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Evaluation of Innovation Capacity in Egyptian Governorates

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To the memory and spirit of my supervisor, Attila Varga, who passed away on October 23, 2023.

Attila Varga was a brilliant researcher as well as a dedicated educator. He was always willing to assist his pupils, and he had a significant effect on my academic career. I will never forget his guidance and support, and I'm glad for the chance to work under his supervision.

I shall always treasure my memories of Attila Varga. He was a person who was kind and encouraging. I shall be eternally thankful for his friendship and mentoring.

Dedication

In honor of my parents and my wonderful, faithful wife, I dedicate this dissertation

والديّ الأحباء وزوجتي الرائعة المخلصة أهدى اليكم هذه الرسالة

Acknowledge

Praise and thanks be to God for His help and assistance in accomplishing this work.

Since embarking on my PhD journey in September 2018, I have come to recognize the invaluable contributions of many others to my success.

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List of Abbreviations

ASRT: Academy of Scientific Research and Technology

BUS: business services activities

CAPMS: the Central Agency for Public Mobilization and Statistics

CCC: Commander Control Center

COC: City Operating Center

EIS: European Innovation Scoreboard

EPO: Egyptian Patent Office

GCR: Greater Cairo Region

GERD: Gross Expenditure of Research and Development

ICT: Information and communication technology

IoT: Internet of Things

IPP: Innovation Policy Platform

IT: Information technology

LQ: Location Quotients

MENA: The Middle East and North Africa

NAC: New Administrative Capital

NCA: New City of El Alamein

NUCA: New Urban Communities Authority

OECD: Organization for Economic Co-operation and Development

OTT: Over the Top

RIC: Regional Innovation Capacity

RICI: Regional Innovation Capacity Index

RIPs: Regional Innovation Policies

RIS: Regional Innovation System

RQ: Research Question

SC: Smart city

SLR: Systematic Literature Review

SQs: Search Queries

TTOs: Technology Transfer Offices

TICO: Technology Innovation Commercialization Office

Abstract

In 2016, Egypt launched its new national development strategy, Egypt Vision 2030, aiming to address socio-economic challenges and achieve sustainable development. This strategic plan sets out a comprehensive agenda to guide the country's progress. Its main objective is to address pressing issues and provide a solid foundation for development and a bright future for the nation. The new strategy underlines the crucial role of *innovation* in promoting balanced regional development in the country.

In response to the challenges outlined in the strategy, Egypt has decided to create fourteen new urban centers, commonly referred to as *fourth-generation* or *smart cities*. Construction has started, and the cities are now at various stages of implementation. Through the establishment of these modern urban centers across the country, policymakers aim to achieve a more balanced regional development of the country. In addition, political decision-makers envision these new cities as Egypt's future innovation hubs, which will shape the growth and development of their regions and the entire country. The strategy stresses that for these new cities to become innovation hubs, they need to have a strong and efficient innovation ecosystem.

As smart cities, this new generation of urban centers is characterized by their heavy reliance on modern technology, in particular, information and communication technologies (ICT) and artificial intelligence, which is expected to accelerate the transformation of the whole country into a high-tech society. On the other hand, smart cities are expected to attract tens of millions of educated and talented individuals, thanks to the millions of job opportunities, and the promise of a high quality of life provided by modern urban services. The influx of masses into new cities is a positive phenomenon in two respects. Firstly, moving people to these new cities is a potential solution for areas (existing big cities) facing persistent overpopulation due to population growth. Second, the high concentration of talented people (and their activities) in these new cities is essential for the creation and maintenance of a well-developed innovation ecosystem. In addition, according to the planning documents, policymakers intend to implement numerous policy measures that promote the emergence of key components of the innovation ecosystem in the new cities. On the other hand, in line with smart city literature, it is assumed that new smart cities themselves will have the potential to generate innovation.

Nevertheless, theories that explain the spatiality of innovation emphasize that innovation's emergence depends on the characteristics of a region. This underscores the

importance of location, physical proximity, and spatial factors such as unique attributes, resources, and opportunities. The Egypt Vision 2030 and other related planning documents clearly emphasize that the background conditions and endowments within the governorates of new cities are key to the success of Egypt's innovation-focused regional development policy. However, in addition to emphasizing the above, the planning phase of smart cities did not include a comprehensive assessment of the innovation capacity of the governorates hosting the new smart cities.

Consequently, in my dissertation, *I investigate the extent to which the governorates of Egypt can foster the development of new smart cities as innovation hubs*. To answer this question, *I analyze the innovation capacity of Egyptian governorates*. It can be assumed that Egyptian governorates with a higher innovation capacity are in a better position to contribute to the creation of high-level innovation centers. Conversely, governorates with low innovation capacity can only contribute to a limited extent.

In my dissertation, I used three different research methods: (1) a systematic literature review, (2) a qualitative approach involving the analysis of policy documents and conducting semi-structured interviews with high-ranking Egyptian officials, and (3) a quantitative approach comprising three empirical techniques; namely the construction of a composite indicator of regional innovation capacity (RICI), cluster analysis, and spatial autocorrelation analysis. Thanks to my scientific research, first, I have gained valuable insights through a comprehensive literature review focused on innovation-driven regional development. The innovation theory emphasizes the importance of fostering interactions and collaboration among local actors in the innovation process, along with their competencies and capabilities that develop through localized mechanisms that facilitate these interactions. Second, by examining case studies of smart cities in some developing countries, one can observe that the concept has the potential to effectively tackle numerous urban challenges and also contribute to regional development goals. Third, a thorough analysis of Egyptian policy documents has revealed that significant differences in innovation elements exist among various Egyptian governorates. Fourth, interviews with Egyptian officials also stressed the importance of considering the territorial aspects and regional conditions of each governorate. Fifth, the assessment of the innovation capacity of Egyptian governorates revealed significant differences in knowledge production, knowledge use, and supporting background factors. Measuring regional innovation capacity is key because it is theorized that governorates with a strong innovation capacity are more likely to contribute effectively to an innovation-driven regional development. Conversely, those with limited innovation

capacity are less likely to meet the ambitious objectives of Egypt’s new strategy. Policymakers should focus on increasing the innovation capacity of the latter group to contribute to balanced regional development.

Keywords: regional development, innovation capacity, smart cities, new (fourth-generation) cities, Egypt Vision 2030, spatial autocorrelation

1. Introduction

1.1 Research topic

Egypt faces many challenges. First, the government faces a major challenge in effectively managing the country's rapid population growth, which strains the available resources and infrastructure. Egypt's population grew from 27 million in 1960 to 71.4 million in 2000 and 110.9 million in 2022 (World Bank, 2023a). Second, there is a shortage of habitable land, which makes urban development and expansion difficult. Third, there are significant regional disparities resulting from the unequal distribution of economic activities and population across the country. There is a sharp contrast between the population densities of different regions. The Nile Valley and Delta regions are densely populated. In general, urban areas have lower rates of poverty and more employment opportunities than rural areas. Especially in southern and remote areas, where poverty and unemployment are high. Fourth, previous attempts at economic reform have consistently failed due to a lack of a clear vision and strategy (Ministry of Planning and Administrