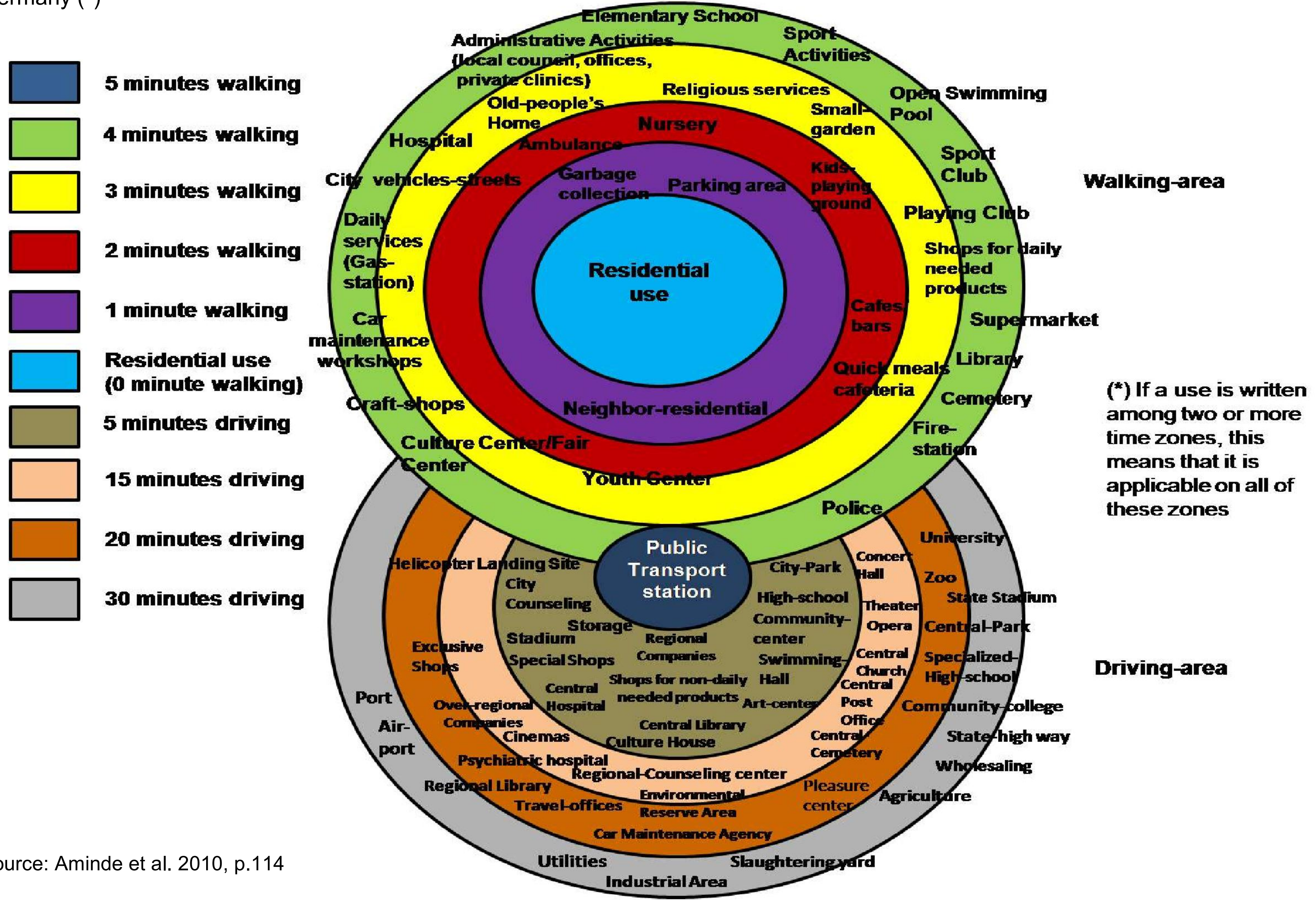
1. Residential uses.
2. Commercial service for daily-needed products (e.g. food shops, bakeries, and pharmacies).
3. Mixed uses (e.g. mixed residential use with daily services, or mixed administrative use with daily commercial uses).
4. Craft shops (non-interfering or non-polluting).
5. Religious service.
6. Social and cultural activities (e.g. old people houses, social clubs, museums, and art galleries).
7. Medical service.
8. Recreational, green, and open spaces (e.g. parks, sports, vacant lands, and agriculture land).
9. Daily services (e.g. hair-cuts, post offices, and gas stations).
10. Parking spaces, streets, and squares.
11. Polluting activities (e.g. factories, wastes collection, and polluting craft-shops).

12. Educational service (e.g. various schools, institutes, and universities).
13. Pre-educational service (nurseries).
14. Security services like fire stations and police unit.
15. Administrative activities (e.g. offices, banks, companies, and private clinics).
16. Hospitality activities like hotels and youth houses.
17. Commercial service for non-daily needed products service like electric devices stores.
18. Public transport stations.
19. Utilities (e.g. sewage and electricity stations).
20. Storage areas.

(8.3.3.1) The Methodology for Identifying the Compatibility Degrees among Various Land-uses:

The challenge was to find definite recommendations from previous studies for the ideal relations between the locations of various land-uses types within urban areas, or what are the recommended transfer time periods between them. This is in order to convert these relations into compatibility degrees between these land-uses types. However, there are already identified relations between the residential uses and any other land-uses, which are identified by Aminde et al. for the residential areas in the Federal Republic of Germany as shown in the next figure (Aminde et al. 2010, p.114).

Fig.(8.11) The locations of the important public and private facilities with regards to the residential areas within the Federal Republic of Germany (*)



Source: Aminde et al. 2010, p.114

Figure (8.11) shows the relations between the residential uses and other land-uses types according to the walking minutes or driving time between each land-use type and the residential use. These are based on the needs priorities for various uses by the residents. For example, the parking and the nurseries should be nearer to the residential use than the commercial services for daily-needed products. (Aminde et al. 2010, p.114)

There are two parts within figure (8.11), the upper part represents the walking time period of the transfer between the residential use and other land-uses. The lower part represents the driving time period of the transfer among various land-uses.

The center of the upper part is represented in the residential uses or houses (the light blue color zone). Around it, there are the land uses types that should be within the locations of one-minute walking away from the residential uses (the purple color zone). These are the direct neighboring land-uses types to the residential use. And so, these uses take the value 10 as compatibility degree, which means the highest degree of compatibility with the residential type, as these types should be directly neighboring to the residential uses. These land-uses are parking spaces and other neighboring residential uses including the place for collecting garbage.

The land-uses types that can be within the locations of two-minutes away from the residential uses (the red color zone) are the types that are located after the direct neighbor land uses types to the residential use (two-minutes walking). These uses take the value 9 as compatibility degree, which means the second highest degree of compatibility with the residential use. These land-uses are mainly[19] represented in the emergency medical service and pre-educational service (nurseries).

The third land uses group are located within the locations of three-minutes away from the residential use (the yellow color zone) to be the third compatibility degree land uses types with the value 8 as compatibility degree with residential uses. These land-uses are mainly represented in religious, social, cultural, cafes, recreational activities, sports, and open spaces or green areas.

The forth land uses group are located within the locations of four-minutes away from the residential use (the green color zone) to be the fourth compatibility degree land uses types with the value 7 as compatibility degree with residential uses. These land-uses are mainly represented in educational uses and security service like fire stations.

The fifth land-uses group are located within the locations of five-minutes away from the residential use (the dark blue color zone) to be the fifth compatibility degree land uses types with value 6 as compatibility degree with residential uses. These land-uses are represented in the public transport stations.

The sixth land-uses group are located within the locations of five-minutes driving away from the residential use or beginning of six-minutes walking away from the residential use[20] (the olive color zone). These land-uses have the sixth compatibility degree, as they take the value 5 as

[19] The other not mentioned uses are located within more than one “walking time zone” as will be clarified later.

[20] As they are directly located after the zone of “5 minutes walking away” from the residential use.

compatibility degree with residential uses. These land-uses are represented in each of the commercial land uses for non-daily needed products and the storage land-use.

The following aspects were taken into consideration in the calculations of the compatibility degrees within the predefined criteria of the land-use compatibility tool:

- The compatibility degree of any polluting activity with the residential use or any other land-use type has the value zero except with itself (i.e. another polluting activity), as it has the value 10.
- The compatibility degree between land-uses of the same land-use type is equal 10.
- The medical land-uses are considered to be within 3 minutes walking from the residential use (compatibility degree 8 with the residential use). This is because the emergency medical service is located within the 2 minutes walking zone, whereas the normal medical service is located within each of the 3 and 4 minutes zones. So, their average is 3 minutes walking.
- The commercial land-uses (daily needed products) are considered to be within 3.5 minutes walking from the residential use (compatibility degree 7.5 with the residential use). Because they are located within two time zones (3 and 4 minutes walking).
- The craft activities are considered to be within 3.5 minutes walking from the residential use (compatibility degree 7.5 with the residential use). Because they are located within two time zones (3 and 4 minutes walking).
- The social or cultural activities (e.g. old-people’s homes, culture center, fair center, cafes, cafeterias, and libraries) are considered to be within 3 minutes walking from the residential use (compatibility degree 8 with the residential use). Because they are located within three time zones (2, 3, and 4 minutes walking).
- The recreational and open spaces (e.g. sport activities, parks, cemetery, agricultural and vacant lands) are considered to be within 3 minutes walking from the residential use (compatibility degree 8 with the residential use). Because they are located within three time zones (2, 3, and 4 minutes walking).
- The daily service activities (e.g. haircuts, post offices, and gas stations) are considered to be within 3.5 minutes walking from the residential use (compatibility degree 7.5 with the residential use). Because they are located within two time zones (3 and 4 minutes walking).
- The administrative activities (e.g. local council, offices, small companies, and private clinics) are considered to be within 3.5 minutes walking from the residential use (compatibility degree 7.5 with the residential use). Because they are located within two time zones (3 and 4 minutes walking).
- The hospitality services (e.g. hotels and youth centers[21]) are considered to be within 2.5 minutes walking from the residential use (compatibility degree 8.5 with the residential use). Because they are located within two time zones (2 and 3 minutes walking).
- Some of the utilities (like the electricity provision stations[22], garbage recycle station, natural gas provision station, and drainage stations) are harmful to be nearby residential

[21] Here the youth center is considered as a hospitality service within 2.5 minutes walking from the residential use, and not considered as a cultural service, as the cultural services are already considered within 3 minutes walking, which is almost the same.

areas. Other utilities (like water provision stations) are not harmful, but not preferred to be nearby the other uses, i.e. they are preferred to be on the boundary of the city mass. So, the value zero is given as a compatibility degree between any utility and all the other uses including the polluting activities, as these activities may negatively affect the utility.

- A mixed land-use is the case of locating more than one land-use type in the same land, which can be a large number of probabilities. So, it is more logic to consider a general case for calculating the compatibility degree between a residential use and a mixed land-use. This compatibility degree is equal the arithmetic mean or the average of the compatibility degree values of 17 land-use types[23] out of the 20 land-uses types with the residential use. This average is approx. 8 (7.61), which is respective to a walking time (3) minutes. However, in case that any mixed land-use includes a polluting activity or utilities, the user should consider it as undesired land-use category, so it will take compatibility value zero.
- The cemetery is an undesired use according to the Egyptian planning concepts to be within urban areas. So, the cemeteries should be identified by the user of the land-use compatibility tool within the undesired activities category to take the value zero as compatibility degree with other land-uses. However, cemeteries are accepted to be within the open spaces in cities according to the Western planning concepts, so if they are considered by the user as open spaces, they will take a compatibility degree 7 with the residential use. And the same for the cafes, they can be considered as social activities in one country and as cultural in another country or as commercial, and so on, Therefore, the user can identify the category of each activity according to his/her vision, and the land-use compatibility tool will calculate the compatibility degrees based on what is identified by the user.

The relations shown in figure (8.11) are the ideal case for the relations between the residential areas and the other cities' areas like the cities' centers. However, in most cases, the residential areas include some land-uses types from these other cities' areas. There are three cases or probabilities for land-uses relations in cities:

a. Land-uses that are supposed to be far away or on a driving distance from residential uses, but they can be considered the alternative for some uses that should be within the residential areas: Because these land-uses can provide the same function of those uses within the residential areas, so they take the same compatibility values. For example:

– The zoo or central park or stadium are supposed to be within 20 minutes driving. However, these uses can replace the recreational and sport activities on the residential area level that are supposed to be within 3 minutes walking.

– The central hospital is supposed to be within 5 minutes driving. However, it can work as an alternative medical service within the residential areas, which is supposed to be within 3 minutes walking.

– The central social and cultural uses.

– The services that can replace the daily-needed services like central post office.

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[22] High voltage area.

[23] The 17 land-uses are all the previously stated 20 land-use types or categories without each of the utilities, polluting activities, and the mixed land-use itself.

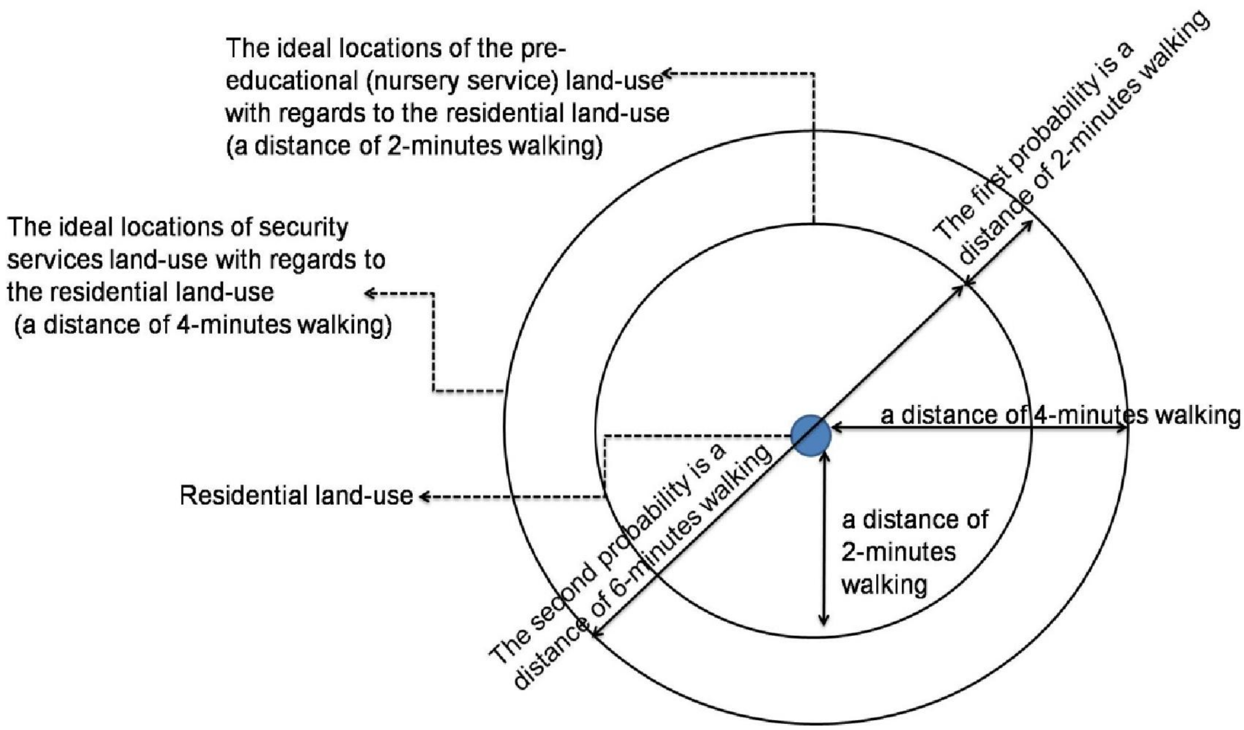
– The big scale commercial services (e.g. Wholesaling) can be considered alternatives to the daily commercial service, if they are providing the daily needed products.
– The central administrative services.

b. Land-uses that are that are not harmful to be within the residential areas, but they cannot replace the function of the uses on the residential areas level. Examples:
– The educational uses like the universities and high-school are not supposed to be within the residential areas, but at the same time they are not harmful uses. So, the user can consider them as educational uses. However, they cannot replace the function of the primary educational services on the residential area level (elementary school). As the presence of educational uses like the universities and high-school inside the residential areas is accepted from the environmental point of view, but it may be not accepted from the economic and the social points of view in case of the insufficiency or the absence of the required primary educational services in the study area. This will be detected through the land-use sufficiency tool, and may be through the service accessibility tool.
– The agriculture and natural reserve areas can be considered by the user as open or green spaces land-uses within the residential areas, but they cannot replace the recreational and open spaces role in the residential areas. So, as environmental point of view, the uses like agriculture are compatible to be within the residential areas, but there may be social and economic inefficiency due to shortage in the required recreational services in the residential areas. This will be detected through the land-use sufficiency tool, and may be through the service accessibility tool.

c. Land-uses that are not harmful outside the residential areas, but they are considered as undesired land-uses within the residential areas. Examples:
– Special uses like ports, air-ports, and helicopter landing site.
– Slaughtering yard.
– Industrial areas.

<u>The following figure illustrates an example for how the compatibility degrees among various land-uses were calculated:</u>

Fig. (8.12) The methodology of calculating degree of compatibility between the nurseries land-use and the security service land-use



Source: by own

The main concept for identifying the relations among various land-uses is based on the relation between each land-use type and the residential use. This means that the relation between any land-use type and another type is identified according to the relation of each of these two types with regards to the residential use. In other words, the residential use is considered as the center or bench marking for all the other uses. Therefore, through attaining the previously mentioned recommended relations between various land-use types and the residential type, the ideal relations among these land-uses with each other can be attained.

Figure (8.12) shows two con-centric circles, the circumference of each circle represents the ideal locations of each of pre-educational and the security service land-uses with regards to the residential use. As the inner circle is for the pre-educational use with radius 2 minutes (because this use is belonged to the group of land uses with second highest compatibility degree value with the residential uses “9”). And the outer circle is for the security service land-use with radius 4 minutes (because this use is belonged to the group of land uses with forth highest compatibility degree value with the residential uses “7”).

The common center of the two circles is the location of the residential uses. So, there are two probabilities for the relation between the location of any security service land-use and a pre-educational use (according to their ideal locations with regards to the residential use):

- The first probability is that the two land-uses are located in one side of the residential use. So, they are on a distance equal to the difference between the two circles’ radii. This means that the transfer time between these two land-uses is 2 minutes (4 minutes-2 minutes= 2 minutes).

- The second probability is that the two land-uses are located in the two different sides of the residential use. This means that the transfer time between these two land-uses is 6 minutes ([4 minutes-2 minutes]+ [4 minutes]= 6 minutes).

Therefore, the ideal relation between each of the pre-educational land-uses and the security service land-use is the average among the two previously mentioned probabilities. This is equal to (2+6)/2= 4 minutes, which is equivalent to compatibility degree values “7”. This means that in order to attain the ideal relations between each of these two uses and each other as well as between each of them and the residential use, they should be located in a distance that needs 4 minutes walking.

(8.3.3.2) The Compatibility Degrees Ranges and the Compatibility Values Matrix:

There are three ranges of land uses compatibility degrees, which are:

- Totally compatible (values more than or equal 6.70 and less than or equal 10).
- Partially compatible (values more than or equal 3.35 and less than 6.70).
- Non- compatible (Values more than or 0 and less than 3.35).

The next table presents the output matrix for the calculated compatibility values between all probable land-uses within areas in cities.

Table (8.9) Compatibility values matrix for all probable land-uses within areas in cities:

Compatibility Degree value (transfer distance in minutes) **for** **l**and-uses	**Residential**	**Daily commercial**	**Mixed-uses**	**Craft shops**	**Religious**	**Social/ Cultural**	**Medical**	**Recreational /Open spaces**	**Daily services**	**Parking spaces**	**Polluting Activities**	**Educational**	**Pre-educational**	**Security Services**	**Administrative**	**Hospitality Activities**	**Non-daily Commercial**	**Public transport stations**	**Utilities**	**Storage Areas**
Residential	**10** (1 min walking)	**7.5** (3.5 min walking)	**8** (3 min walking)	**7.5** (3.5 min walking)	**8** (3 min walking)	**8** (3 min walking)	**8** (3 min walking)	**8** (3 min walking)	**7.5** (3.5 min walking)	**10** (1 min walking)	**0** (isolated)	**7** (4 min walking)	**9** (2 min walking)	**7** (4 min walking)	**7.5** (3.5 min walking)	**8.5** (2.5 min walking)	**5** (up of 6 min walking)	**6** (5 min walking)	**0** (30 min by vehicles)	**5** (up of 6 min walking)
Daily commercial	7.5	10	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	0	7	7.5	7	7.5	7.5	5	6	0	5
Mixed-uses	8	7.5	10	7.5	8	8	8	8	7.5	8	0	7	8	7	7.5	8	5	6	0	5
Craft shops	7.5	7.5	7.5	10	7.5	7.5	7.5	7.5	7.5	7.5	0	7	7.5	7	7.5	7.5	5	6	0	5
Religious	8	7.5	8	7.5	10	8	8	8	7.5	8	0	7	8	7	7.5	8	5	6	0	5
Social/ Cultural	8	7.5	8	7.5	8	10	8	8	7.5	8	0	7	8	7	7.5	8	5	6	0	5
Medical	8	7.5	8	7.5	8	8	10	8	7.5	8	0	7	8	7	7.5	8	5	6	0	5
Recreational/ Open spaces	8	7.5	8	7.5	8	8	8	10	7.5	8	0	7	8	7	7.5	8	5	6	0	5
Daily services	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	10	7.5	0	7	7.5	7	7.5	7.5	5	6	0	5
Parking spaces	10	7.5	8	7.5	8	8	8	8	7.5	10	0	7	9	7	7.5	8.5	5	6	0	5
Polluting Activities	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Educational Service	7	7	7	7	7	7	7	7	7	7	0	10	7	7	7	7	5	6	0	5
Pre-educational Service	9	7.5	8	7.5	8	8	8	8	7.5	9	0	7	10	7	7.5	8.5	5	6	0	5
Security Services	7	7	7	7	7	7	7	7	7	7	0	7	7	10	7	7	5	6	0	5
Administrative	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	0	7	7.5	7	10	7.5	5	6	0	5
Hospitality Activities	8.5	7.5	8	7.5	8	8	8	8	7.5	8.5	0	7	8.5	7	7.5	10	5	6	0	5
Non-daily Commercial	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	10	6	0	5
Public transport stations	6	6	6	6	6	6	6	6	6	6	0	6	6	6	6	6	5	10	0	5
Utilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
Storage Areas	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	5	6	0	10

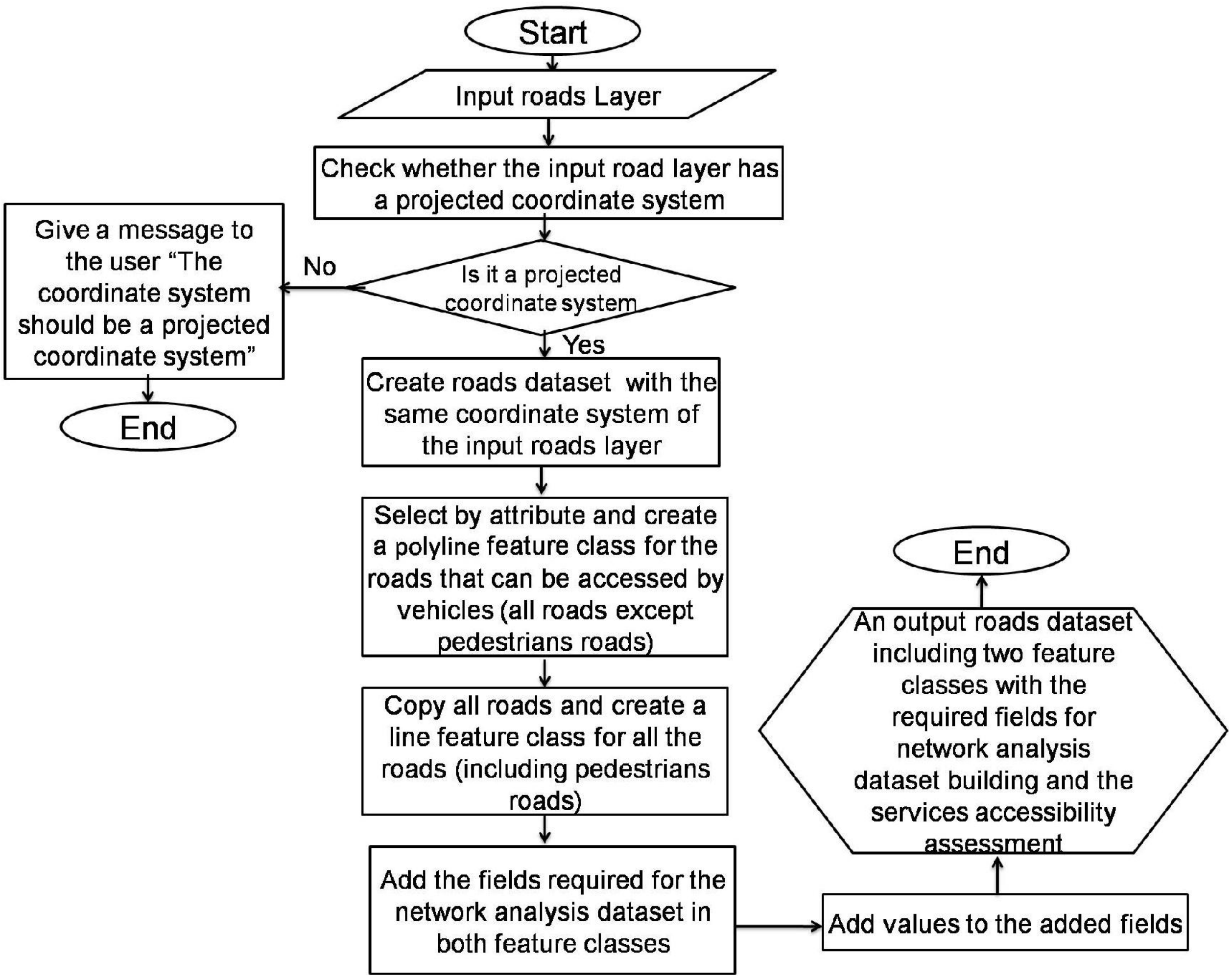
Source: by own based on the previously illustrated methodology

(8.4) Modelling the Assessment Model as “Land-use Sustainability Analysis” Tool box (the Flow Charts for each Tool):

The following present the flow charts for each tool within the developed toolbox:

(8.4.1) Data Preparation Tool:

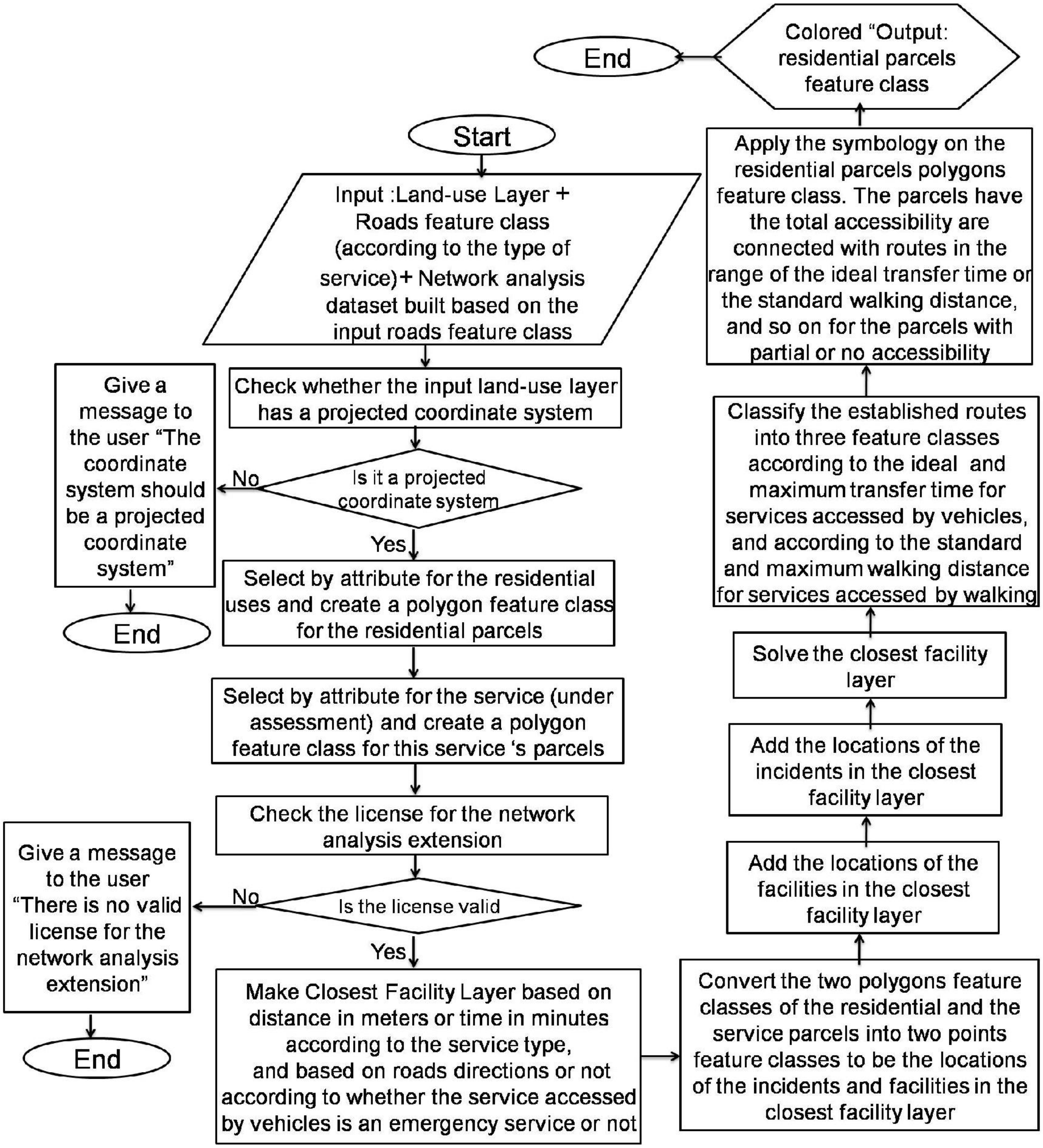
Fig. (8.13)The flow chart for modeling the data preparation tool



Source: by own

(8.4.2) Services Accessibility Tool:

Fig. (8.14) The flow chart for modeling the services accessibility tools[24]

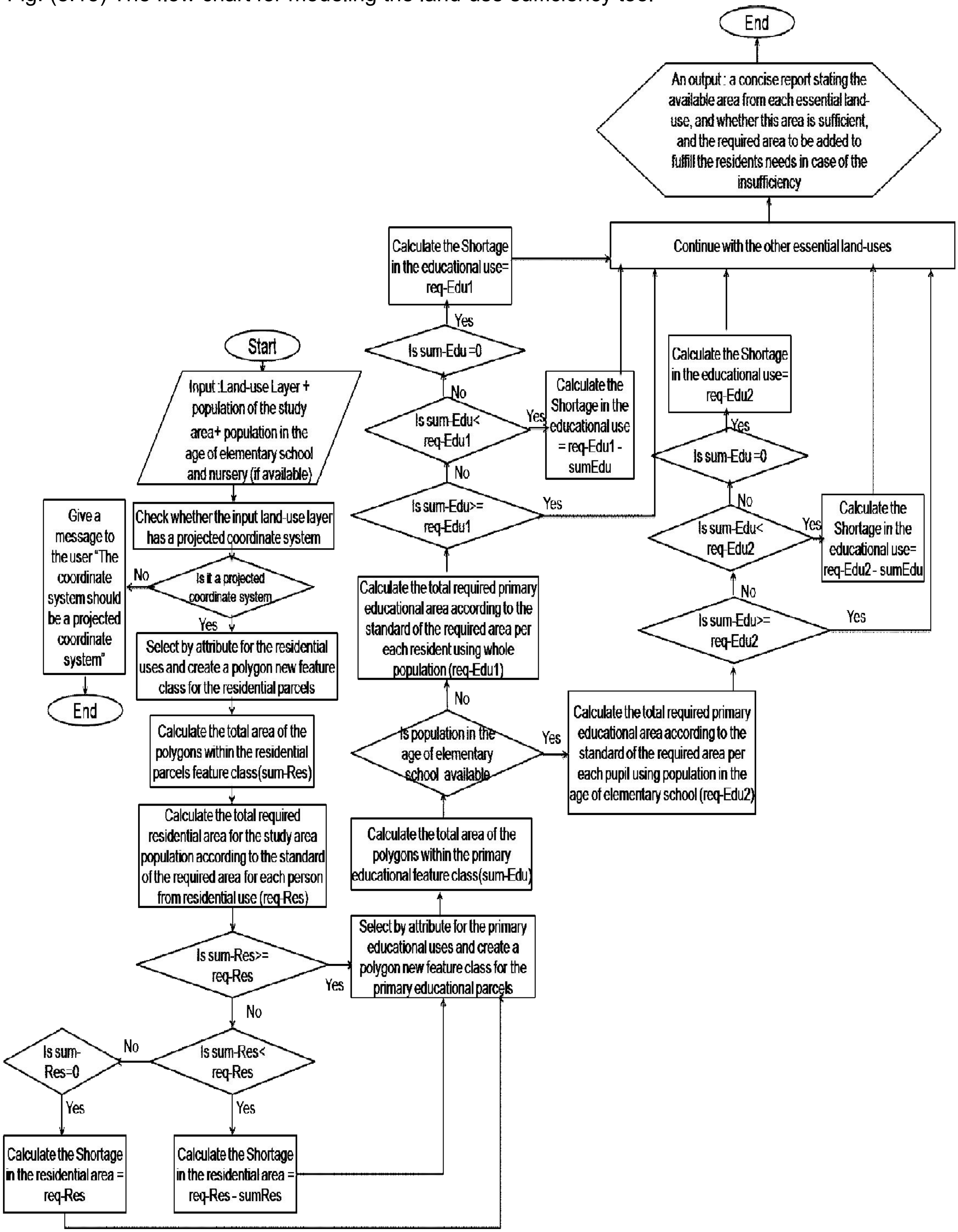


Source: by own

[24] As mentioned before there are two assessing criteria used by services accessibility assessment tools. The first is for evaluating the accessibility by vehicles to services (either emergency or non-emergency). The second is for evaluating the accessibility by walking to services. The shown flow chart of service accessibility clarifies the idea of how these tools work in a general manner.

(8.4.3) Land-Use Sufficiency Tool:

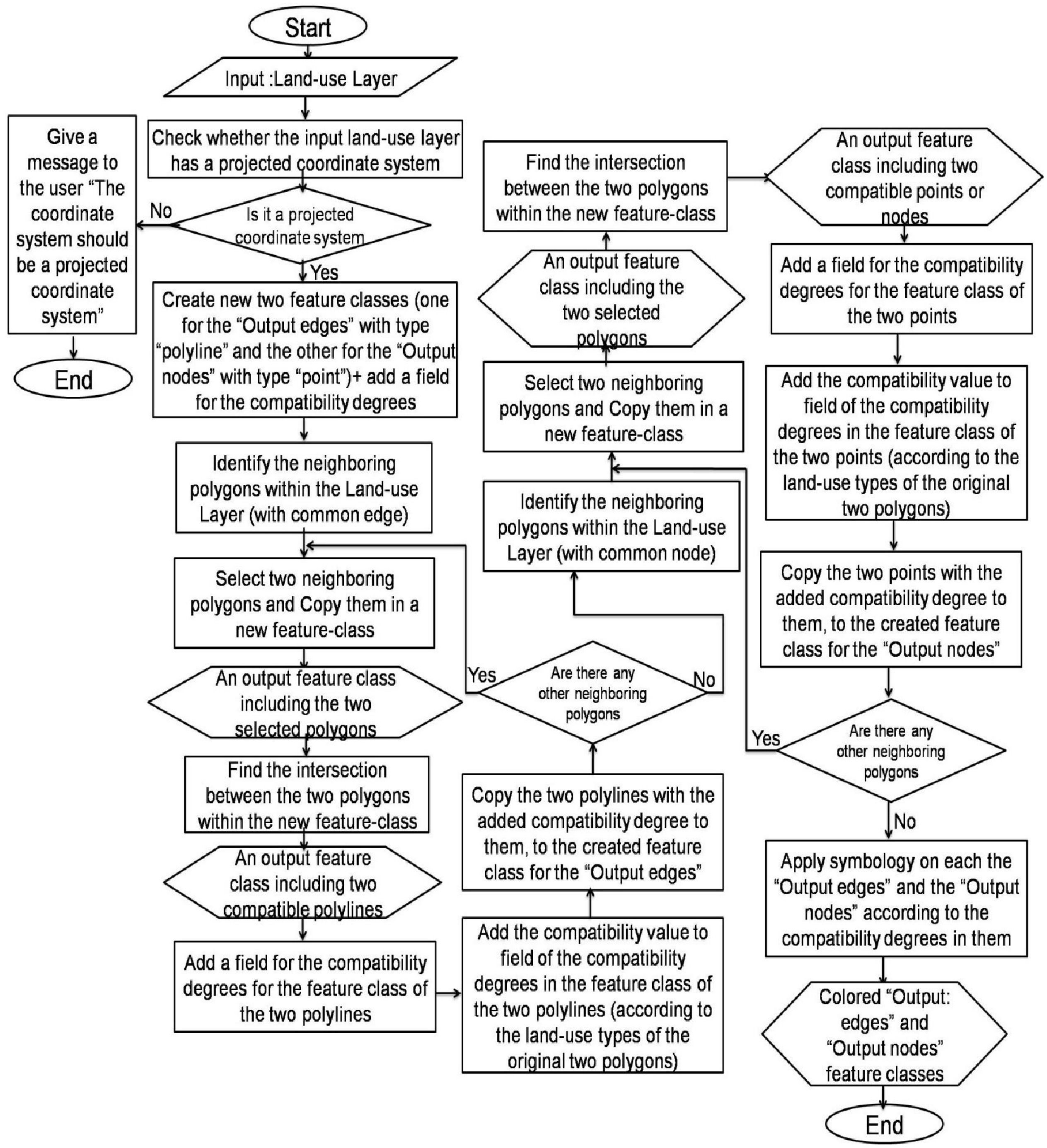
Fig. (8.15) The flow chart for modeling the land-use sufficiency tool



Source: by own

(8.4.4) Land-Use Compatibility Tool:

Fig. (8.16)The flow chart for modeling the land-use compatibility tool



Source: by own

(8.5) The Advantages of "Land-use Sustainability Analysis" Toolbox:

The developed toolbox has general advantages in all its script tools, in addition to specific advantages in each script tool. This shows how beneficial this toolbox is. However, there are also some disadvantages in the toolbox, which are the focus of the future upgrades of it, which are mentioned in chapter 10.

(8.5.1) General Advantages:

There are general advantages, which are common in all the script tools within the toolbox:

- The toolbox can be established within other GIS software (than ArcGIS™) that use Python language in geo-scripting like Quantum GIS- QGIS software, which has the advantage of being open source software.
- The toolbox can not only assess an area or a part of the city, but also it can assess a whole city in one time in case that it is a medium or small city with uncomplicated transport modes. As the service accessibility tool will assess the accessibility of each residential parcel to the closet services. And the land use compatibility tool will assess the relations among the attached land-uses. Also, the land use sufficiency tool will assess the sufficiency of the essential land-uses for all the residents.
- The toolbox can be applied on other urban areas (other than residential areas), e.g. city center and industrial areas.
- Its results can be easily understood by non-expert people in urban planning.
- It can be applied to analyze current or suggested (planned) land-use structure.
- It is flexible to any language of the data entry.
- It is flexible to any country standards, as the toolbox is provided by default values for the required areas of the essential land-uses, the ideal and maximum distance or time for accessing various services (according to the German standards). At the same time, the user can put the standards of the country, in which the study area is located.
- It is flexible to any layer type of the input land-use map (as a feature class or shape-file[25]) for each of the land-use sufficiency, land-use compatibility, and services accessibility tools. It is also flexible to any layer type of the input roads network (as a feature class or shape-file) for the data preparation tool. However, for the services accessibility tool, the input roads layer should be one of the two feature classes, which are within the feature dataset, which is prepared by the data preparation tool.
- The tools within the toolbox check the appropriateness of the coordinate system of the entered feature class or shape file, as it should be a projected coordinate system (with length units), not a geographic coordinate system (with degrees units). This is in order to have values in the shape length and shape areas fields.

[25] There are aspects of similarity between feature classes and shape-file, both include a group of features with the same spatial type (e.g. points, lines, or polygons) and the same data type in the connected attribute table. The main difference is that feature classes can be stored directly in geodatabases or within a feature-dataset inside geodatabases, whereas the shape-file is always stored within a file folder. And so, there are potentials in geodatabases storge, which are not available for shape-file, like domains and topologic relationships.

(8.5.2) Advantages in the Services Accessibility Task:

- It is not important to have a good background in Network Analyst extension[26] to use this task. As it helps those who are not expert with “Network Analysis” extension by preparing the entered roads feature class or shape-file in the form of roads dataset with the required fields for building the network dataset -ND through the “Data preparation” tool. Then, the user has only to build the network dataset. After that, one of the services accessibility tools will complete the task. So, the user will not have to choose the suitable type of the network analysis layer according to the type of service (e.g. closest facility, best route, service area, etc.).
- This task guarantees realistic results through:
  – Considering both the vehicles roads and non-vehicles roads, (i.e. pedestrian roads, ladders, etc.). This is to avoid any illogic routes to services by confirming that the routes, which are suggested to access services using vehicles are based on actual vehicles roads.
  – Considering the roads hierarchy, (if its data is given by the user).
  – Considering the roads directions, (one-way streets or two-ways streets). However, the roads directions are not considered in case of evaluating the accessibility to emergency services, as the emergency vehicles are free to obey the roads directions’ rules. (ArcGIS™ Help: “Closest facility analysis- Restriction”, 2017).
- The services accessibility tools can be flexibly applied on any other service types than the six essential services types for the residential areas (e.g. post offices or gas stations). This is through just identifying the way to access the service (by walking or vehicles), so that the user builds the network dataset based on the appropriate feature class from the two feature classes within the feature dataset (the “data preparation” tool output). Then, the user selects the service nomination in the parameter concerning the land-use type in the service accessibility tool, and identifies the standard value for the ideal and the maximum (time or distance) for this type of service.
- The user can evaluate the accessibility to the daily-needed commercial services in general or according to each category in these services. The services accessibility tool can separately evaluate each category of the daily-needed commercial services in each time (e.g. food shops, pharmacies, and bakeries) in order to get more accurate and realistic results.

(8.5.3) Advantages in the Land-Use Sufficiency Task/Tool:

- This tool can be flexibly applied on other land-uses types than the seven previously mentioned land-uses types (e.g. parking areas). This is through identifying each the land-use nomination, the default value for the required area per person in square meter (according to the country planning standards). These are in addition to the number of the

[26] The ArcGIS™ Network Analyst extension supports the identification of answers for questions regarding roads and transportation. For example, identifying the quickest route to move between two points, houses within 5-minutes driving from a fire-station, the nearest store branch, and etc. (ArcGIS Desktop website:”What is Network Analyst Extension?”, 2017)

residents, who will need this land use (either the whole residents or definite category of them).

- This task can not only evaluate the sufficiency of a land-use type. It also identifies the required area that is needed to be added from this land-use type to fulfill the population’s needs.
- It is flexible for the presence or the absence of any type of the seven essential land-use types. As the tool will calculate the area required for each type, even it is already not existed in the study area .
- There is no need for identifying the number of floors in each land parcel for calculating the sufficiency of each land-use type. As the default standards in the land-use sufficiency tool, are based on the land area, as the tool does not require the number of floors.
- It is flexible for the presence or the absence of the data regarding various age categories population for the residents of the study area, (i.e. the number of residents in the age of the nursery or the primary education services). As sometimes this type of data is not available for the user. So for this case, the tool is already provided with default values for the minimum required area from each type of these two services, with regards to the whole population of the study area (according to the German standards). This is beside the default values for the minimum required area for each actual user for services, (e.g. pupil, child, etc.). These default values can be also easily re-adjusted by the user to any standards of any country.

(8.5.4) Advantages in the Land-Use Compatibility Task/Tool:

- There are 20 various land-use categories available by this tool to cover any probable land-use type. This also allows the user to consider any land-use type within any category of the 20 categories according to the planning concepts of the country, in which the study area is located. Examples:
  – The cafes can be considered as social or as cultural activities in one country, or as commercial activity in other country, and so on. So that, the user can select the category of each land-use type according to his/her vision.
  – The cemetery can be considered as an undesired use according to the planning concepts and culture of some countries like Egypt . However, the cemetery can be considered within the open spaces areas according to other countries planning concepts and culture like Germany.
- This task can deal with mixed-uses in the land-use structure according to the user vision. As the user can consider the land-use type of the multi-use land parcel as:
  – Definite land-use category from the available land-use categories in the tool according to what is planned for this land parcel in the future.
  – Or as the dominant land-use type in this multi-use parcel.
  – Or as mixed use category in general.
- It is flexible for the presence or the absence of any land-use category in the study area. The tool also considers the probability of the presence of undesired or polluting land-use types.

- This tool is designed in the way that avoids double selection. When the user selects definite value(s) as a land-use category (e.g. residential category) from the land-use values list within the study area, the selected value(s) will disappear from this list in the other land-use categories, unless this or these values is/are unselected from the previous categories. This is to avoid double selection of any values as two land-use categories, and to avoid missing any land-use values without identifying a category for it.
- It can assess not only the relation between land-uses with common edge, but also it considers the relation between land-uses that have common node or vertex. As even having only common node, this will cause the impact between the land-uses especially if one of these land-uses is a polluting activity.

(8.5.5) Disadvantages in the Tools of the Toolbox:

- Land-use compatibility tool cannot analyze the compatibility between land-use types in any two land parcels, in case that these land parcels are not attached. So if there is a polluting activity that its land parcel has no common edge or node with other parcels, the tool will not be able to detect the lack of compatibility resulted by this polluting activity. However, this can be overcome by converting all the spaces like streets between parcels into polygons through making buffer around the streets lines, so that all the land-uses are placed into attached polygons.

  Also in case of mistakes in drawing the land-lots polygons like having gaps in-between, there will be no common edge or node, and so the compatibility cannot be analyzed. Therefore, it is recommended to check on these mistakes using the Topology[27] function in ArcGIS™ before applying the tool.
- Land-use compatibility tool needs a lot of time to analyze the compatibility degree between each two attached land parcels with common edge or node, especially in large study areas that include a large number of attached land-lots.
- The service accessibility tool cannot work properly in case of mistakes in drawing the roads network like two roads are seemed to be intersected, but with zooming, it is clear that they are actually not intersected. As the roads should be intersected, and have two compatible vertices in the intersection, otherwise this tool gives misleading results to some extent. So (as previously mentioned for the land-use compatibility tool) it is recommended to check that, by using the Topology function in ArcGIS™ before applying the tool.

(8.6) Reflection:

This chapter browses the development of the toolbox “Land-use Sustainability Analysis”. An assessment model from the comprehensive proposed SPSS in this research was selected to be developed as a new toolbox performing a new function in the GIS software ArcGIS™. The comparison between the proposed SPSS and the assessment model shows that the model (or

[27] Topology is a group of rules, which are accompanied by some editing tools and techniques that give more accuracy in the geometric relationships of features (points, polylines, and polygons) drawn in the feature classes within geodatabase (ArcGIS Desktop website: “Topology Basics”, 2017).

the established toolbox) is like a minimized version or a prototype from the proposed comprehensive SPSS in this dissertation.

The methodology for identifying the predefined criteria for all the tools within the toolbox is illustrated in details, as well as the modelling process these tools, which are the flow charts for the work of each tool. The design concepts, input, output data, and guide for the tools are explained. And so, the advantages and disadvantages of the toolbox are discussed. However, it is clear that there are few disadvantages with regards to the number of advantages. The next chapter presents the application of this toolbox on two study areas (German and Egyptian).

Chapter 9
Applying the Developed “Land-use Sustainability Analysis” Toolbox on German and Egyptian Study Areas

(9.1) Introduction:

In the previous chapter, each of the development process and the assessing criteria of the “Land-use Sustainability Analysis” toolbox are illustrated. In this chapter, the main focus is on the application of the developed toolbox on two German and Egyptian study areas. Firstly, an introduction to the German planning system is presented. Then, a comparison between the planning and administration systems in Germany and these systems in Egypt, (which are illustrated before in chapter 7). Then, the results of applying the toolbox on the two areas are presented. And so, the conclusions and recommendations regarding the two areas are identified.

The researcher visited the two study areas, the Egyptian area was visited on August 2016 and March 2017, the German area on August 2017. These visits gave impressions on each of the urban pattern, main characteristics, and main problems in the study areas. The purpose of the dissertation is to present the planning support tools or systems as assistants for planners. However, the planner should interact with the areas proposed to planning or assessment and not just work from the office to produce feasible applicable plans.

(9.2) Introduction to Planning System in Germany and Comparison between the Planning and Administration Systems in Germany and Egypt:

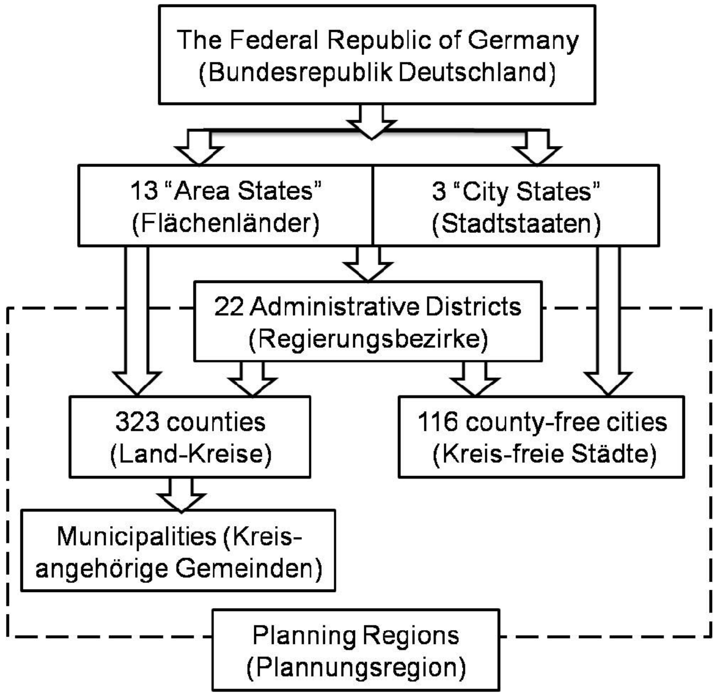
As chapter 7 in this thesis introduces the planning and administration system in Egypt, so before applying the toolbox on the two study areas (German and Egyptian). There should be an abstract introduction on the planning and administration system in Germany.

(9.2.1) Administration Division in Germany:

There are three main administration levels, on which each of the legislature, executive, and judiciary powers are separated within the constitutional structure and the governance system in Germany. These levels are the federal level for the whole country, the state level, and the local government or the local administration level (Pahl-Weber and Henckel 2008, p.18,19).

The federal republic of Germany (Bundesrepublik Deutschland) is composed of 16 states (Länder), which are divided among 22 administrative districts (Regierungsbezirke). There are two types of states. These are 13 “area states” (Flächenländer), which are states that are composed of more than one city, and 3 “city states” (Stadtstaaten) , which are states that are composed of only one big city. These “city states” are Berlin, Hamburg, and Bremen, and they include 116 county-free cities (Kreis-freie Städte). The 13 “area states” include 323 counties (Land-Kreise), which include a group of municipalities or communities (Gemeinden). The municipalities are considered the smallest unit within the local official administration division in Germany. (Pahl-Weber and Henckel 2008, p.13).

Fig. (9.1) The German administrative divisions



Source: Pahl-Weber and Henckel 2008, p.13

(9.2.2) Planning levels in Germany with the Trend Towards Decentralisation and Attaining Social Equity:

The planning levels differ from the aforementioned three administration levels of federal structure of Germany. As there are four planning levels in Germany, on which the main actors in the planning process work. These planning levels are federal spatial planning, state spatial planning, regional planning, and local planning (Pahl-Weber and Henckel 2008, p.39).

The main actors in the planning process are the federal government, the 16 state governments, 114 planning regions (Plannungsregion), and about 14,000 municipalities. The decision-making within this process is done in a decentralized way through a strong framework supported by the basic law or the constitution (Grundgesetz). As the federal government does not perform the spatial plans, but sets the comprehensive national framework. This is guarantees the consistency among the planning process on the other three lower planning levels (state, regional, and local planning). So, the states, regions, and municipalities are considered the actual planning actors (Schmidt and Buehler 2007, p,57).

One of three main goals of the comprehensive national framework of spatial planning, which were set by the federal government is the social equity beside the sustainable spatial development and the strengthening of the regional resources. (Federal Office for Building and Regional Planning 2001, p.5). This goal is supposed to be achieved through various planning levels. The social equity is defined according to the German constitution as equality in the accessibility to infrastructure, services, and opportunities among people in Germany. This was spatially translated into definite policies supported by the federal spatial planning law of the year 1965. These policies are the focusing on remote rural areas and the provision of funding for services and infrastructure to the central located cities according to their “urban hierarchy rank”.

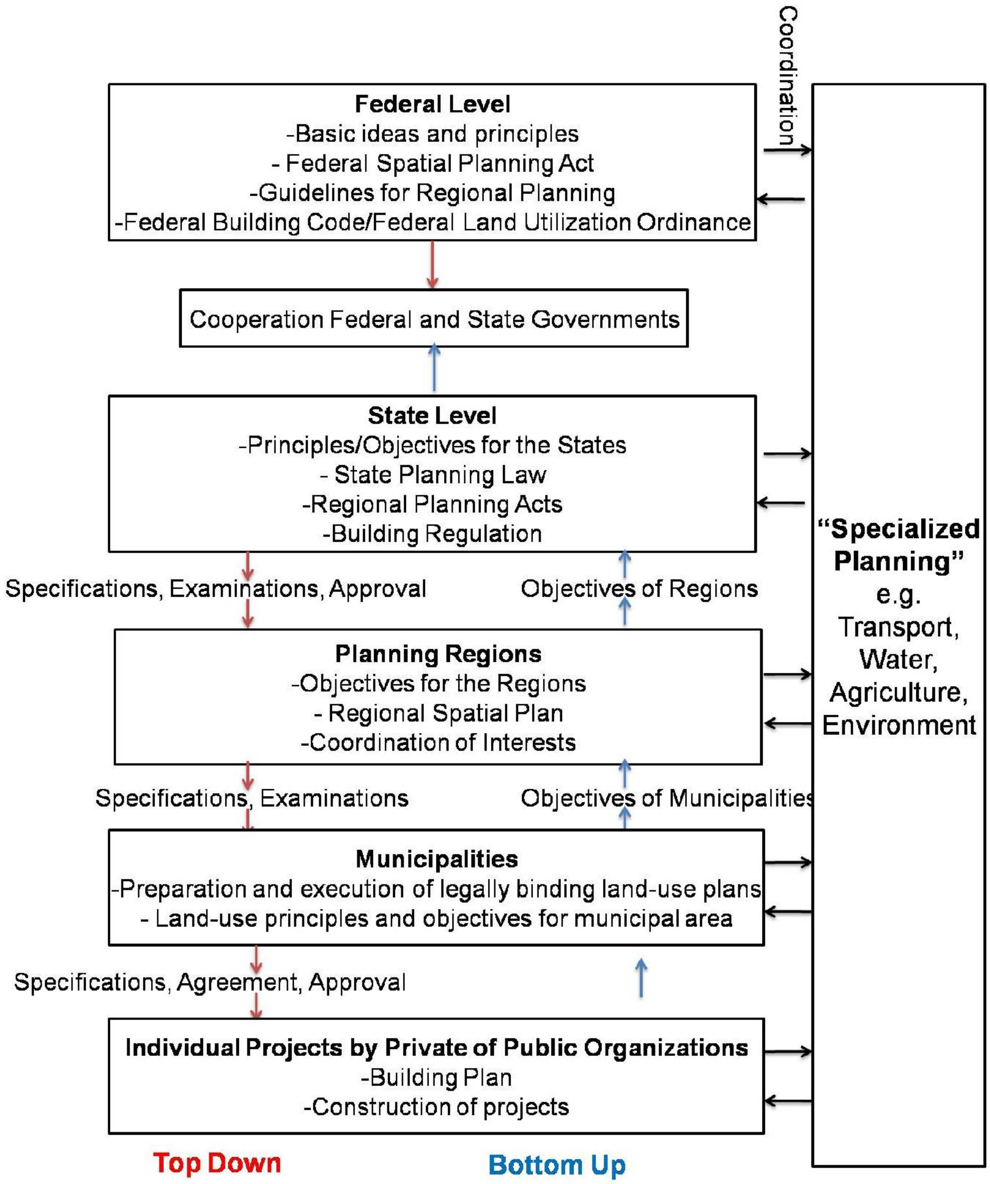
This is the extent of the serving coverage of each central located city for the surrounded municipalities. (Schmidt and Buehler 2007, p,61).

(9.2.3) Counter-current Principle in the German Planning System:

The spatial planning in Germany is based on what is called “the counter-current principle” (Gegenstromprinzip). This principle includes two directions for managing the planning process all over various levels in Germany. The top-down direction, in which the adjustment or the controlling proceedings are done from the higher planning levels to the lower ones, so that the plans on the lower levels are within the goals and objectives identified by the higher ones. And the bottom-up direction, in which inputs are presented from the lower planning levels to the higher ones, as the public agencies and the sectoral planning are involved in the planning process along the planning levels. (Pahl-Weber and Henckel 2008,p.40).

The next figure shows how the planning process is managed in a reciprocal way among the institutions of various levels through the counter-current principle. The municipalities’ interests are represented at the regional level, and the regional institutions give input to the plans on the state level. The state ministries are responsible for identifying the federal planning guidelines and visions. So, the responsibility and detail degrees of plans are higher in case of local government or lower planning levels. There are also specialized institutions like ministries for transportation, which coordinate in the planning system on various levels. This is through providing inputs regarding sector plans in the spatial plans to be integrated by the planning institutions within the spatial plans formulation. (Schmidt and Buehler 2007, p, 57,58)

Fig. (9.2) Counter-current principle in the German planning system



Source: Schmidt and Buehler 2007, p. 58.

The counter-current concept is supported by normative regulations. For example, there are articles in the building code[1], which condition that the local land-use plans are committed to attain the comprehensive spatial planning goals through the counter-current concept application among various planning levels. This is to avoid contradiction in the planning process, and support the execution of the guiding principles within the German planning system. (Pahl-Weber and Henckel 2008, p.40).

(9.2.4) Organizing Regulations and the Institutions Involved within Various Planning Levels in Germany:

[1] One of the regulations organizing the local planning level.

There is a difference between the nature of the planning process on the three higher planning levels (federal, state, and regional levels), and the lowest planning level (local level). The planning process on these three higher levels is a spatial planning process (Raumordnung), whereas the lowest planning level is a land use planning process (Bauleitplanung). (Schmidt and Buehler 2007, p.57). Both processes have definite tasks, as will be illustrated.

(9.2.4.1) Organizing Regulations for Various Planning Levels in Germany :

The most significant planning regulations are divided into two types:

First. regulations for spatial planning process on the three higher planning levels:

The regulations controlling the spatial planning process on the three higher planning levels include the federal spatial planning act “Bundes-Raumordnungsgesetz” (1965), state spatial planning acts, and regional planning acts. These also guide the formulation of “the spatial planning” report. This report is prepared by the federal office for building and regional planning “Bundesamt für Bauwesen und Raumordnung” (BBR) to be presented to the German parliament. It provides an overall view for each of the spatial development and spatial planning process, as well as the spatially effective sector planning. (The website of the German law archive, 2017).

Second regulations for land-use planning process on the lowest planning level:

These regulations include the federal building code Baugesetzbuch-BauGB (1960), land utilization ordinance (Baunutzungsverordnung-BauNVO (1962), and plan notation or symbols ordinance Planzeichenverordnung (1965).(Pahl-Weber and Henckel 2008, p.41). These regulations are within the the urban development law. (Figure of “structure of the planning law” Pahl-Weber and Henckel 2008, p.60). These regulations organize the land-use planning process on the local level of the municipalities. (Pahl-Weber and Henckel 2008, p.41).

(9.2.4.2) The Institutions Involved within Various Planning Levels in Germany:

Before stating the institutions that affect and are involved in each planning level, it is worth to mention that the spatial development process in Germany is affected by citizens and businesses bodies through their interests and activities. As people identify the areas’ structure through selecting the places to live, work, buy, and have their recreation activities. Businesses and investment activities also affect the spatial development through their decisions regarding locations and the investment types. The federal government, the states, and the municipalities identify the locations of the administrative, services, and infrastructure facilities, which also affect the decisions of citizens and businesses bodies regarding the housing and work locations. (Federal Office for Building and Regional Planning 2001, p.3). So, it is like a reciprocal relation between the citizens and businesses bodies on the one hand, and the governmental decisions on the other hand.

The following illustrates the tasks performed by each planning level in Germany and the institutions involved in each level:

1. Federal spatial planning: mainly formulates the guiding and legal principles for the state spatial planning. It also controls the public investment activities and the sectoral planning, which should be coordinated within the spatial planning process on its various levels according to the structural national and regional policies. Furthermore, it formulates the criteria for effective spatial and infrastructural development to attain equity in the living conditions all over the country’s states. This is supported by the federal spatial planning act that conditions the

involvement of the states in state spatial planning process through the state spatial planning acts. These acts execute the guiding principles of spatial planning in each state according to its circumstances. (Pahl-Weber and Henckel 2008, p.38,39).

The most recent guiding principles of the spatial development process of the federal government and states were released in March 2016 within the ministerial conference of spatial planning. These strategic guiding principles are represented in the supporting of competitiveness, protecting public services, manage and preserve the sustainable use of space, facing the climate change, as well as the regeneration for energy. (The website of the federal ministry for transport and digital infrastructure, 2017).

The institutions in charge of the federal spatial planning are the federal and state ministers within the aforementioned ministerial conference. (Pahl-Weber and Henckel 2008,p. 41).

2. <u>State spatial planning</u>: supports the implementation of the aforementioned guiding principles of spatial planning on the state level. The main task for the state spatial planning is to attain the balance between the goals and principles of national or federal spatial planning and the activities of the local government planning. This is called a “mixed top-down/bottom-up” planning system, so that the urban land-use planning of the local level not only harmonizes with the state spatial planning’s development goals, but also supports them. This is to avoid wrong decisions in the planned investments. (Pahl-Weber and Henckel 2008, p.38,39).

The institutions in charge of the state spatial planning are state governments. (Pahl-Weber and Henckel 2008, p. 41).

3. <u>The regional planning</u>: focuses on the regions (subdivisions of a state). It is considered the connection point between state spatial planning and local urban land-use planning. So, the regional planning should adapt with the federal and state spatial planning (Pahl-Weber and Henckel 2008, p. 39,40).

The main tasks performed through the regional planning are the integration among the sectoral planning fields and execution of the state spatial planning goals. (Pahl-Weber and Henckel 2008, p. 39). The regional planning also coordinates among the public interests of each region regarding the land-use issues of the areas outside the municipal boundaries in it, as well as the special interests of local authorities inside this region regarding these areas. (The website of COMMIN-Germany 2017, p.46)

According to the federal spatial planning act, the regional planning should offer consultations for the authorities of the urban land-use planning and planning agencies (public and private). It also performs the updating of each of the state spatial development plan and the development plans for the state sectors. These are in addition to studying the development problems within regions, in the light of the local government planning, as well as the balance among the projects (that are on higher level than regional level) with the needs on the regional level and other tasks. (The website of COMMIN-Germany 2017, p.46).

The institutions in charge of the regional spatial planning are the counties councils. (Pahl-Weber and Henckel 2008,p. 41).

4. The local land use planning is the lowest planning level, which is responsible for the land-use regulations for building purposes and other land-uses (Bauleitplanung) according to the guiding principles. (Pahl-Weber and Henckel 2008, p.38,39). The local level has the strongest power to implement planning in Germany. This planning level (especially the city land-use planning) is the focus of this dissertation, so the cities land-use planning or the local urban land-use planning in Germany will be illustrated in details in the next point.

(9.2.5) Cities or Local Urban Land-use Planning in Germany:

The local planning works on the municipalities (cities or villages). The municipalities are independent self-government according to the German constitution. The municipalities work according to a solid political, economic, and administrative planning system, which depends on the coordination among various governmental levels. So, this means that all decisions regarding the land-use planning and economic issues are done within a regional, state, or national framework, and not taken directly according to the local situation in the municipalities. (Schmidt and Buehler 2007, p. 63). This is the counter-current principle, which is adopted in the whole German planning system, as previously illustrated.

The local urban land-use planning is controlled by the federal building code. The main task of urban land-use planning is the identification and controlling of the land and building uses. (Pahl-Weber and Henckel 2008, p. 42). This in order to attain the sustainable urban development through the social equity in using the land for the common benefit of the community with the consideration of the environment protection and the urban cultural heritage preservation. This is because the local urban land-use planning is considered the most effective and significant level for the execution of spatial planning requirements. (Pahl-Weber and Henckel 2008, p. 43).

The local urban land-use planning is subdivided or carried out on two levels, which are preparatory and binding land-use planning. The preparatory land-use plan deals with general land uses like residential, commercial, and industrial uses, whereas the binding land-use plan deals with land uses like special residential areas and rural areas. (Pahl-Weber and Henckel 2008,p. 55).

(9.2.5.1) The Preparatory Land-use Plan (Flächenutzungsplan – FNP):

The preparatory land-use plan identifies the land-use types for the whole area in the municipality proposed to planning. The development areas within planned municipalities may include general land-use types or specific land-use types. Examples of general land-use types are services, infrastructure, transport facilities, utilities, and recreation areas, which include specific land-use types like green and open spaces, sports areas, restricted environmental protection, and others. (Pahl-Weber and Henckel 2008,p. 54).

(9.2.5.2) The Binding Land-use Plan (Bebauungsplan – B-Plan):

It is a more detailed and specific land-use plan than the preparatory land-use plan. It deals with only the areas that are planned to have growth or extension. The binding land-use plan should agree with the preparatory land-use plan, and it is connected with private landowners. It identifies the detailed specifications for construction activities like building’s height, the percentage of the built area within the land lots, and withdraw distances of the buildings in the land lots. Like this, the municipality can control the development process within these extended areas. (Schmidt and Buehler 2007, p.64).

The binding land-use plan also identifies the obligatory regulations for land-uses types, the development type, the locations of traffic areas, service areas, waste disposal and drainage areas, special urban development regulations, and others. (Pahl-Weber and Henckel 2008, p. 54, 55).

(9.2.6) Comparison among the Planning and Administration Systems in the Two Countries:

The scale of the planning region is one of the main differences between Egypt and Germany. Germany includes 114 planning regions, which is considered a large number of planning regions with comparison to Egypt (7 planning regions). This is because of the difference in the concept of the planning regions among the two countries. In Egypt, the planning region includes two or more governorates (states), whereas in Germany, the state includes many planning regions. Therefore, the regional strategic planning in Egypt is higher and with a bigger scale than the governorate planning (see Chapter 7). In contrast to Germany, the state spatial planning is higher than the regional planning.

In the following table, some of the main differences among the planning and administration systems in Egypt and Germany are presented:

Table (9.1) Comparison among the planning and administration systems in Egypt and Germany:

Comparison Points	Egypt	Germany
1.Administration division	- Urban governorates: the governorate is one city divided into districts. - Rural governorates: the governorate includes some markaz including one or more cities and villages. - Mixed governorates: the governorate includes some markaz (including one city and villages) and one city (including districts).	- Area states (Flächenländer): the state includes some counties including municipalities. -City states (Stadtstaaten): the state is one city that includes some county-free cities.
2.Planning levels	- National strategic planning. - Regional strategic planning. - Governorate strategic planning. - Master strategic plan for cities or villages and the detailed planning for areas.	- Federal spatial planning. - State spatial planning. - Regional planning. - Local planning level (Preparatory land-use plan and Binding land-use plan).
3.Planning on the local level	Physical community (city or village): It is the most effective planning level with direct tangible impacts	Municipality (city or village): It has the strongest power to implement planning.
4.Planning of areas within cities	Detailed land-use plan	Binding land-use plan
5.Coordination among various planning levels	Not supported by law (Despite it is stated in the law that each planning level should be within the framework of the higher level of it (Article 2 Law119, p.3,4), there are no executive regulations for applying that).	Supported by law through the counter current principle.

Comparison Points	Egypt	Germany
6.Management of the planning process	Centralization attitude: All the institutions affecting the physical development are centrally managed (including the GOPP). As all the related branches or administrations of these institutions in the lower geographical levels are just executors for the central visions and polices. The centralization is the general political attitude in Egypt in all fields (not the physical planning field only).	Decentralization attitude: according to the counter-current principle. Planning process is managed in a reciprocal way among the institutions of various levels through top-down direction in which the adjustment or the controlling proceedings are done from the higher planning levels to the lower ones, and the bottom-up in which inputs are presented from the lower planning levels to the higher ones.
7.Public involvement in the planning process	Represented in the citizens sharing in various stages of plans formulation (on local planning level). Examples: -The public meetings with stakeholders and the importance of their agreement on each of the legal construction boundary and the master plan. - The negotiations with the land owners for allocating many suggested new facilities inside the new city’s boundary, which require the donation of some lands by their owners.	Represented in the citizens‘ influences in identifying the areas’ structure through selecting the places to live, work, buy, and have their recreation activities. However, there is a reciprocal relation between the citizens and businesses bodies from the one hand and the government decisions from the other hand.
8.Coordination with services sectors affecting the physical development process	There is no actual coordination between the GOPP and various ministries affecting the physical development. As these ministries plan independently for projects that affect the development and the GOPP just takes these projects into consideration when performing any city plan. However, these ministries are involved in the cities' planning process as stakeholders in the public meetings, but this does-not lead to commitment from these ministries to execute projects suggested in plans.	Sector plans (Fachpläne) are performed independently from spatial plans by specific ministries like ministries of water and energy. Then, these sector plans are integrated by planning authorities in the spatial plans. (Schmidt and Buehler 2007, p.57,58).
9.Transport and planning	Two independent ministries in Egypt (ministry of housing and physical development and ministry of transport).	One federal ministry for transport, building, and housing is the authority that concerns with spatial planning process in Germany. (Federal Office for Building and Regional Planning 2001, Foreword page).

Comparison Points	Egypt	Germany
10.Current regulations organizing the planning and development processes	There is one comprehensive general law for all Egypt’s governorates that concerns with the physical planning, construction activities, and urban design. This is the unified construction law (act no. 119 for the year 2008) and its executive regulations (activated on May 2009). However, there are laws that indirectly affect the physical development process like the law of the architectural heritage preservation.	Two main laws (including acts according the state): -The spatial planning law (federal, state, and regional levels).It includes the federal spatial planning act, state spatial planning acts, and regional planning acts. -The public building law (on the local level of the municipalities). It includes: 1. Planning law (urban development law), which includes the federal building code, the land utilization ordinance, and other additional regulations. 2. Building regulations that include the building control law and the building regulations of the states. (Figure of “structure of the planning law” Pahl-Weber and Henckel 2008, p.60).
11.Environmental impact assessment in land use planning	The environmental law (act no. 9 of 2009) is one of the laws that affect the physical planning process with an indirect way. As its articles are not obligatory in the planning procedure organized by the unified construction law.	The modifications in the federal building code (2001, 2004) have conditioned the environmental impact assessment to be applied on the binding land-use plans as a specialization of the Building Code (Pahl-Weber and Henckel 2008, p.38).
12.Challenges	- Spatial problems in the existing communities. - Mismanagement of the physical development process. -Financial and political centralization	- The inequality among various locations in Germany in aspects of income, employment and growth, because of the economic restructuring and the East and West union. - Changes in environment policy are needed to integrate with the European Union (Schmidt and Buehler 2007, p.66)

Source: by own (based on the previously stated references).

The previous table shows that there are three common points between planning system in Germany and Egypt. These points are the planning levels, the scale of the local planning level, and its effectiveness on the planning system, as well as the adoption of the detailed planning (on parcel level) for planning the cities’ areas. The public influence on the planning process exists in both countries, but with different ways.

However, the main differences between planning systems in Germany and Egypt are represented in the coordination among various planning levels, which is supported by law in Germany, but it is not the case in Egypt. Also, the management of the planning process is centralized in Egypt, unlike Germany that adopts a general decentralization policy in most of fields. This is in addition that the coordination with services sectors within the planning process is performed in Germany, unlike the situation in Egypt. The environmental factors consideration is supported by law in Germany unlike Egypt. The transport and planning are managed through separated authorities in Egypt, whereas they are managed through one federal ministry in Germany.

(9.3) Applying the Toolbox on the Two Study Areas:

Two German and Egyptian areas were selected as study areas for applying the toolbox with nearby areas (the first 3.18 km^2 and the second 2.11 km^2). The current state for the German area was evaluated using the toolbox, whereas the planned state for the Egyptian area was evaluated using it. This is to show the applicability of the toolbox to deal with either current or planned states for urban areas.

The main criterion in selecting the study areas, is being a residential area that has an identified population number. For Germany, the city unit is the "district" or "Stadtteil", for which there is available data regarding the current population. For Egypt, the matter is a bit different, as the application was on the planned state. The selected “city Asyut city” was totally re-planned as zones through the master strategic plan, which was assigned in 2014. After finishing the master strategic plan, definite areas were selected to be planned in details or as parcels (red shaded areas in fig. 9.26) through the detailed plans that were assigned in 2015. One of these areas was the selected Egyptian case study that has identified estimated population number in the detailed plan target year.

Therefore, the two cases were selected, because of the accessibility to their data. Also, both of them are located within a medium or small city, which is the focus of this dissertation. However, the more important in selecting these two case is their representation for respective planning style rather than their location.

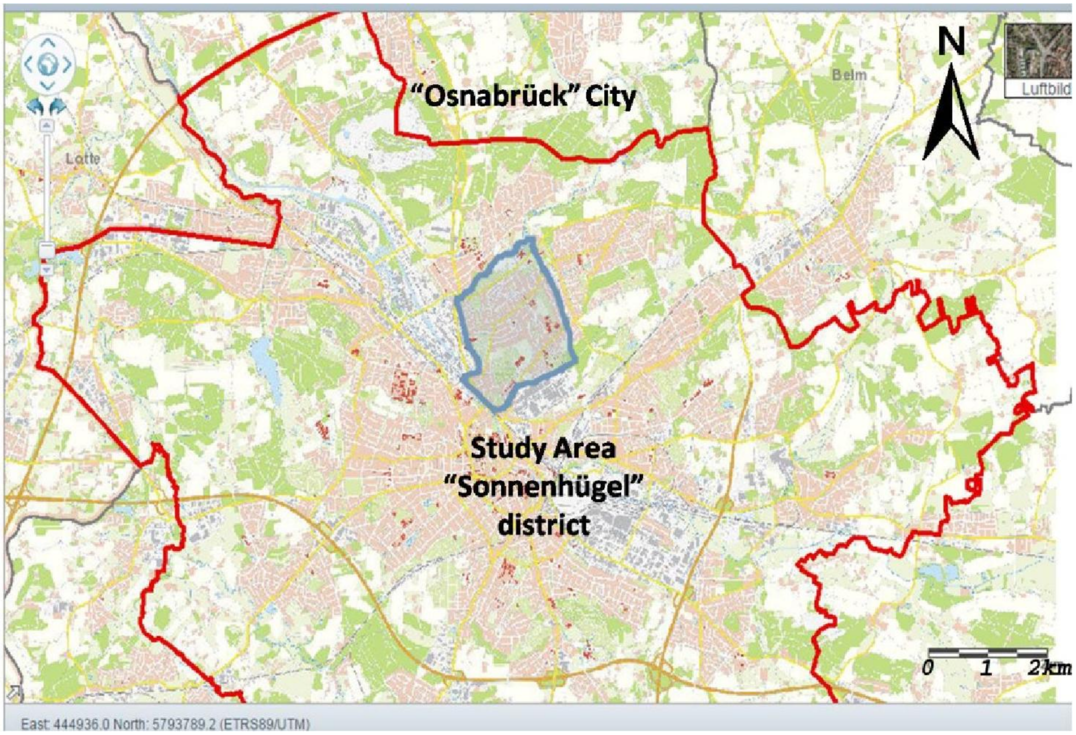
(9.3.1) Applying the Toolbox on the German Study Area

The current state for the land-use structure of “Sonnenhügel” district in “Osnabrück” City was selected as a German case study for its location aspects and urban form. “Osnabrück” City is located in “Lower Saxony” state in the North West of Germany.

(9.3.1.1) Introduction of the German Study Area “Sonnenhügel” District /“Osnabrück” City and the Field Trip Results:

“Sonnenhügel” district (3.18 km^2) had 9253 residents on 30.06.2017 according to the city’s website. It is located in the north of “Osnabrück” City as shown in the next figure. (The official website of Osnabrück city plan “Amtlicher Stadtplan ” 2017).

Fig. (9.3) “Sonnenhügel” district’s location inside “Osnabrück” City



Source: Osnabrück city plan website “Amtlicher Stadtplan ”, Stadtteile, “Sonnenhügel ” 2017

(9.3.1.1.1) The Urban Pattern and Main Characteristics of “Sonnenhügel” District:

“Sonnenhügel” district is characterized by non-condensed residential urban pattern. Most of the residential houses are separated buildings. These houses are either one family houses or houses for more than one family, which do not surpass three or four floors.

Fig. (9.4) Example for one family houses in “Sonnenhügel” district

Source: by own through the field trip in August 2017

Fig. (9.5) Examples for houses for more than one family in “Sonnenhügel” district

Source: by own through the field trip in August 2017

The district has a lot of open and green spaces like recreational services, “Burger” natural park, and areas around building and between them. This represents the main characteristic in it, as these areas make up about 33% of the summation of the land-uses areas in the district[2]. This is without considering the green areas in various services like schools or sport spaces or water areas. This represents the main advantage in this district planning.

Fig. (9.6) Example for green and open areas in front of buildings in “Sonnenhügel” district

Source: by own through the field trip in August 2017

There are some important sport and social activities located in this district. The sport activities include ice and roller sports center in the north east (the next figure), tennis club in the south west, as well as a society club and another sport facility center in the east.

2 This percentage was calculated using the statistics tool in the ArcGIS.

Fig. (9.7) The ice and roller sports center in the north east of “Sonnenhügel” district

Source: by own through the field trip in August 2017

There are some social activities in “Sonnenhügel” district like old people's homes, care for disable people, and non-governmental social organizations.

Fig. (9.8) Examples for social activities in “Sonnenhügel” district

Source: by own through the field trip in August 2017

There is a large cemetery located in the South West of “Sonnenhügel” district. This cemetery is directly near the large natural park “Burger park”. The cemetery is used as walking or recreational area by the residents.

Fig. (9.9) The cemetery in the South West of “Sonnenhügel” district

Source: by own through the field trip in August 2017

There is a large industrial and commercial area with about 49,5674.5 square meter area, which borders “Sonnenhügel” district from the south.

<u>(9.3.1.1.2) The Main Problems in “Sonnenhügel” District:</u>

The main problem in “Sonnenhügel” district is the lack of grocery stores, as there are only a few available grocery stores, which are not equally distributed within the district. Also, each of the primary education and medical services are not distributed on several locations within the district. As there are two elementary schools “Heilig-Geist-Schule” and “Albert-Schweitzer-Schule”, which locate in the same location (in the North East of the district). The two medical services “AMEOS Klinikum Osnabrück” and “HBO-Klinik Osnabrück” locate in the same location (in the South West of the district). “AMEOS Klinikum Osnabrück” is a big medical center that has many specifications and buildings, and locates on a large area (as shown in the next figure).

Fig. (9.10) The“AMEOS Klinikum Osnabrück” guide map

Source: by own through the field trip in August 2017

(9.3.1.1.3) The Current Available Essential Services for “Sonnenhügel” District:

The six essential services for residential areas are considered available to the residents of “Sonnenhügel” district. However, the fire station service is provided by two fire stations that are located outside the district, but close to it as it is illustrated in the point of the services accessibility assessment results.

First. The Primary Educational Service: There are two elementary schools with a common playground.

Fig. (9.11) The front entrance of Albert-Schweitzer-school (an elementary school) in “Sonnenhügel” district

Source: by own through the field trip in August 2017

Second. The Nursery Service: The nurseries in “Sonnenhügel” district are in separated locations with gardens or playground areas.

Fig. (9.12) The front entrance of „Katholische Kindertagesstätte Heilig-Geist“ in “Sonnenhügel” district

Source: by own through the field trip in August 2017

Third. The Recreational Service: As aforementioned, there is a large natural park “Burger park” and the cemetery is also used as walking or recreational area by the residents.

Fig. (9.13) The “Burger park” in “Sonnenhügel” district

Source: by own through the field trip in August 2017

Fourth. The Daily Commercial Service: This service includes bakeries, pharmacies, and grocery stores.

Fig. (9.14) Examples of available daily commercial shops in “Sonnenhügel” district.

Source: by own through the field trip in August 2017

<u>Fifth. The Medical Service</u>: The next figure shows the two aforementioned medical services in “Sonnenhügel” district (“AMEOS Klinikum” on the left and “HBO-Klinik” on the right)

Fig. (9.15) The two medical services in “Sonnenhügel” district.

Source: by own through the field trip in August 2017

<u>Sixth. The Fire Station Service</u>: The next figure shows the fire station “Schlauchturm BF Osnabrück”, which is located outside “Sonnenhügel” district in the South West of it.

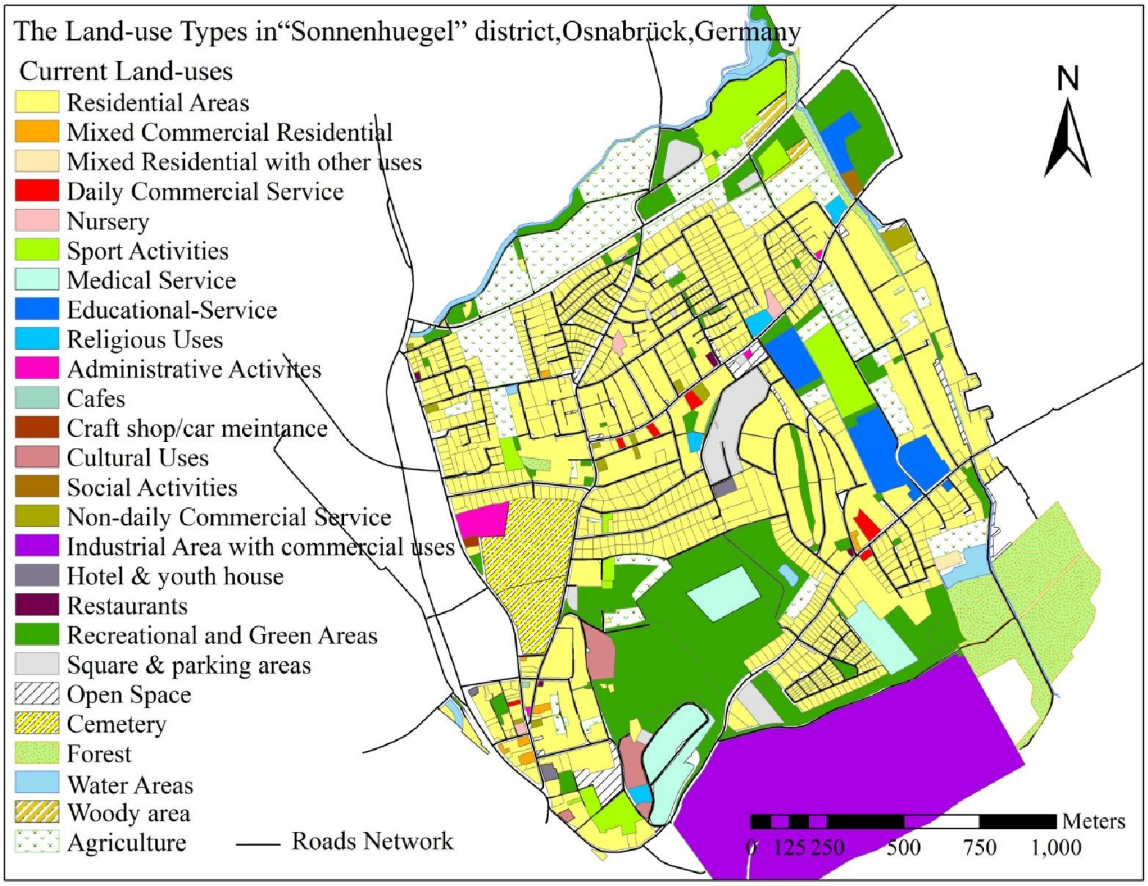
Fig. (9.16) The fire station “Schlauchturm BF Osnabrück”

Source: by own through the field trip in August 2017

(9.3.1.2) Current Land-uses Types within the German Study Area:

The next figure shows the current land-use structure of “Sonnenhügel ” district.

Fig. (9.17) The current land-use types within “Sonnenhügel” district



Source of the geo-data by which this map was formulated: “Osnabrück City- Department of Geo-data and Transport facilities, Geo-data Technical service”

Notes:

- Some of the residential areas are divided to land-parcels by the author, because the toolbox is designed to mainly deal with land-parcels . This division is not in the original data.

- The industrial area south of the district is not within the official boundary of it, (i.e. its area is not within the 3.18 km^2 area of “Sonnenhügel”). This industrial area belongs to another district called “Gartlage”. The consideration of this industrial area does not affect the land-use sufficiency and services accessibility assessment. But, the existence of this industrial area should be considered in the land-use compatibility assessment.

(9.3.1.3) Services Accessibility Assessment Results for the German Study Area: [3]

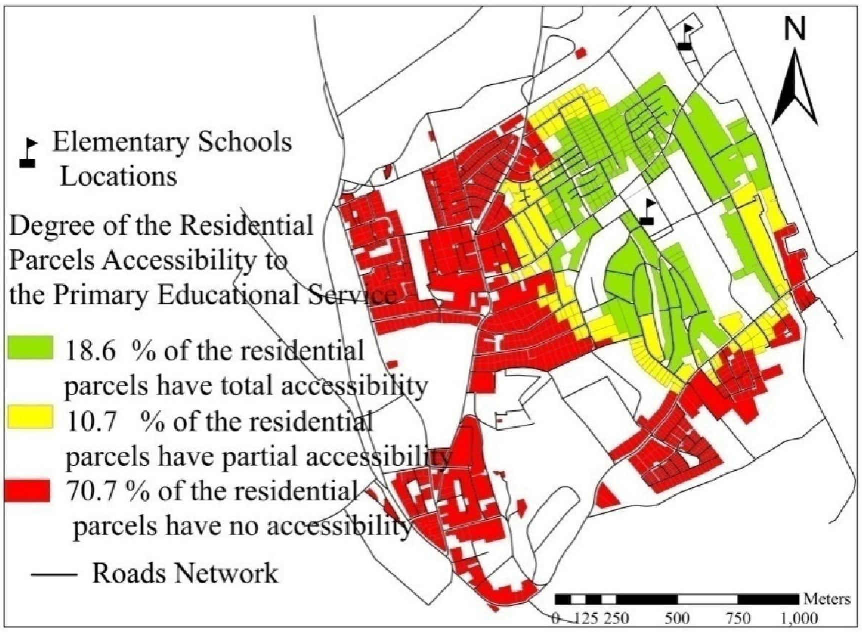
[3] The source of the output maps and the formulated results for the assessment of each of the service accessibility, land-use compatibility, and land-use sufficiency is by own using the established toolbox and the geo-data taken from Department of Geo-data in “Osnabrück City.

The next six figures show the services accessibility assessment obtained by applying the services accessibility tools on services accessed by walking and other emergency ones that are accessed by vehicles.

(9.3.1.3.1) The Accessibility to Services through Walking:

a. The Accessibility to the Primary Educational Service

Fig. (9.18) The residential parcels accessibility degrees to the primary educational service in “Sonnenhügel” district

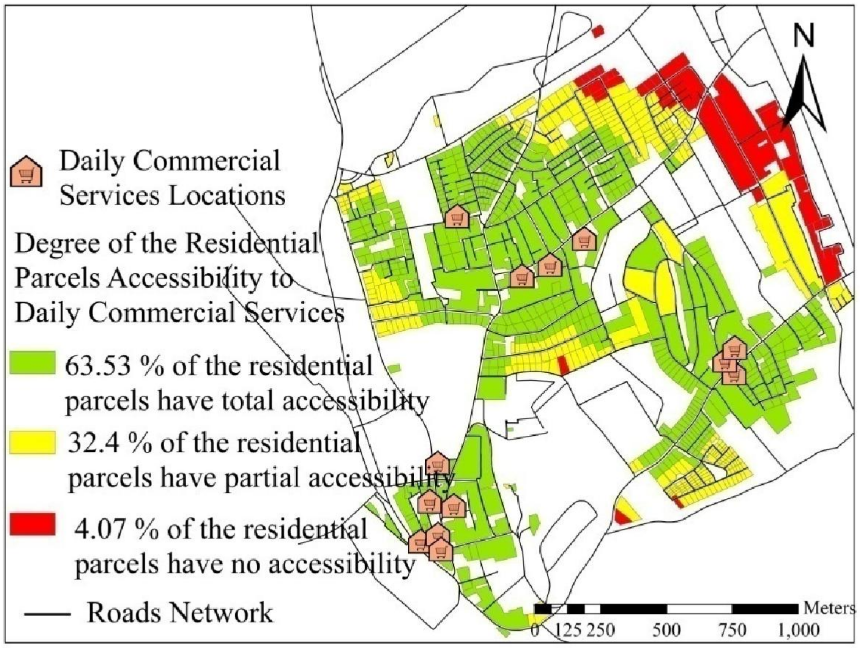


b. The Accessibility to the Recreational Areas

Fig. (9.19) The residential parcels accessibility degrees to the recreational areas in “Sonnenhügel” district

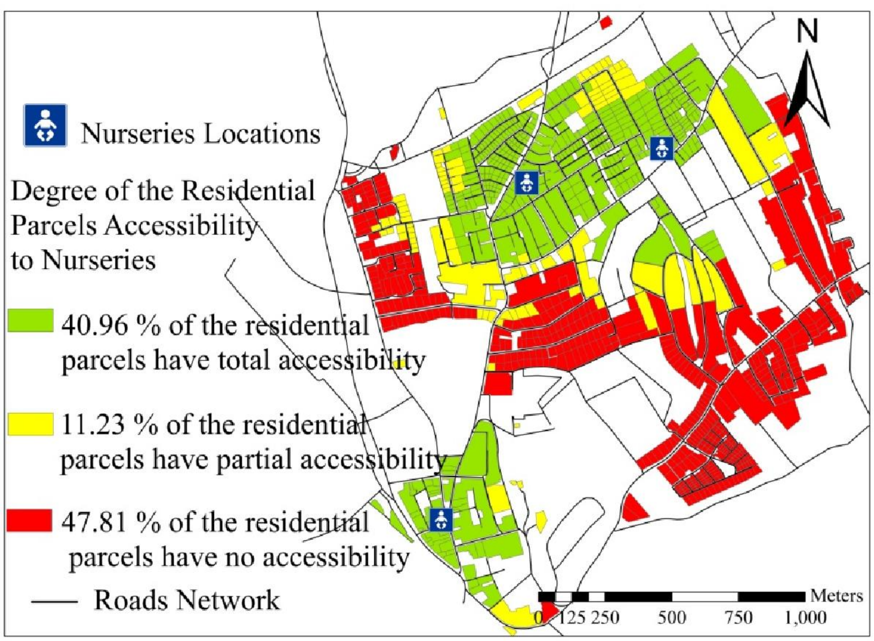
c. The Accessibility to the Daily Commercial Service

Fig. (9.20) The residential parcels accessibility degrees to the commercial service for daily-needed products in “Sonnenhügel” district



d. The Accessibility to Nurseries Service

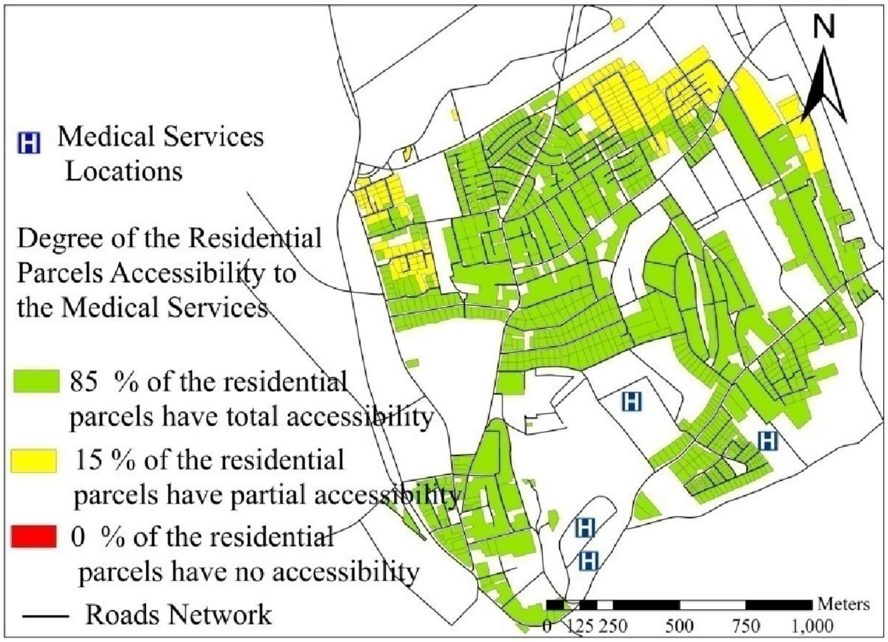
Fig. (9.21) The residential parcels accessibility degrees to the nurseries service in “Sonnenhügel” district



(9.3.1.3.2) The Accessibility to Emergency Services through Vehicles

a. The Accessibility to Medical Service

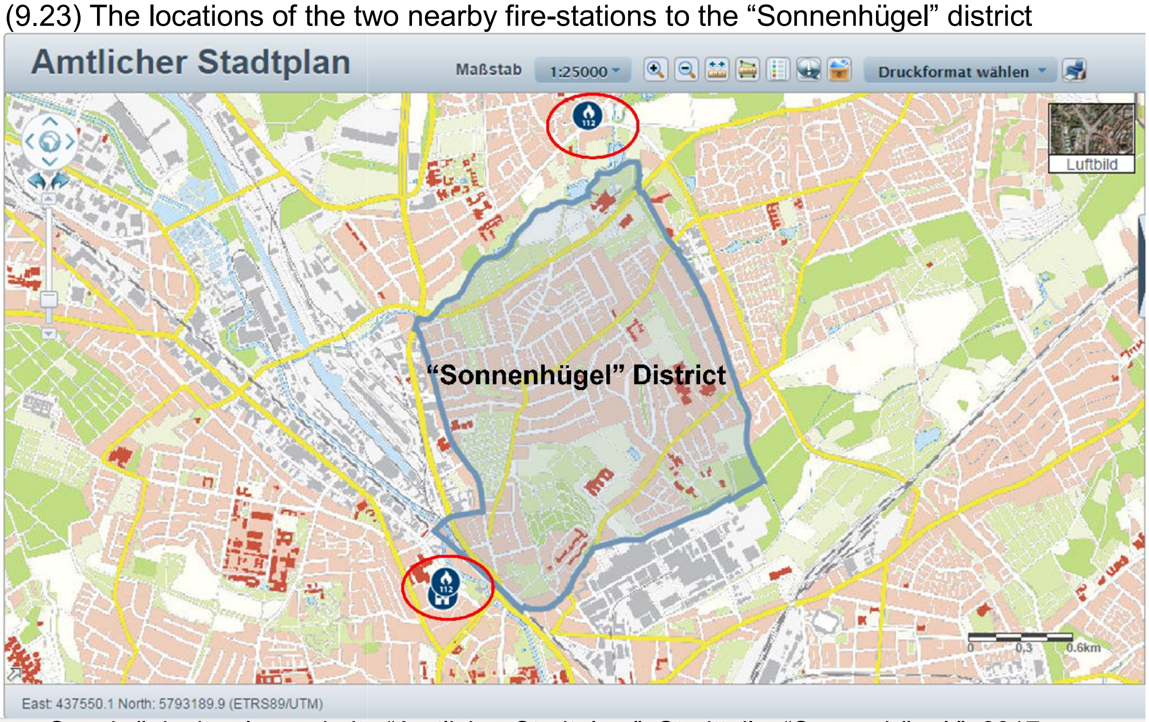
Fig. (9.22) The residential parcels accessibility degrees to the emergency medical service in “Sonnenhügel” district



b. The accessibility to Fire Stations

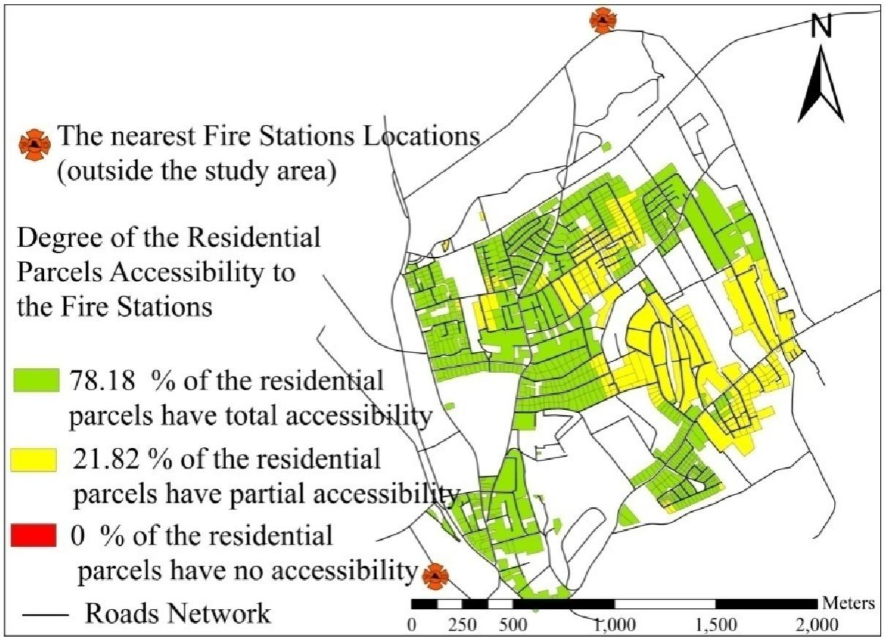
The two nearby fire stations (one in the North of “Sonnenhügel” district and another to the South West of it) provide this service for the residential parcels within this district. The following result is for accessibility assessment of the residential parcels to these two fire stations:

Fig. (9.23) The locations of the two nearby fire-stations to the “Sonnenhügel” district



Source: Osnabrück city plan website “Amtlicher Stadtplan ”, Stadtteile, “Sonnenhügel ”, 2017

Fig. (9.24) The residential parcels accessibility degrees to the available fire stations nearby “Sonnenhügel” district



(9.3.1.4) Land-use sufficiency Results for the German Study Area

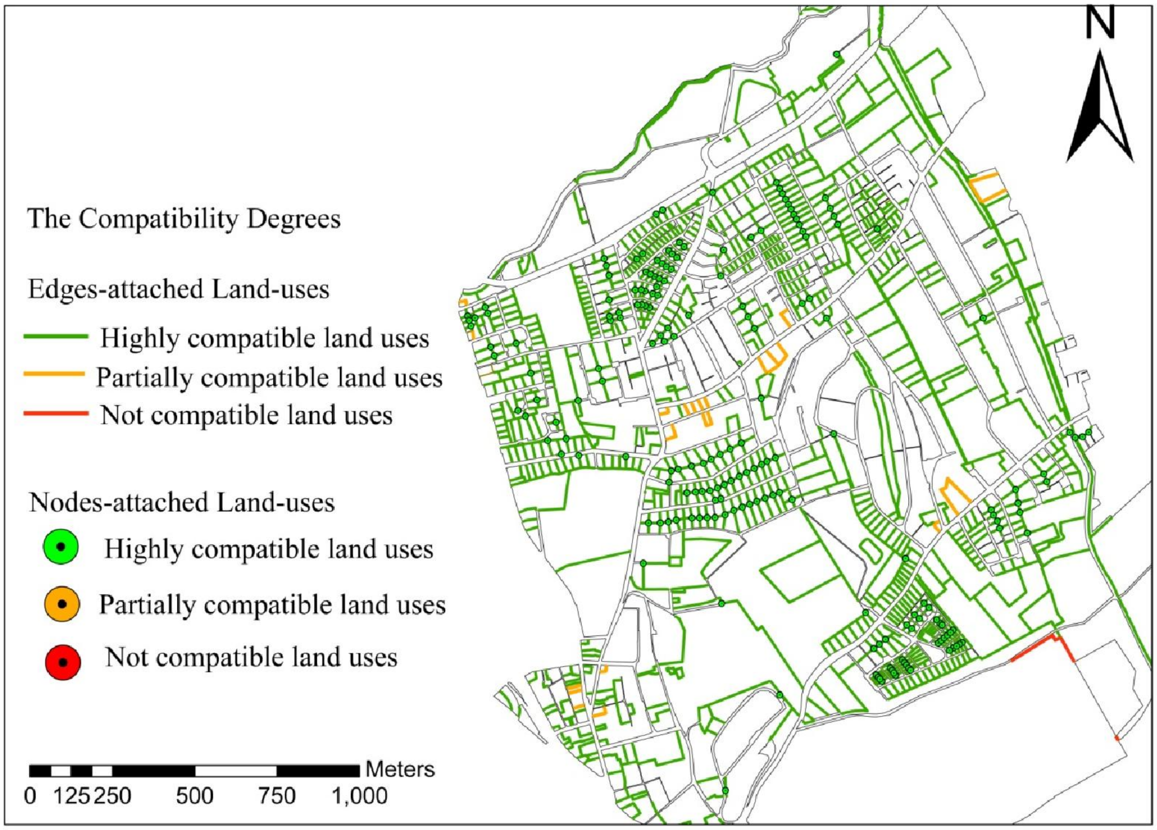
The shortage in the essential land-uses types with regards to the residents current need is in only in the fire-station service by 100 %. As there is no available fire station service in this area. This requires allocating this service with at least area equal 138.795 m^2 to fulfill the residents current need. However, the other six essential land-uses are sufficient for the current residents need.

(9.3.1.5) Land-use Compatibility Results for the German Study Area

Most of the compatibility degrees are within the highly compatible range except of one incompatible case, where there is an industrial zone south of the area, which causes a lack of compatibility. The industrial uses should be within the zone of 30-minutes driving away from residential zone (Aminde et al. 2010, p.114). There is one craft-shop, but it is not a polluting activity.

Also there are some partially compatible cases, some of them are due to the direct neighboring between residential parcels and non-daily commercial service parcel. The non-daily commercial uses are preferred to be within the zone of 5-minutes driving away from the residential zone (Aminde et al. 2010, p.114).

Fig. (9.25) The compatibility degrees between the attached land-uses types in “Sonnenhügel” district



(9.3.2) Applying the Toolbox on the Egyptian Study Area:

The planned state of the land-use structure of “El-Moalimeen/El-Arbieen/El-Sadat [4]” in “Asyut” City was selected as an Egyptian case study, because of the availability of various land-uses types in it. Another reason is that its urban pattern is a mixture between the new and old urban patterns, which are represented in a new planned part and old existing re-planned parts. This is the case of most of the existing [5] Egyptian cities. “Asyut” is located in “Asyut” Governorate in the Upper Egypt (south Egypt).

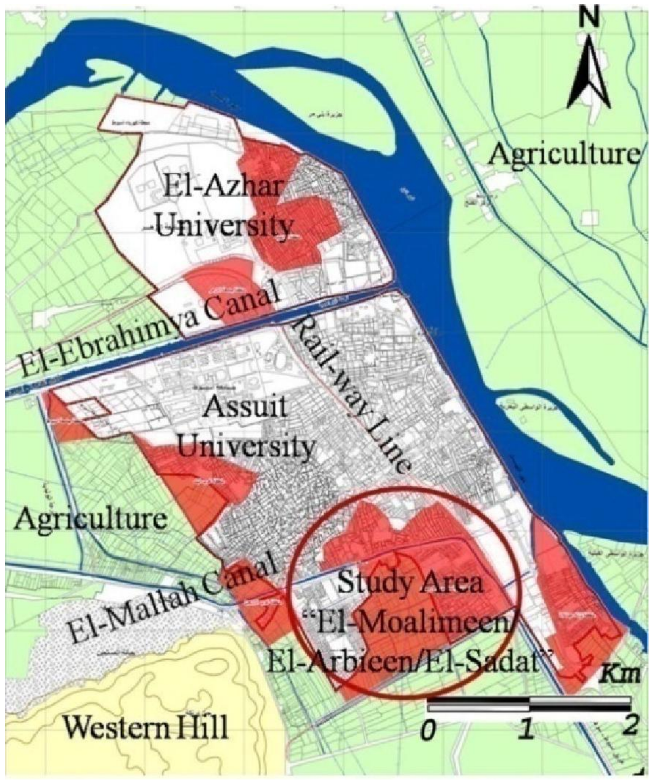
(9.3.2.1) Introduction of the Egyptian Study Area “El-Moalimeen/El-Arbieen/El-Sadat” Area /“Asyut” City and the Field Trip Results:

The “El-Moalimeen/El-Arbieen/El-Sadat” area (2.11km^2) had 29,276 residents in 2009. It is estimated to have 42,918 residents in 2027, which is the target year for the evaluated detailed plan of this area. (Detailed plans report of Asyut areas-GOPP 2015, p.25). It is located in the South of “Asyut” City, as shown in the next figure.

4 It is a complex name because that area includes parts from three various city’s areas.

5 As previously mentioned in chapter7, there are two governmental city types in Egypt; new planned and existing old cities.

Fig. (9.26) “El-Moalimeen/El-Arbieen/El-Sadat” area’s location inside “Asyut” city (the area within the circle).



Source: Asyut City strategic plan report, GOPP 2015.

(9.3.2.1.1) The Urban Pattern and Main Characteristics of “El-Moalimeen/El-Arbieen/El-Sadat” Area:

“El-Moalimeen/El-Arbieen/El-Sadat” area is characterized by a condensed residential urban pattern. Most of the residential buildings are connected buildings. These buildings are high multi-storey, which may reach twelve floors.

Fig. (9.27) Examples for high residential buildings in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

Like most of the Egyptian cities, the gourd floor of the residential buildings is used as commercial service, the “El-Moalimeen/El-Arbieen/El-Sadat” area has many residential buildings, which have commercial activities like grocery shops, cafes, nurseries service, and small workshops in the gourd floor.

Fig. (9.28) Examples for the usage of the gourd floor of the residential buildings for commercial purposes in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in March 2017

Also the presence of many workshops within the residential mass is one of “El-Moalimeen/El-Arbieen/El-Sadat” area noticed characteristics like most of the Egyptian cities. These workshops are for performing non-polluting activities like quick fixing for vehicles or carpentry. But in many cases, these can perform polluting activities like vehicles painting or producing small products.

Fig. (9.29) Examples for workshops in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in March 2017

“El-Moalimeen/El-Arbieen/El-Sadat” area is bordered by an agriculture land from the South and South West as shown in the next figure.

Fig. (9.30) The agriculture land bordering “El-Moalimeen/El-Arbieen/El-Sadat” area from the South and South West

Source: by own through the field trip in August 2016

(9.3.2.1.2) The Main Problems in “El-Moalimeen/El-Arbieen/El-Sadat” Area:

There are some currently pressing problems in “El-Moalimeen/El-Arbieen/El-Sadat” area, which are expected to be alleviated through the planning of this area, which is assessed in this part.

The main problem is the pollution from the accumulated garbage especially around “El-Mallah” Canal in the North of the area as shown in the next figure. This is due to the shortage in the garbage collection service. However, this canal is planned to be covered in the future state, and re-using its area as recreational area.

Fig. (9.31) The accumulated garbage problem around “El-Mallah” Canal

Source: by own through the field trip in March 2017

The penetration of the ring road in the south part of Asyut city within “El-Moalimeen/El-Arbieen/El-Sadat” area represents a traffic and safety problem as shown in the next figure. This problem can be solved by establishing another ring road in the most South of Asyut city (i.e. south of“El-Moalimeen/El-Arbieen/El-Sadat” area), or at least prevention of heavy vehicles from passing in the ring road penetrating this area.

Fig. (9.32) The penetration of the ring road in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

Unlike the German case study, there is a lack of green areas in the Egyptian case study, as there is currently only one small park. However, in the planned state there are some recreational areas, but as mentioned later, there is still a shortage of 80.3% in these planned recreational areas, which is considered a huge shortage that must be re-considered in this planned state. Moreover, it was realized during the field survey that some of these planned recreational areas have been already built as residential buildings in an illegal way.

There is currently an area that is used as one of the main transport stops in Asyut city within “El-Moalimeen/El-Arbieen/El-Sadat” area. This transport stop causes noise pollution for the residents. However, it is planned to remove this transport stop from the area’s plan.

Fig. (9.33) The current transport stop north of “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in March 2017

There is a line of high voltage towers passing through the residential buildings, which represents a danger for the residents health, as shown in the next figure.

Fig. (9.34) High voltage towers passing through the residential buildings in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

There are many illegal construction activities in “El-Moalimeen/El-Arbieen/El-Sadat” area that began due to the lack of security since the revolution time (in 2011) as shown in the next figure.

Fig. (9.35) Examples for current illegal construction activities in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

(9.3.2.1.3) The Current Available Essential Services for “El-Moalimeen/El-Arbieen/El-Sadat” Area:

The six essential services are considered available to the residents of “El-Moalimeen/El-Arbieen/El-Sadat” area. However, the fire station service is provided by one station, which is located outside the area (directly attached to the north west of it), which is illustrated in the point of the services accessibility assessment results.

First. The Primary Educational Service: The basic education in Egypt is divided into two stages the primary stages (from age 6-11), and the preparatory stage (from age 12-15)[6]. The current

6 The guide for the planning criteria and standards for services in the Arab Republic of Egypt (1st part - Educational Services)-GOPP 2014, p.19

available educational service in “El-Moalimeen/El-Arbieen/El-Sadat” area is only a preparatory school.

Fig. (9.36) The current available preparatory school in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

<u>Second. The Nursery Service</u>: All the existing nurseries in “El-Moalimeen/El-Arbieen/El-Sadat” area are established in the ground floors of residential buildings with no gardens or playground areas.

Fig. (9.37) Examples for current available nurseries in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

<u>Third. The Recreational Service:</u> As aforementioned, there is currently a lack in this service in “El-Moalimeen/El-Arbieen/El-Sadat” area. The next figure shows the only currently available small park.

Fig. (9.38) The current available park in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in March 2017

Fourth. The Daily Commercial Service: This service includes bakeries, pharmacies, and grocery stores. As aforementioned, this service is presented through shops in ground floors of residential buildings, which is the general attitude in Egypt.

Fig. (9.39) Examples for current available daily commercial shops in “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in August 2016

Fifth. The Medical Service: The next figure shows the two current available medical service. The first is a governmental hospital, but it is currently closed due to unavailability of some required medical equipment (on the left side of the next figure). The second is a private specialized hospital for treating burns (on the right side of the next figure). So, there is currently no available emergency medical service in “El-Moalimeen/El-Arbieen/El-Sadat” area.

Fig. (9.40) The current established hospitals in the “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in March 2017

<u>Sixth. The Fire Station Service</u>: The next figure shows “El-Basary fire station”, which is directly attached to the north west of “El-Moalimeen/El-Arbieen/El-Sadat” area.

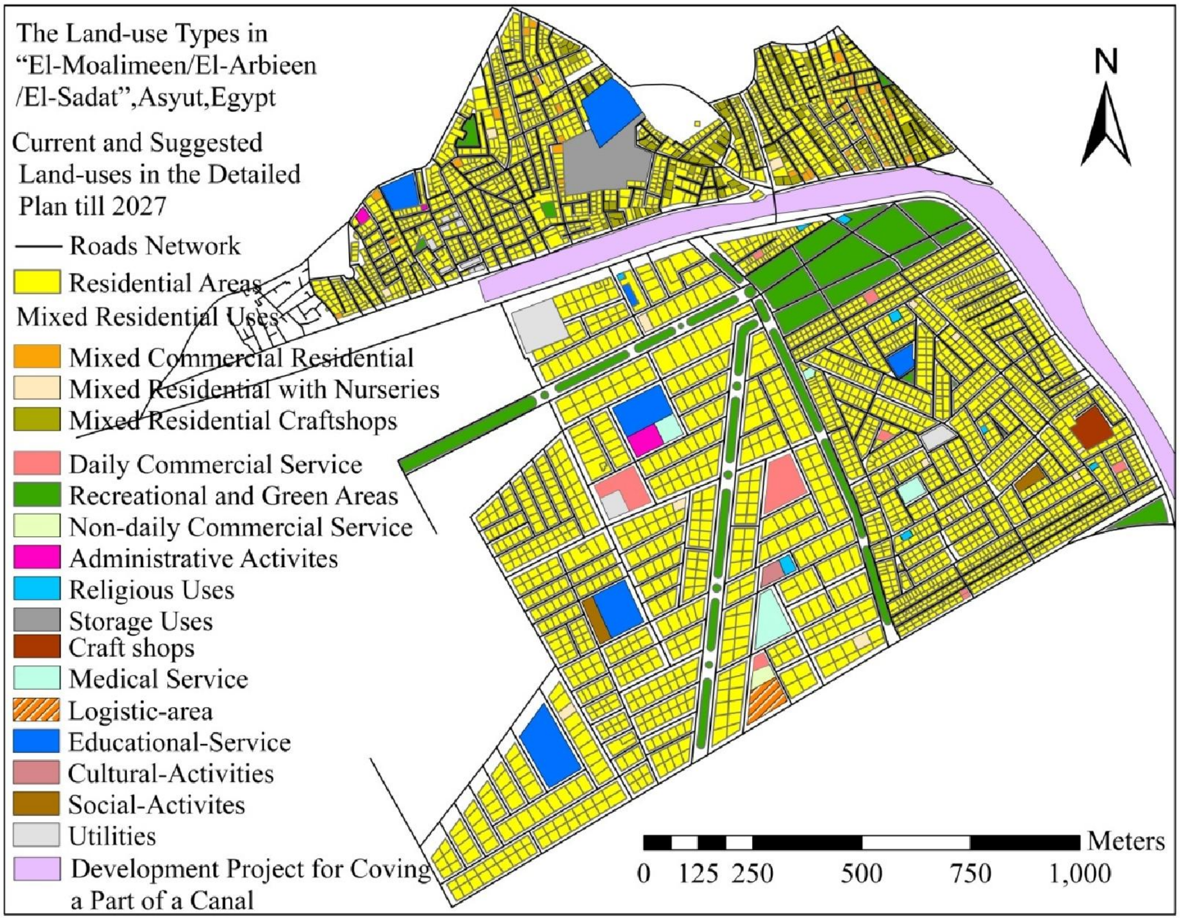
Fig. (9.41) The fire station “El-Basary” in north west of “El-Moalimeen/El-Arbieen/El-Sadat” area

Source: by own through the field trip in March 2017

(9.3.2.2) Planned Land-uses Types within the Egyptian Study Area:

The next figure shows the planned land-use structure of “El-Moalimeen/El-Arbieen/El-Sadat” area.

Fig. (9.42) The planned land-use types within the detailed plan for “El-Moalimeen/El-Arbieen/El-Sadat” area



Source: The detailed plans’ report- Asyut City Strategic plan, GOPP 2015.

Notes:

- Some of the residential areas are divided to land-parcels by the author, as this was not in the original data, because the toolbox is designed to mainly deal with land-parcels.

-Regarding the assessment of the services accessibility and the land-use sufficiency of the Egyptian area, there are currently some unavailable services standards in the Egyptian services standard guide. So, the German standards were used instead of these unavailable standards.

(9.3.2.3) Services Accessibility Assessment Results for the Egyptian Study Area:[7]

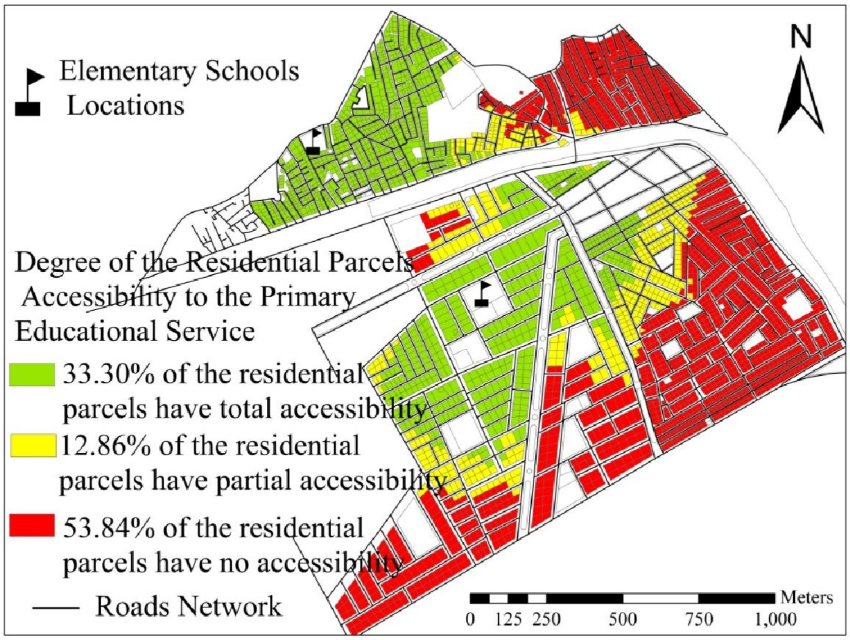
[7] The source of the output maps and the formulated results for the assessment of each of the service accessibility, the land-use compatibility, and the land-use sufficiency is by own using the established toolbox and data within the report of detailed plans of Asyut areas-the General Organization for Physical Planning- Egypt, 2015.

The next six figures show the services accessibility assessment obtained through applying the services accessibility tools on services accessed by walking, and other emergency ones that are accessed by vehicles.

<u>(9.3.2.3.1) The Accessibility to Services through Walking:</u>

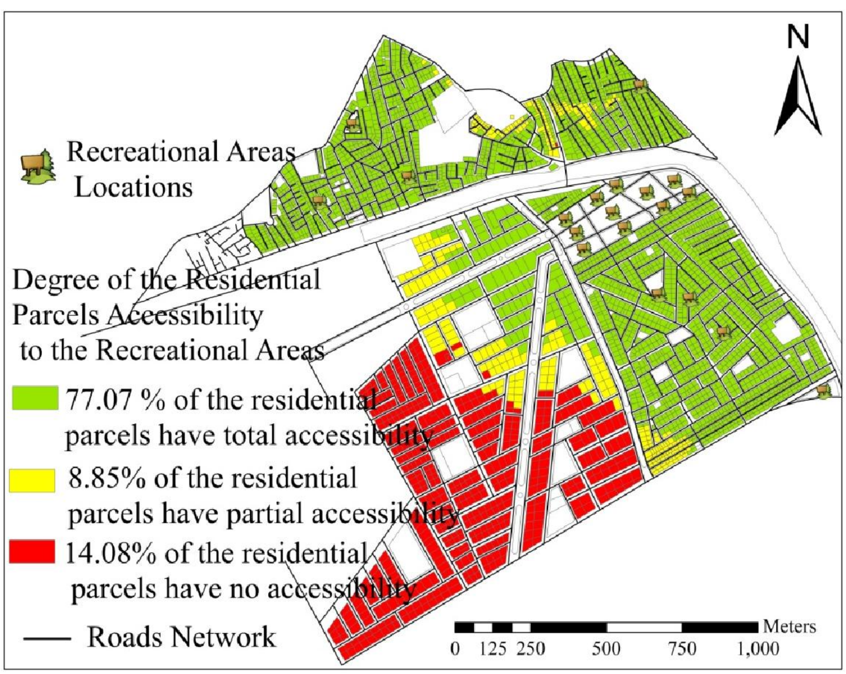
a. The Accessibility to the Primary Educational Service

Fig. (9.43) The residential parcels accessibility degrees to the primary educational service in “El-Moalimeen/El-Arbieen/El-Sadat” area



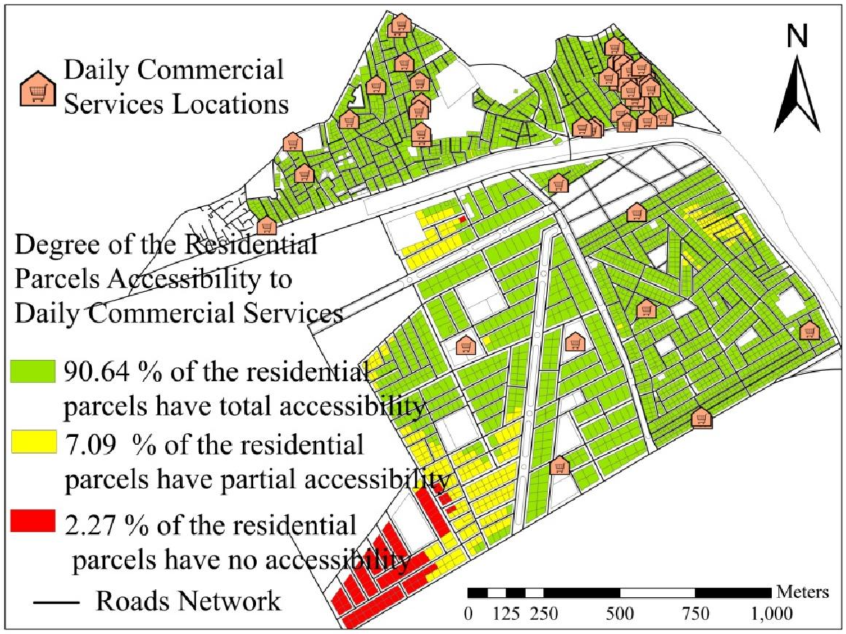
b. The Accessibility to the Recreational Areas

Fig. (9.44) The residential parcels accessibility degrees to the recreational areas in “El-Moalimeen/El-Arbieen/El-Sadat” area



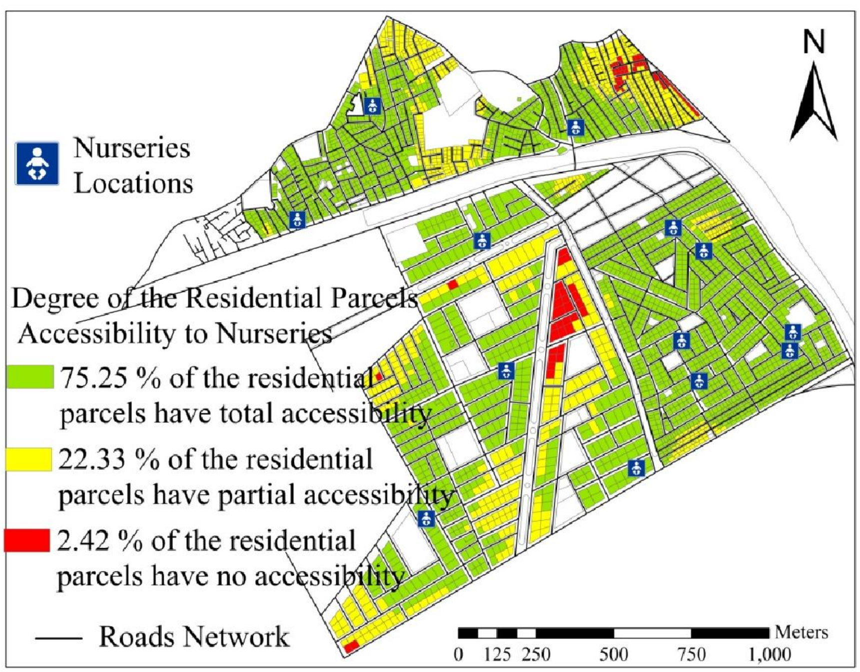
c. The Accessibility to the Daily Commercial Service

Fig. (9.45) The residential parcels accessibility degrees to the daily commercial service in “El-Moalimeen/El-Arbieen/El-Sadat” area



d. The Accessibility to Nurseries Service

Fig. (9.46) The residential parcels accessibility degrees to the nurseries service in “El-Moalimeen/El-Arbieen/El-Sadat” area

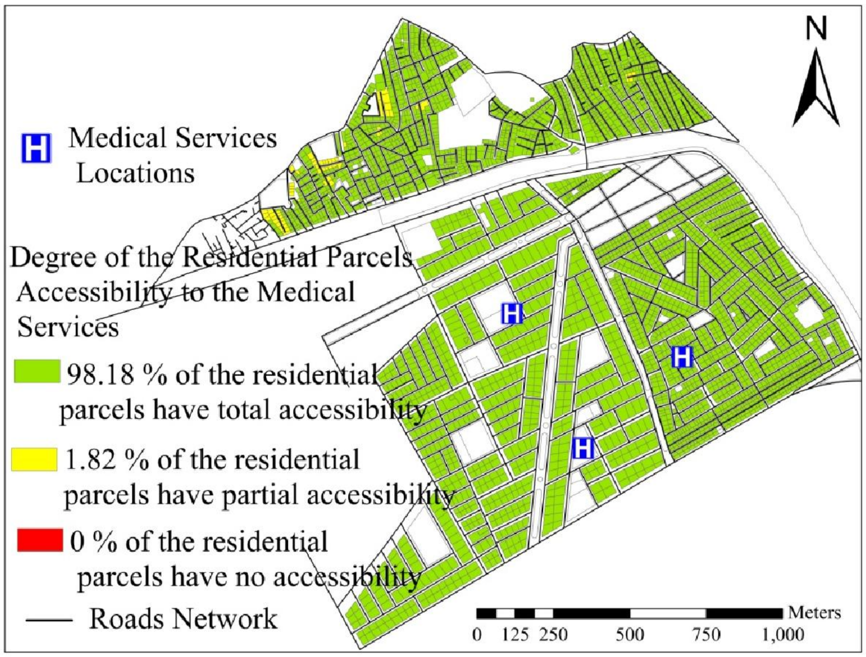


(9.3.2.3.2) The Accessibility to Emergency Services through Vehicles:

a. The Accessibility to Medical Service

In the planned state of the area, there are three governmental hospitals, two of them are not established yet. The third is established, but currently closed, as previously mentioned. However, the evaluation is based on these three hospitals, considering their performance by the target year of the plan.

Fig. (9.47) The residential parcels accessibility degrees to the emergency medical service in “El-Moalimeen/El-Arbieen/El-Sadat” area



Note: As aforementioned, there is a specialized private hospital in burns, but this hospital has not been considered as emergency or public medical service.

b. The accessibility to Fire Stations

There is no available fire station in the Egyptian case study. However, there is one nearby fire station that is directly attached to the north west of El-Moalimeen/El-Arbieen/El-Sadat” area. So considering the serving of this station for the residential parcels within this area, the following shows the result for assessing these residential parcels accessibility to this nearby fire station:

Fig. (9.48) The location of the nearest fire-station to the “El-Moalimeen/El-Arbieen/El-Sadat” area

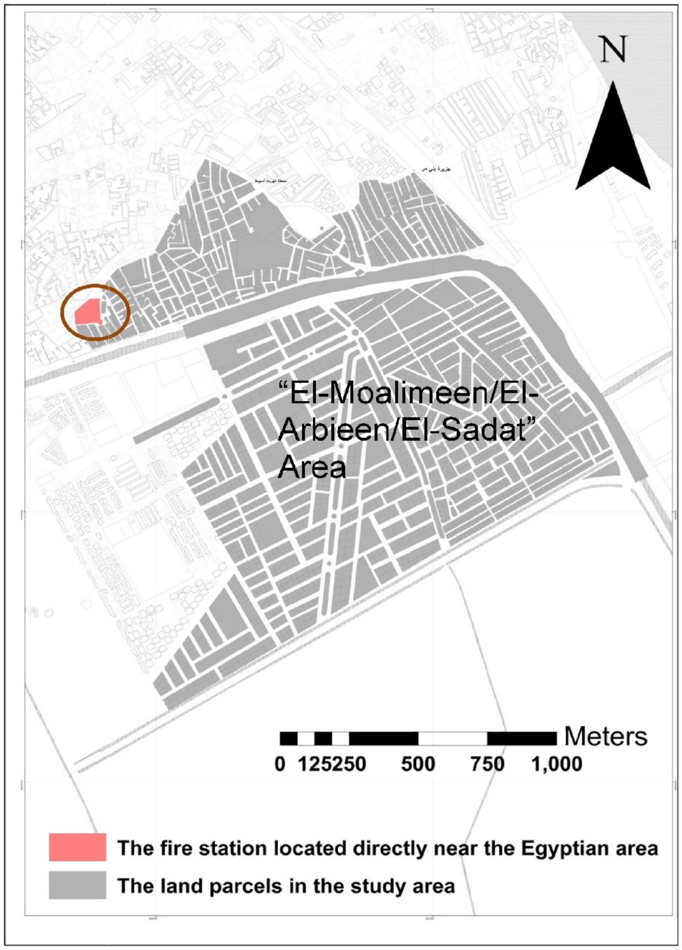
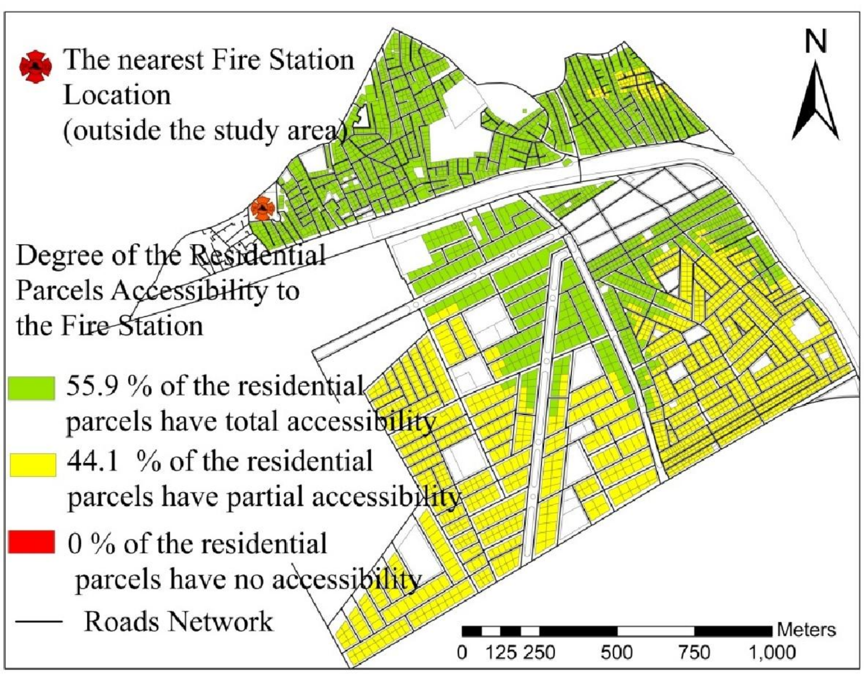


Fig. (9.49) The residential parcels accessibility degrees to the fire station nearby “El-Moalimeen/El-Arbieen/El-Sadat” area



(9.3.2.4) Land-use sufficiency Results for the Egyptian Study Area:

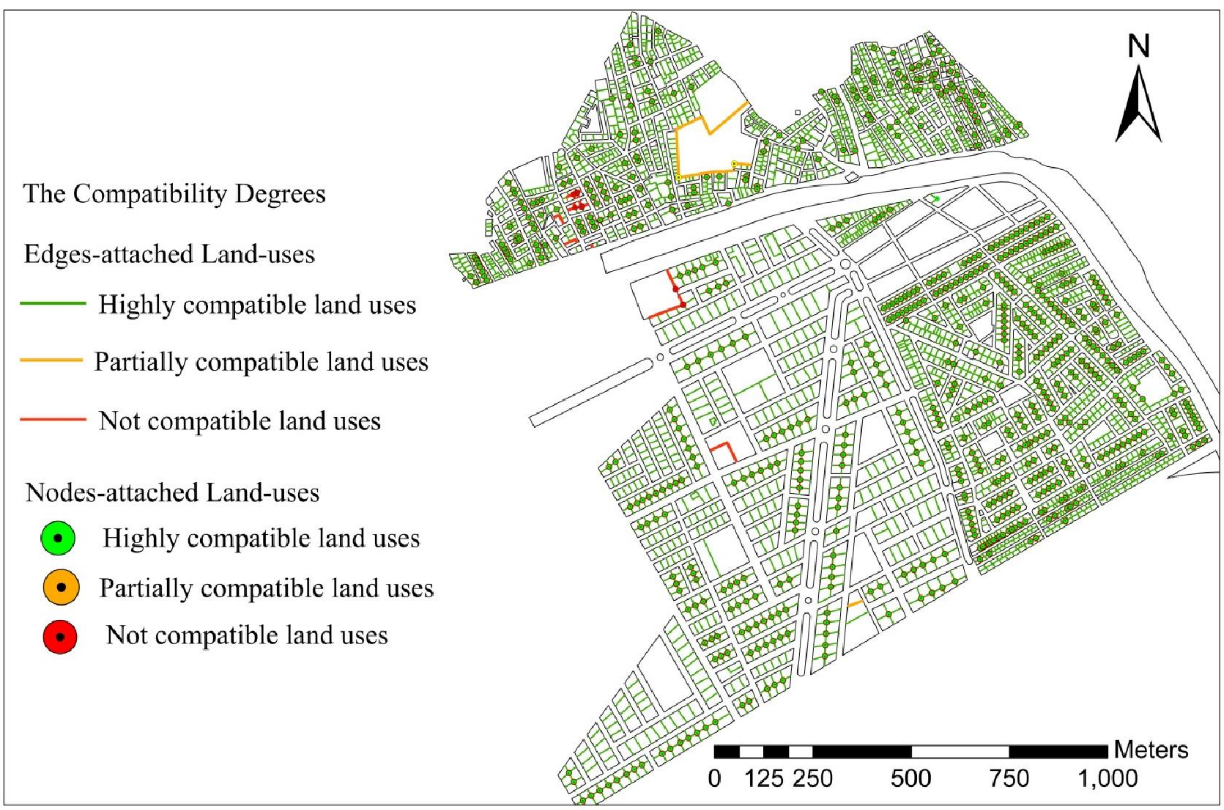
Shortages in each of recreational areas, primary educational, nurseries, and commercial services for daily-needed products are about 80.3%, 73 %, 60%, and 11% respectively from the residents’ expected need in the plan’s target year. Moreover, there is no fire-station service, which requires allocating this service at least area equal 643.77 m^2 to fulfill the residents’ need. However, the residential and the medical uses are sufficient for the residents’ need till this year.

(9.3.2.5) Land-use Compatibility Results for the Egyptian Study Area:

Most of the compatibility degrees are within the highly compatible range except some incompatible cases, where there are utilities directly alongside residential uses. The utilities are preferred to be within the zone of 30-minutes driving away from residential uses (Aminde et al. 2010, p.114).

There are some craft-shops[8] within mixed residential uses, but they are not polluting activities. Also, there are three partially compatible cases, two of them are due to the direct neighboring between a storage use with an educational use and residential uses in the north of the area. The storage uses are preferred to be within the zone of 5-minutes driving away from the residential zone including educational uses (Aminde et al.,2010,p.114).

Fig. (9.50) The compatibility degrees between the attached land-uses types in “El-Moalimeen/El-Arbieen/El-Sadat” area



(9.4) Conclusions and Recommendations Regarding the Two Study Areas:

8 It is supposed that the current polluting workshops will be removed by the target year of the area’s plan.

This section deduces conclusions from the results of applying the developed toolbox on the two case studies. As it will be clarified later, the significance of these results is in guiding the planner for what should be changed to have more sustainable land-use structure, as stated in the recommendations regarding each case study.

(9.4.1) General Conclusions and Recommendations:

(9.4.1.1) General Conclusions:

The designed toolbox supports the sustainable land-use planning by assessing the attainment of the three sustainability dimensions in the land-use structure of the study area.

The toolbox results guide the planner to what should be changed. As it is clear in the service accessibility results that the residential parcels that are marked with red (i.e. have no accessibility to the service) are in need to allocate the service nearby them and re-evaluate the accessibility in the new location.

The same for the land-use compatibility results, the red edges or nodes (i.e. the land-uses are incompatible) show the land-use types that should be changed. The land-use sufficiency results identify the land-use types that have shortage in their areas and the required areas to be added to these types to fulfill the residents need.

It is clear in the two cases that some services are sufficient for the residents (economic efficiency), but not totally accessible to all the residential parcels (social equity), and vice versa. This means that there should be a balance among attaining the three sustainability axes in the land-use structure.

The results of the toolbox (regarding the two cases with the differences in the cultural and planning concepts in the two countries) are considered logical. Example, one of the dominant Egyptian cultural attitude is the mixed residential uses, which is represented in using the ground floor of the residential buildings in activities like small food-shops, nurseries, and cafes. This cultural attitude leads to have higher accessibility percentage to these services in the Egyptian case than in the German one, unlike the dominant German attitude, which is represented in having these services in separated buildings.

Fig. (9.51) Examples for activities established in ground floor of the residential buildings

Source: by own through the field trip in March 2017

Also the low population density in Germany due to the spread of green and open areas within the urban pattern of German cities (unlike the compact urban pattern of the Egyptian cities with small available green areas) leads to two results. The first is the low population number in the German area, in comparison to the Egyptian area[9]. And consequently, the second result is the sufficiency of the services' areas with regards to the population number in the German cities, especially the recreational areas unlike most of the Egyptian cities.

(9.4.1.2) General Recommendations:

The presented toolbox is considered to be a new function in ArcGIS™ software. However, it is recommended to be the core for establishing a spatial planning support system-SPSS as a new independent software, which is the proposed system in this dissertation. This can be used for comprehensively assessing sustainability in the land-use planning process on city level.

This will require formulating comprehensive criteria for assessing the efficiency of the cities' land-use planning for the country of interest, and establishing the SPSS to be flexibly used for supporting the land-use planning process of any country using its own criteria as stated in details in chapter 10.

(9.4.2) German Study Area:

(9.4.2.1) Conclusions Regarding the German Study Area:

Regarding the services accessibility, there is a lack of accessibility to fire-station service, as it is not available at all. However, the serving of the two closest fire stations for the residential parcels within the German area, was considered. And the results of the accessibility evaluation show good accessibility to these two fire-stations, for about 78.18% of the residential parcels within this area.

There is a weak accessibility to the primary educational (70.7% of the residential parcels have no accessibility to schools). For nurseries service, 47.81% of the residential parcels have no accessibility to nurseries, but at the same time, 40.96% of them have good accessibility to nurseries.

There is a good accessibility to each of the medical service (85% of the residential parcels), recreational services (99.04%), and daily-commercial services (63.53%).

Regarding the land-use sufficiency, despite six uses out of seven essential land-uses are sufficient for the current residents need, but these may be not sufficient in the future with the residents increase. Moreover, there is a current need for allocating a fire-station.

So, some of the available services in the area are sufficient for the residents, but not totally accessible by the higher percentage from the residential parcels. These are primary educational, and nurseries services.

Regarding the land-use compatibility, the industrial zone south of Sonnenhügel district is not compatible to be directly attached to the residential zone. Despite there is a green belt

[9] Although the German study area (3.18km^2) is bigger than the Egyptian one (2.11km^2) and the Egyptian area is a studied planned state, the estimated Egyptian area's population (42,918residents) in its future land-use structure is more than four and half times the current German area's population (9253 residents). However, this is still within the permitted limit for the Egyptian standard population density (150 person/4200m^2).

separating this industrial zone from the district, but it is not enough, as its width in some locations is only 15 meters.

(9.4.2.2) Recommendations Regarding the German Study Area:

- There is a need for allocating a fire-station with minimum area of 138.795 m^2 considering to be in a central location in the area [10].
- It is better that the industrial zone is replaced by another more compatible land-use. However, considering the economic cost, it is recommended to increase the width of the green belt separating this zone from the residential zone and using specialized high trees for this purpose.
- The expected population increase should be considered in the available services areas.
- The change of the locations of the nurseries and primary educational and daily commercial [11] services should be studied to be accessible for more residents. The allocation of new ones in the areas, where the residential parcels have no accessibility to them, would also be a solution.

(9.4.3) Egyptian Study Area:

(9.4.3.1) Conclusions Regarding the Egyptian Study Area:

The current state of this area is different than what is planned, e.g. some of the suggested locations for recreational areas are already used as residential uses with illegal buildings. This was realized through the field survey in this area.

Regarding the services accessibility, there is a lack of accessibility to fire-station service, as it is not available at all. However, the serving of a nearby fire station for the residential parcels within the Egyptian area was considered. And the results of the accessibility evaluation show good accessibility to this fire-station for about 55.9 % of the residential parcels within this area, and about 44.1% of them have partial accessibility to this station.

There is a weak accessibility to the primary educational service (53.84% of the residential parcels have no accessibility to the elementary schools), but at the same time 33.3% of them have good accessibility to this service. There is also a good accessibility to each of the recreational (77.07%), nurseries (75.25%), medical (98.18%), and daily-commercial (90.64%) services.

Regarding the land-use sufficiency, despite the Egyptian area is a planned state, all the essential land-uses are not sufficient for the expected residents except the residential and medical use. The shortages in the recreational areas, primary educational, and nurseries are very high with about 80.3%, 73 %, 60% respectively, which should be seriously considered. Also there is no available fire-station service at all.

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[10] Most of the residential parcels (78.18%) have total accessibility to fire-stations service through the two nearby fire-stations. However, still 21.82% have partial accessibility.

[11] Most of the residential parcels (63.53%) have total accessibility to daily commercial service. However, still 32.4% have partial accessibility and 4.07% of them have no accessibility.

Therefore, all available the services in the area (except the educational service) are partially or totally accessible by most of the residential parcels. However, the areas of these services are not sufficient for the residents (except the medical service).

Regarding the land-use compatibility, the utilities use is not compatible to be directly attached to the residential use.

(9.4.3.2) Recommendations Regarding the Egyptian Study Area:

- There is a need for allocating a fire-station with minimum area of 643.77 m^2 considering to being in a central location in the area[12]. And the area of each of recreational, primary educational, nurseries, and daily-commercial services should be increased by at least 275942.5, 37633.25, 10313.2, and 3316.4 m^2 respectively. These can be attained through decreasing the areas of residential uses. As the areas specialized for the residential uses exceed double the actual need of the expected population. However, as previously mentioned in chapter 7, most of the land ownerships are private, so allocating these services will require negotiations with the owners.
- The utilities should be moved away from the residential zone especially that most of them are suggested, and do not exist yet.
- Egyptian studies are required regarding the standards of the residential, fire-stations service, and the daily commercial service[13] according to the Egyptian circumstances.
- The change of the recreational[14] and primary educational services[15] locations should be studied to increase their accessibility to residents or allocating new ones in the areas, where the residential parcels have no accessibility to them.

(9.5) Reflections:

This chapter presents the second part of the empirical part of this dissertation. It illustrates the application of the developed toolbox on the German and Egyptian study areas. The results confirm the differences in the cultural attitudes in both countries.

As previously mentioned, the toolbox has many potentials and advantages. However, there are some suggested upgrades for this toolbox to enhance the performance of the toolbox, and provide more beneficial results. These suggested upgrades are presented in the next chapter thatis the last chapter, in which the extracted conclusions from the theoretical and empirical part of the dissertation are drawn. As well as the whole research recommendations are deduced. And so the future research agenda is identified.

[12] Most of the residential parcels (55.9%) have total accessibility to fire-station service through the nearby fire-station. However, still 44.1% have partial accessibility.

[13] There are available Egyptian standards guides of cultural, social, educational, normal medical services (not emergency medical), youth and sport activities. Also the recreational, administrative, and religious services are under preparation.

[14] Most of the residential parcels (77.07%) have total accessibility to recreational areas. However, still 8.85% have partial accessibility, and 14.08% of them have no accessibility.

[15] There are two elementary schools in the land-use structure, one of them is suggested in the new part of the area, and not established yet. So, it is doable to change its location before executing the area’s plan, and the same for the recreational areas as most of them are suggested in the plan.

Chapter 10
Conclusions, Recommendations, and Future Research Agenda
(10.1) Introduction:

This chapter is the result of analysing each of the theoretical and empirical parts of the dissertation. This is in order to conclude definite points regarding PSSs, the Egyptian administration and planning systems, sustainability attainment in the land-use planning process in Egyptian cities, the proposed SPSS, as well as the developed toolbox.

Various recommendations are determined regarding these topics. And so, the future research agenda in the fields of sustainable urban land-use planning, planning support science, and development process in the Egyptian cities is identified.

However, an important question should be firstly discussed:

(10.2) Has the Research Attained its Goals:

The main goal of the research is to design a computational SPSS for supporting sustainability of the land-use planning process in the Egyptian cities. The research presents the technical framework for the SPSS, the requirements for establishing it, and the administrative framework for applying it in Egypt. The research also studies each of sustainability in urban land-use planning, planning support systems, selected previous examples in the field of sustainability assessment using various tools types, and the Egyptian context. This is to thoroughly covering the issue of sustainability assessment of the land-use planning process in the Egyptian cities.

The three secondary goals for attaining the main goal were achieved as shown in the next table:

Table (10.1) The achievement of the three secondary goals of the research:

Secondary goals	Achievement within the research
First goal: is the identification of the constraints for attaining sustainable land-use planning within the existing Egyptian cities through studying their planning and the administrative systems to be the base for designing the technical and administrative frameworks for the proposed SPSS.	The dissertation studied the Egyptian context with its administrative and spatial problems and other problems. And so, it identifies expectations from SPSS to deal with these problems through its administrative and technical frameworks, which are based on extracted lessons from previous experiences.
Second goal: the development of an assessment model (a minimized version or prototype from the proposed SPSS) for assessing sustainability in land-use structure of urban areas and the application of this model on land-use plans of case study areas	An assessment model from the SPSS was identified and established as a new toolbox in ArcGIS™. The assessing criteria of the sustainability attainment in the land-use structure of urban areas in Egypt and Germany were determined to apply the toolbox on two study areas.
Third goal: is the identification of the improvements required in the model and the recommendations for developing the proposed SPSS to be applied on medium or small Egyptian cities.	The dissertation identifies the modifications in the assessment model (developed toolbox) with recommendations for developing and applying the SPSS on medium or small Egyptian cities.

Source: own design

(10.3) The Research Conclusions:

The research conclusions cover its main topics:

(10.3.1) Conclusions Regarding the PSSs:

The PSSs are not only beneficial as assistants in the planning process, they can lead to improvements within the planning practice, and so better outcomes of the planning process. This is in case that the inputs to the analysis process using PSS are efficient enough to produce better planning-decisions and plans.

PSSs represent an added value for the sustainability attainment in urban land-use planning in a special way. As there is a need for supporting instruments such PSSs for dealing with the dynamic complexity in attaining sustainability in the urban development. However, there is no strong evidence that the PSSs can totally deal with the dynamic complexity. But, many successful experiences show the importance of PSSs in sustainability attainment in the urban development process. Chapter 5 presents in details examples for PSSs that support the sustainability attainment and assessment in land-use planning.

On the individual level, PSSs support the learning process about various objects of planning (e.g. problem type), and the perspective of other stakeholders (e.g. the planner can know the residents’ expectations or other experts’ perspectives). On the group level, PSSs support each of the communication, collaboration, consensus, and efficiency within the planning process. On the outcome level, PSSs support obtaining much better plans and decisions.

However, there are disadvantages for PSSs like impeding the urban designer creativity in some cases, and in other cases disturbing the communication process rather than supporting it. Therefore, Pelzer sees that PSSs alone cannot be the magic solution for all the planning problems, because they are beneficial in definite tasks for specific purposes. (Pelzer 2015, p.161)

(10.3.2) Conclusions Regarding the Egyptian Local Administration System:

The local administration system negatively affects the physical development process of the existing Egyptian cities because of the gaps from outside and inside this system. The financial relations between the central and local authorities are the main problem affecting the physical development process from outside the local administration system. The complication within the regulations that identify the nature of the relations between the local popular councils and executive councils is the main problem affecting the physical development process from inside the local administration system. This is because of gaps in the local administration law (act no. 43, 1979).

(10.3.3) Conclusions Regarding the Egyptian Planning System:

The current adopted planning approach in Egypt is the strategic approach, which is based on the public contribution. It has been adopted since the activation of the unified construction law (act 119, 2008) and its executive regulations (2009).The strategic planning is not only land-uses planning, but also roads and infrastructure networks planning with the identification of projects supporting the development, which are called "priority projects”.

The research identifies the gaps in managing the physical planning and development processes in Egypt in general. These are caused from the centralization in managing these processes and the weak horizontal relations among institutions affecting directly and indirectly the physical development on various levels in Egypt. The research also identifies the gaps in managing the land-use planning process in the existing Egyptian cities in particular. As it throws the light on the complication in the management procedure of this process, which causes a long time period for this procedure especially with insecurity circumstances like the revolution time.

However, there are many advantages in the strategic planning approach. These confirm its success, (to some extent) in the re-planning process of these cities like meetings with stakeholders in various planning stages and using satellite images for establishing accurate base maps for the cities’ masses.

<u>(10.3.4) Conclusions Regarding the Sustainability Attainment in the Land-use Planning Process in Egyptian Cities:</u>

The main obstacles facing the sustainability attainment in the land-use planning process in existing Egyptian cities are:

- Management problems as aforementioned.
- Spatial problem represented in difficulties in developing old parts of cities.
- Funding problem because of the main dependence on the governmental resources for funding the required services and infrastructure as well as executing the priority development projects.
- Legislations problem (e.g. there are no obligatory articles within the unified construction law regarding the consideration of the environmental impacts within the land-use plans and no obligatory articles within the planning law for funding the execution of the plans).
- Tenure problem as most of the lands ownerships in the cities are private ownership that makes the matter difficult to allocate public services and infrastructure networks.

For performing the assessment process for the sustainability attainment in the land-use planning of existing Egyptian cities:

- A SPSS is needed to be adopted for assessing the sustainability attainment in the land-use planning process. Its technical framework considers the spatial circumstances with the economic, social, and environmental aspects. And it involves all the entities affecting and affected by the land-use planning process within its administrative framework.
- The criteria for sustainable land-use structures of urban areas are required. These criteria should be appropriate for the Egyptian circumstances and according to the Egyptian planning principles and regulations.

<u>(10.3.5) Conclusions Regarding the Proposed SPSS :</u>

The following points show the advantages in the design of the proposed system:

- The technical framework of the SPSS can be applied for assessing the sustainability attainment of the land-use re-planning of the existing cities in any country, (not only Egypt). This requires the formulation of the pre-defined criteria that are appropriate for the country of application. However, each country needs a unique administrative framework of the SPSS according to the way and problems in managing the urban land-use planning process in it.
- The SPSS is flexible to be applied on master land-use plans (zones level) and detailed land-use plans (parcel level).

- The SPSS can be applied on either parts of cities (areas) or cities.
- The SPSS can be also applied on the suggested plans for new cities to guarantee the sustainability attainment in these cities.
- The SPSS performs specialized criteria for each city beside the general predefined criteria.
- The SPSS interacts with the users’ feedback regarding the specialized criteria for the study area or city.
- The SPSS firstly checks the fulfilment of the suggested state (plan) for the current residents’ needs before checking its fulfilment for the expected residents’ needs. Because unfulfilment of plan for the current residents’ needs means its unfulfilment for the future residents’ needs.
- The SPSS considers the residents expectations and needs.
- A recent satellite image is one of the main entries to ensure the compatibility of the actual state in the study area to the input map of the current state.
- The SPSS is based on AI, so that it can deduce non-predefined information like suggesting the suitable output form for the assessment results and deducing the nature of the city from its characteristics.
- The SPSS has a self-learning ability, as it concludes new criteria from several resembling assessed cases, and it can also learn from successful cases as benchmarks.
- The administrative framework includes all the entities that should be involved within the planning process to ensure the execution of the plan.
- The SPSS considers the social, economic, and environmental parameters beside the spatial ones.
- The infrastructure networks are considered in the assessment process.
- The SPSS supports the decentralization of managing the planning process in Egypt. As the main actors in the SPSS are the regional planning center of GOPP and the physical planning and development administration of the governorate.
- The results are easily understood by users. However, the degree of details of the results are according to the user’s background, (e.g. maps with specific and detailed comments, or simple maps).

Despite all the potentials in the proposed SPSS, it willl not replace the planner’s role, or make the planner totally dependent on technology, as previously mentioned in chapter 1. PSSs are tools for enhancing the performance and outputs of the planning process, but they are not substituent for the planner’s role in this process. Even the artificial intelligence technologies cannot compete the human’s mind potentials. For example, planner should decide adding or omitting items from the suggested specialized criteria for each study area according to the stakeholders’ feedback, (see chapters 6 and 7). The system’s user can also customize the assessment process for focusing on definite aspects.

(10.3.6) Conclusions Regarding the Developed Toolbox:

The developed toolbox supports the sustainable land-use planning by assessing the attainment of the three sustainability dimensions in the land-use structure of the study area. The toolbox results guide the planner to what should be changed. The service accessibility results identify the residential parcels that have no or partial access to the service under assessment, and in need to allocate the service nearby them. The land-use compatibility identify the incompatible land-uses types that should be changed. The land-use sufficiency results identify the land-use types that have shortage in their areas and the areas that are required to be added from these types to fulfill the residents need.

The toolbox has many advantages, the general ones include:

- The toolbox can not only assess an area or a part of the city, it can also assess a whole city in one time.
- Its results can be easily understood by non-expert people in urban planning.
- It can be applied to analyze current or suggested (planned) land-use structures.
- It is flexible to any language of the data entry.
- It is flexible to any country standards.
- It is flexible to any layer type of the input land-use map.

(10.4)The Research Recommendations:

The research recommendations are regarding the following:

(10.4.1) Recommendations Regarding the Challenges Facing the Development and Application of PSSs:

There are two directions for recommendations regarding PSSs:

(10.4.1.1) Recommendations Regarding the PSSs Development:

- Mature technology is important to produce simple and easy using PSSs.
- The provision and harmonization of information support the efficiency of the PSSs.
- The methodology or the procedure programmed in PSSs should be studied regarding its efficiency in solving the planning problem or performing the proposed planning task. As the simple the modeling process of a PSS is, the more successful is this PSS.

(10.4.1.2) Recommendations Regarding the PSSs Application:

- It is beneficial that PSSs support the real time interactive process between stakeholders.
- The simple user-friendly interface for a PSS is important to facilitate the user-interaction with it.
- PSSs should be made transparent and understandable for users.
- The acceptable price of PSSs is very significant.

(10.4.2) Recommendations Regarding the Egyptian Local Administration System:

The local administration system in Egypt needs more empowering to attain the decentralization in Egypt. The following recommendations focus on suggested modifications in this system that may support the sustainability attainment in the urban development process:

- There is a need for changing the centralized financial policy in Egypt, so that each governorate identifies its portion from the national annual budget based on the outputs of the strategic planning process for cities and villages in each governorate. This requires a general political reformation.
- The local popular councils should have the authority to suggest and decide executing development projects.
- The local popular councils should be involved in the assessment process using proposed the SPSS.

- Establishing direct horizontal relations between the local popular councils and executive councils on the city or village or district levels, is required, for avoiding the complicated and time consuming procedure for any development project on these levels.
- Members working in the physical planning institutions (i.e GOPP and the administration for planning and development of the governorate) should be assigned in the executive councils. This is to raise the awareness regarding the development process. At the same time, the executive councils should be involved in an effective way in the all the planning procedure stages, and not only in the preparation stage for plans. The executive councils should be also involved in the assessment process using proposed the SPSS.

(10.4.3) Recommendations Regarding the Egyptian Planning System:

The recommendations for the Egyptian planning system are regarding the general way of managing the physical planning and development processes in Egypt and the procedure of performing plans for cities:

(10.4.3.1) Recommendations Regarding the Management of the Physical Planning and Development Processes in Egypt:

- There is a need for formulating and enacting of connecting articles between each of the planning law (regulating the general finance plan of the country) and the unified construction law. This is to guarantee the funding of the execution of the plans done by the GOPP.
- The MoP (represented by the financial planning administration of the governorate) should be involved in the assessment process in the SPSS, (especially in the final results stage).
- A mechanism (supported by the planning law and the unified construction law) is required for horizontal coordination among the institutions affecting directly and indirectly the physical development process.
- The local branches or administrations of the institutions or entities affecting directly and indirectly the physical development process should be involved in the assessment process in the SPSS, (especially in the data input stage).
- The regional planning centers and the physical planning administrations of the governorates should be the main actors in performing plans of cities and villages.
- There should be an article in the unified construction law for identifying the definite role of each of GOPP and NCPSLU for dealing with the governmental lands within the strategic plans on the levels higher than the local level under the supervision of SCPUD and ministry of defense. This is to solve the contradiction in the legal and institutional framework, regarding the role of the NCPSLU and GOPP in managing the land-uses of governmental lands located outside the legal construction boundaries of cities and villages.
- There should be an article in the planning law for the coordination regulation of the SCPUD and MoP from one side with GOPP and NCPSLU from the other side.
- Articles for empowering the role of regional institutions in the development and planning processes on the regional level should be added to the unified construction law.
- A mechanism is needed to be supported by each of the planning law and the unified construction law. This mechanism is for establishing a horizontal coordination on the

governorate level in performing cities’ plans among each of the physical planning administration, the financial planning administration related to MoP, and branches and administrations related the ministries presenting services projects.

- Training programs are required for engineers in physical planning administration of the governorates and the construction activities control administrations in the local administration units. These are for raising their capacity in using GIS.
- The role of experts should be limited by definite tasks for avoiding the inaccuracy in performing the plans. As these experts are hired by the GOPP and so the planning process sometimes become a kind of business.
- An article for identifying the maximum period for performing the plans should be added to the unified construction law. This is to avoid unconsidered changes in the current state of the city within the re-planning process.
- Strategies (supported by law) are required for motivating the civil society, NGOs, and private sector to be effectively involved in the planning and development processes.
- The representatives of the civil society, NGOs, and private sector should be involved in the assessment process in the SPSS (especially in the data input and the final results stages).
- Modifications are required in the unified construction law for considering the regulations in the environmental law (act 9, 2009) as obligatory conditions in the planning procedure.
- The regulations in the environmental law should be considered in the assessment criteria in the SPSS.

(10.4.3.2) Recommendations Regarding the Procedure of Performing Plans for Cities:

- The regional planning offices should be the actual supervisor on the master strategic planning stage of cities without the need to take the permission from the GOPP for every step.
- Regarding the detailed planning stage, the governor should have the authority for the assignment of re-planned and the un-planned areas. This is according to the validations, which are decided through the cooperation between the physical planning administration of the governorate and the consulting office responsible for the city planning.
- The assignment of the division projects should be through a committee including planning engineers under the supervision of the local popular council, and not restricted by the governor agreement.
- The regulations on the use of any building (or land) in any city should be decided within the governorate with the agreement of the city local popular council, and not restricted by the SCPUD decision.

(10.4.4) Recommendations Regarding the Spatial Problems Facing Sustainable Urban Land-use Planning in Egypt:

(10.4.4.1) Law Modification:

There is a need for modifications in the unified construction law and its executive regulations, in the following:

- The article that allows the existing buildings remain for a permission period (5-10 from the plan assignment) should be modified by decreasing this permission period to not exceed 5 years.

- Adding an article regarding the obligation on the immediate transfer all the polluting activities outside the residential areas is required.
- The application of the environmental impacts assessment in the planning procedure, should be obligatory within the unified construction law.
- The negotiation process with the private land owners should be regulated with definite law articles.

(10.4.4.2) Recommended Strategies:

- The transport system between the existing old cities to the new cities should be improved to encourage the people to live in the new cities.
- The land owners in any city should be invited to be members in the group team for this city or at least representatives for them. This is to make them involved within the plan preparation. And so, they may cooperate by donating parts of their lands to be used as public services and facilities.
- The tenure type of each land should be considered during the process of including lands to the legal construction boundary to include governmental lands, as far as it is possible.

(10.4.5) Recommendations Regarding the Establishment of the Proposed SPSS:

As the SPSS performs three main tasks (assessment of current and planned states, modifications suggestion, and self-learning for adding new criteria) the requirements for establishing the SPSS are also three. These are the general predefined criteria, the rules for formulation of the modifications of the planned state, and the rules for extraction new criteria from resembling cases. The SPSS requirements can be prepared regarding any country (not only Egypt) to apply the SPSS in sustainability attainment in the land-use re-planning of the existing cities in this country. The following are recommended to be studied for the fulfillment of the SPSS requirements :

- The identification of the predefined criteria for the assessment of the current and planned states, which include:

  -The standards of the assessment of the social, economic, and environmental dimensions of sustainability, which include the standards of the roads and infrastructure networks. These are the criteria used in the three groups of urban indicators (including GIS based indicators) within the “realization” and “analyzing sections” of the SPSS.

  -The standards of the assessment of the spatial dimension of sustainability. These are the criteria for each of:

  1. Evaluating the balance between the land supply and demand in the current state of the study area, within the “realization section” of the SPSS.

  2. The assessment of each of the equity of the services distribution, the sufficiency of the areas specialized for various required land-uses, and the compatible relations between land-uses in the planned state of the study area within the “analyzing section” of the SPSS.
- The identification of the rules for suggesting modifications of the planned state within the “action section” of the SPSS.
- The identification of the rules for extracting new criteria from resembling cases within the “knowledge base section” of the SPSS.

There are also identified requirements for adopting SPSS in the planning process for Egyptian cities (stated in chapter 7). These are according to the studied administrative gaps and expectations from the SPSS to deal with these gaps

(10.4.6) Recommendations Regarding the Application of the Developed Toolbox:

The research recommends the following suggested upgrades or improvements for the toolbox for more beneficial results:

(10.4.6.1) General Upgrades in the Toolbox:

- The group of tools can be in several forms including: toolbar, menu list, and software extension to be easily used by the ArcGIS user. This requires extra Python scripting adjustments for each of the dialogue boxes and the formats of the outputs (maps and reports).
- The toolbox can automatically convert the geographic coordinate system of the input layers to projected coordinate system.
- The toolbox can deal with rural spaces.
- The scope of the assessing criteria used in the toolbox can include further criteria. These are:

- The minimum required area per each person from various land-use types.
- The ideal and maximum time for the transfer by vehicles among various land-uses.
- The standard and maximum distance for the transfer by vehicles among various land-uses.
- The standard and maximum distance for the transfer by walking among various land-uses.
- The standard and maximum time for the transfer by walking among various land-uses.

(10.4.6.2) Upgrades in the Land-use Sufficiency Task:

This task does not need upgrading except the format of the output report from this task. As the tool may give the user several options for this format like percentage of the shortage in the area of each evaluated land-use type with regards to the total required area or bar charts for the percentages.

(10.4.6.3) Upgrades in the Services Accessibility Task:

- The services accessibility tools can identify the most appropriate service location(s) to be more accessible by a larger number of residential land-lots.
- The services accessibility tools can be combined to be one tool with several uses.
- The services accessibility tools can assess the accessibility between any two land-uses types, (e.g. commercial and storage land-uses).
- The building of the network analysis can be done in an automatic way by tools not by the user, so that the service accessibility evaluation is done by one tool in one step.
- The toolbox can be applied on complicated roads networks within large cities.

(10.4.6.4) Upgrades in the Land-use Compatibility Task:

- The land-use compatibility tool can suggest the change of the land-use type of any land parcel from inappropriate type to other appropriate type.
- The land-use compatibility tool can be applied on unattached land parcels.
- The time consumed by the land-use compatibility in analyzing the compatibility degree between each two land parcels should be reduced.

(10.5)The Future Research Agenda:

The research agenda in the field of attaining sustainability in urban land-use planning using computational planning support systems is within three directions. These research directions are:

(10.5.1) The Future Research Agenda in the Field of Sustainable Urban Land-use Planning:

- Identifying parameters that connect the four dimensions of the sustainable urban land-use planning (the spatial, economic, social, and environmental dimensions).
- Studying the relations and common issues among the recent urban development concepts like sustainable city, resilient city, and smart city: As each concept is considered complementary for the others and not contradictory.
- Studying and identifying definite strategies for attaining these concepts within the land-use planning process.
- Analyzing the good governance requirements and the institutional aspect for attaining the sustainable urban land-use planning.
- Developing practical participation procedures and tools within the urban land-use planning and the assessment process for it (e.g. via internet).
- Studying various development policies in land-use planning like mixed land-use policy.
- Studying the feasibility of various available assessment tools for the sustainable urban land-use planning.

(10.5.2) The Future Research Agenda in the Field of Planning Support Science:

- Studying the development of new computational tools or systems, which are characterized by being easily understood and having smart interface.
- Studying the development of quick applications (Apps) for supporting quick planning decisions like the best location for a new school.
- Studying the improvements for more mature technologies [1] to develop easily used computational tools or systems: The AI should be the main element in the development of these tools, as the current attitude in the urban development field is towards more smarter urban futures. (Geertman et al. 2017, p.5)
- The development of new computational tools or systems covering various needs within the planning and physical development field: These needs are regarding the scale of application; (local to regional scale), tasks types; (assessing, or generating solutions or alternatives, or monitoring problems), and the state time; (past, current, and future state).
- Teaching the planning support science as a branch in educational institutions for the planning and physical development especially the spatial planning.

(10.5.3) The Future Research Agenda of the Development Process in the Egyptian Cities:

- Ways for introducing constitutional modifications in the country dominant policy of centralization within the financial, governance, administrative, and development fields.
- Revising the laws that directly and indirectly affect the physical development process, for formulation of a comprehensive law for managing this process in Egypt.

[1] As previously mentioned, the corner stone in developing any PSS is the technology used in it (Klosterman and Pettit 2005, p.477). As technology is getting more sophisticated and mature, as it is getting easier to use. (Greetman and Stillwell 2009, p.12).

- Reforming of the local administration system and the role of the local popular and executive councils and their relations with the local administration units.
- Studying the authorities of MoP and MoF in deciding funds for the physical development projects.
- Reforming of the vertical relations and horizontal relations within the institutions affecting directly and indirectly the physical development for establishing channels for cooperation between these institutions.
- Developing strategies for encouraging land-owners to donate lands for allocating services and facilities.
- Formulating polices for encouraging the citizens’ movement from existing communities to new communities.
- Performing connecting studies between the environmental and social impacts and land-use changes.
- Formulating policies for finding alternatives, (other than the governmental resources) for funding the urban development process.
- Establishing a national computational platform for the management of the roads and infrastructure networks with connection to changes in the land-use structures.

APPENDICES

<u>(A1) Appendix 1</u>
<u>The Indicators of the Development Sectors</u>

This appendix presents the list of city indicators for assessing the current state regarding the six development sectors in the city. These are according to the terms of references (TOR) for preparation of the strategic master and detailed plans of the Egyptian cities. These indicators represent the first step of the first stage (task 7) within the re-planning process of the existing Egyptian cities.

This list is important for the establishment of the proposed SPSS, as the indicators within this list should be considered in the identification of the indicators base of this SPSS. These indicators are:

<u>(A1.1) The Shelter Sector Indicators:</u>

There are 17 indicators for assessing the shelter issues: (appendix no.16, TOR, GOPP 2010)

- Four indicators for assessing “the tenure secure and housing financing”:
  1. “Tenure type”.
  2. “Average of the residential unit price with regards to the family income”.
  3. “Financing”,
  4. “Financial support”.
- Three indicators for assessing “the housing state”:
  1. “Person portion from the residential area”.
  2. “Construction materials”.
  3. “Congestion rate”.
- Three indicators for assessing “the housing market”:
  1. “Rate of vacant residential units”.
  2. “Rate of occupied residential units”
  3. “Percentage of families without shelter”
- Three indicators for assessing “the housing production”:
  1. “Rate of constructing new residential buildings”.
  2. “Investment in the housing field”
  3. “Percentage of the housing investment from the gross domestic product of the country”
- Two indicators for assessing “the lands issue”:
  1. “Percentage of the income with regards to land price”
  2. “Lands allocated for housing uses”
- Two indicators for assessing “the issue of slums or informal areas”:
  1. “Informal areas’ residents”.
  2. “Provision of the informal areas with facilities”.

<u>(A1.2) The Local Economy Sector Indicators:</u>

There are 6 indicators for assessing the local economy issues: (appendix no.17, TOR, GOPP 2010)

1. “The informal employment”.
2. “The city’s local production or the city domestic product”.
3. “The development of economic activities”.
4. “Unemployment”
5. ”The changes in the family income”.

6.“The sharing in the employment market”.

(A1.3) The Local governance Sector Indicators:

There are 3 indicators for assessing the local governance issues: (appendix no.18, TOR, GOPP 2010)

1. “Income and expenditures”.
2. “Human resource in the city administration unit”.
3. “The cooperation with the international and the national organizations”.

(A1.4) The Indicators of the Infrastructure and Environment Sectors:

There are 13 indicators for assessing the infrastructure and environmental issues (two sectors): (appendix no.19, TOR, GOPP, 2010)

1.“Water consumption”.
2. ”The average of the water price”.
3. “Water quality”.
4.“The treated sewage water”.
5. “Solid wastes”.
6.“The disposal of the solid wastes”.
7. “Air pollution”.
8. “Time of transport within the city”.
9. “The transportation tools types”.
10.“The ownership of the private vehicles”.
11. “Roads state”.
12. “Electricity”.
13.“Communication”.

(A1.5) The Indicators of Sector of the Social Development, Poverty, and Marginalized People Issues:

There are 12 indicators for assessing the social development, poverty, and marginalized people issues: (appendix no.20, TOR, GOPP 2010)

1. “Population”.
2. “Population characteristics”.
3. “The rate of new family formulation”.
4. “Poor families”.
5. “New born rate”.
6. “Death rate”.
7. “The natural increase rate”.
8. “The rate of the death of the mothers during the giving birth”.
9. “The rate of the death of the children under the age of 5 years”.
10. “The number of physicians”.
11. “The number of beds in the hospitals”.
12. “The education rate”.

(A2) Appendix 2

The Priority Projects of the Master Strategic Plan of Asyut City, Upper Egypt

This appendix presents a list for a number of 30 identified priority development projects regarding the six development sectors within the master strategic plan of Asyut city (GOPP 2014). These projects are mentioned as examples for the priority projects, which are identified in the second step of the first stage (task 3) within the re-planning process of the existing Egyptian cities.

This list shows the types of the priority development projects, which can be non-spatial projects or spatial projects as follows: (Report of Asyut master strategic plan project, GOPP 2014).

(A2.1) The Shelter Sector and Slums Issues:

1.The upgrading of the old area in the west of the city.

2. The development of the slum areas and limitation their growth for preventing the establishment of new slums areas.

3. The establishment of economic housing buildings for fulfilling the current and the future demand on residential units.

(A2.2) The Sector of the Basic Services and Infrastructure:

4. The improvement of the basic education in the city through the establishment of a number of 39 primary school with1192 classes and a number of 46 preparatory schools with 682 classes until the plan target year.

5. The improvement of the secondary education through the establishment of a number of 16 secondary schools, which include general secondary schools for Asyut City and specified secondary schools (agricultural, industrial, and commercial secondary schools) for the villages within “Asyut Markaz”.

6. The improvement of the health service in the city and establishing a mental health hospital.

7. The improvement of the youth service by establishing a number of 23 youth centers.

8. The establishment of a transport terminal for taxis, buses, mini, and micro buses for serving all the city’s areas.

8. Establishing a new tunnel under the rail way line that divides Asyut City into two parts for more connection between the east and the west of the city.

10. The supply of the disadvantaged areas with infrastructure networks.

11.The re- design and planning of the city entrances in the way that their capacities will be suitable for the traffic volume.

12.The establishment of 4 high tanks.

13. The establishment of a water supply station.

14. The establishment of 5 distribution electricity boards.

15. The upgrading of the edges of the “River Nile” and “El-Ebrahimya” Canal (in the North of Asyut).

16 . The upgrading of “El-Gomhorya” street.

17. The upgrading of “El-Zahraa Tunnel” park.

18. The establishment of a bridge for connecting the north and the south of “El-Ebrahimya Canal”.

(A2.3) The Local Economy Sector:

19. The establishment of a center for the businessmen services.
20. The establishment of a tourist service project as part of the tourism development of the city.
21. Programs for establishing small technology companies in the city.

(A2.4) The Urban Governance Sector:

22. The building capacity of the local public council leaders.
23. Organizing training programs for the employers in the housing ministry’s branch in each of the leadership and decision-making skills.

(A2.5) The Sector of the Environment Protection Issues:

24. A project for the solid wastes management with partnership of the private sector.
25. Recycling the solid wastes.
26. A project for increasing the residents’ awareness about the environment.
27. The renewal of the cleaning equipments used in Asyut city.
28. A project for covering a part from “El-Mallah Canal” (in the south of Asyut) for a distance of 2 Kilometers.
29. A project for transferring the craft workshops within the city to an industrial area in a village called “Doronka” in the South West of Asyut for the alleviation of noise and air pollution problems.

(A2.6) The Sector of Social development, Poverty, and Margined People Issues:

30. A project for formulating new regulations for facilitating the procedure of obtaining financial supports for women, who are responsible for families.

(A3) Appendix 3
The City Development Prospective

This appendix presents the list of items included within the study of the city development perspective. These items are according to the terms of references (TOR) for preparation of the strategic master and detailed plans of the Egyptian cities. The city development perspective represents the third step of the first stage (task 7) within the re-planning process of the existing Egyptian cities, as follows: (appendix no.40, TOR, GOPP 2010).

- The historical development and emergence of the city.
- The relations of the city including the economic role of the city in the governorate.
- The physical extension of the city’s mass.
- The development axes and hubs in the city including the demographics, the administrative divisions, and the urban design.
- The economy situation of the city including each of the role of the private and informal sector in it, urban poverty, the health services, education, infrastructure and urban services, water sources, sewage, collection and recycling of solid waste, the road lighting, the energy sources, as well as transportation.
- The shelter and slums issues including each of the regulations organizing the residential areas in the city, the tenure security, adequate shelter and resource mobilization, as well as supporting the institutional capacity building and training.
- The cross-sectoral issues including the social services and the basic infrastructure networks.
- The analysis of the characteristics of the land on the edges of the city’s physical mass.
- The required future services.
- The development and dynamics of the local economy including the institutional framework, financial resource for local administration and current programs.
- The data analysis of the field survey of the city.
- The SWOT analysis.
- The analysis of the regional impacts on the basic urban services.
- The need from these services till the plan’s target year.
- The local economy development.
- The future vision and goals.
- The strategic lines of the sectoral development projects.
- The strategic plan of the city including the existing housing areas, the re-planning areas, the unplanned areas that need to be developed and the suggested land uses in the master strategic plan.
- The new legal construction boundary for the city.
- The construction regulations for various areas in the city.
- The logical framework approach (LFA).
- The investment plan.
- A brief description of the priority projects.

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Abbreviations:

Abbreviation	Based on	Firstly mentioned in
A		
ABM	Agent-Based Model	Chapter 4
AHP	Analytical Hierarchy Process (mentioned in more than one example)	Chapter 5
AI	Artificial Intelligence	Chapter 1
AL	Analytical Learning	Chapter 4
ANN	Artificial Neural Network.	Chapter 4
C		
CA	Cellular Automate	Chapter 4
Cabinet	Ministers’ council	Chapter 7
CAMPAS	The Central Agency for Public Mobilization and Statistics, Egypt	Chapter 7
CAPCOG	Capital Area Planning Council of Governments (USA's Example)	Chapter 5
CBR	Case-Based Reasoning	Chapter 4
CCDs	Census Collection Districts (Australia example)	Chapter 5
CEM	Compatibility Evaluation Model (Netherlands' Example)	Chapter 5
CLD	Causal Loop Diagram (India’s Example)	Chapter 5
CoT	Cost of Travel (Iran example)	Chapter 5
COTS	Commercial-off-the-shelf	Chapter 4
CUF	California Urban Futures	Chapter 4
CUPUM	Computers in Urban Planning and Urban Management	Chapter 4
D		
DCA	Decision Consequence Analysis	Chapter 3
DECIDE	D:Determine, E: Explore, C: Choose, I: Identify, D: Decide, and E: Evaluate	Chapter 4
DMSS	Decision Making Support System	Chapter 4
DSSs	Decision Support Systems	Chapter 4
DUEM	Dynamic Urban Evolutionary	Chapter 4
E		
EIA	Environmental Impact Assessment	Chapter 3
EPIs	Environmental Pressure Indicators	Chapter 3
ES	Expert System (Cyprus' Example)	Chapter 5
ESULU	Evaluating Sustainability in Urban Land Use (China example).	Chapter 5
ET	Envision Tomorrow (USA's Example)	Chapter 5
F		
FAR	Floor Area Ratio (India’s Example)	Chapter 5
FESLM	Framework for Evaluation Sustainable Land Management (China example1).	Chapter 3, Chapter 5
G		
GA	Genetic Algorithm	Chapter 4
GAs	Genetic Algorithms (Cyprus' Example)	Chapter 5
GDP	Gross Domestic Product	Chapter 3
GDR	Group Decision Room	Chapter 4
GeoVUE	Geographic Virtual Urban Environments	Chapter 4
GIS	Geographic Information Systems	Chapter 1
GLFI	"global land fragmentation index" (Cyprus' Example)	Chapter 5
GOPP	General Organization for Physical Planning	Chapter 1
GUIs	Graphical User Interfaces	Chapter 4
H		
HTML	Hypertext Markup Language	Chapter 4
I		
ICT	Information and Communications Technology	Chapter 4
IGAS	The Integrated GIS-based Analysis System (China example2).	Chapter 5
INSPIRE	Infrastructure for Spatial Information in Europe	Chapter 4

Abbreviation	Based on	Firstly mentioned in
ISEE	Integrated Spatial Equity Evaluation framework (Iran example)	Chapter 5
ISEW	the index of sustainable economic welfare	Chapter 3
IT	information technology (INDEX Example)	Chapter 5
L		
LACONISS	Land Consolidation Integrated Support System (Cyprus' Example)	Chapter 5
LCC	Land Consolidation Committee (Cyprus' Example)	Chapter 5
LEAM	Land-use Evolution and impact Assessment Model “”	Chapter 4
LFA	logical framework approach	Chapter 7
LFI	"the land fragmentation index"(Cyprus' Example)	Chapter 5
LLUM	Local Land Use Mix index	Chapter 3
LPC	Land Per Capita (Iran example)	Chapter 5
LPCs	Local Popular Councils	Chapter 7
LSA	Land Suitability Analysis	Chapter 4
LUCC	Land use and land cover change	Chapter 4
LUF	Land Use Frequency indicator	Chapter 3
LUM	Land Use Management index	Chapter 3
M		
MADM	Multi-Attribute Decision-Making method (Cyprus' Example)	Chapter 5
MA-OWA	Majority Additive-Ordered Weighted Averaging method (Netherlands' Example)	Chapter 5
MCA	Multi-Criteria Analysis (mentioned in more than one example)	
MCA	Multi Criteria Analysis (China example2).	Chapter 5
MHUUD	Ministry of Housing, Utilities, and Urban Development	Chapter 7
MIPS	The product Material Intensity Analysis index	Chapter 3
MODM	Multi-Objective Decision-Making method (Cyprus' Example)	Chapter 5
MoF	Ministry of Finance	Chapter 7
MOLD	Ministry of Local Development	Chapter 7
MoP	Ministry of Planning and International Cooperation	Chapter 7
N		
NCeSS	National Centre for e-Social Science	Chapter 4
NCPSLU	The National Center for Planning the State Lands Usages	Chapter 7
NGOs	non-governmental organizations-	Chapter 1
NGOs	Non-Governmental Organizations	Chapter 2
NOUH	The National Organization for Urban Harmony	Chapter 7
NSA	Neighborhood Sustainability Assessment	Chapter 3
NUO	National Urban Observatory	Chapter 1
P		
PCA	Principal Component Analysis (China example).	Chapter 5
PCC	The mean Parcel Concentration Coefficient (Cyprus example)	Chapter 5
PGIS	participatory geographic information systems (Iran example)	Chapter 5
PSSs	Planning Support Systems	Chapter 4
Q		
QGIS	Quantum GIS	Chapter 8
R		
RBS	Rule-based system	Chapter 4
RL	Reinforced Learning	Chapter 4
S		
SA	Simulated Annealing	Chapter 4
SCE	Shuffled Complex Evolution	Chapter 4
SCPUD	The Supreme Council for Planning and Urban Development	Chapter 7
SD	System Dynamic (China example2)	Chapter 5
SDSS	Spatial Decision Support System	Chapter 4
SEA	Strategic Environmental Assessment	Chapter 3
SI	Swarm Intelligence	Chapter 4

Abbreviation	Based on	Firstly mentioned in
SIA	Sustainability Impact Assessment	Chapter 3
SIAM	Sustainability Impact Assessment Model (Netherlands' Example)	Chapter 5
SILENT	Sustainable Infrastructure, Land-use, Environment and Transport Model (Australia example)	Chapter 5
SLM	Sustainable Land Management	Chapter 3
SMCA	Spatial Multi-Criteria Analysis (Iran example)	Chapter 5
SMCA	Spatial Multi-Criteria Analysis (Iran example)	Chapter 5
SNI	Sustainable National Income Index	Chapter 3
SPSS	Spatial Planning Support System	Chapter 1
SULUES	Sustainable Urban Land Use Evaluating System (China example).	Chapter 5
SWOT	Strengths, Weakness, Opportunities, Threatens	Chapter 7
T		
TBL	Triple Bottom Line approach	Chapter 3
TOR	Terms Of Reference	Chapter 1
U		
UGBs	Urban Growth Boundaries (Haiez)	Chapter 7
V		
VBA	Visual Basic for Application (Cyprus' Example)	Chapter 5
W		
WLC	Weighted Linear Combination (Iran example)	Chapter 5
WLC	weighted linear combination (Iran example).	
WOL	Web Ontology Language	Chapter 4
X		
XML	Extensible Markup Language	Chapter 4

Egyptian Arabic Terms:

- Cordon"كردون" : the administrative boundary for the security and the administrative authority for any physical community.
- Fadan "فدان" : an Egyptian area unit = 4200 m^2
- Haiez "حيز": The urban growth boundaries or the legal boundary for construction activities, (i.e. it is totally forbidden to construct any building outside this boundary).
- Markaz "مركز" : a part of a governorate that includes one (or, in rare cases two cities), in addition to some villages
- Zemam "زمام" : the boundary for the agricultural lands, (cultivated and uncultivated), which are subject to the agricultural land tax or property tax. This is called “Zimam” in Arabic, and is mainly connected to villages.

German Terms:

- Baugesetzbuch-BauGB: the federal building code
- Bauleitplanung: the land use planning process
- Baunutzungsverordnung-BauNVO: the land utilization ordinance.
- Bebauungsplan– B-Plan: the binding land-use plan
- Bundesamt für Bauwesen und Raumordnung-BBR: the federal office for building and regional planning.

- Bundes-Raumordnungsgesetz: the federal spatial planning law
- Bundesrepublik Deuschland: the federal republic of Germany
- Flächenländer: area states
- Flächenutzungsplan– FNP: the preparatory land-use plan
- Geminden: municipalities
- Kreis-freie Städte: county-free cities
- Länder: states
- Land-Kreise: counties
- Planzeichenverordnung: the plan notation or symbols ordinance
- Raumordnung: the spatial planning process
- Regierungsbezirke: administrative districts (political division)
- Stadtstaaten: city states

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- 10.2016, *GIS Talk*, Esri Deutschland, Munich, Germany.
- 9.2017*, Real CORP,* Vienna University of Technology, Austria.
- 11.2017, *International Land Use Symposium (ILUS) 2017*, Leibniz Institute of Ecological Urban and Regional Development (IOER) in Dresden, Germany.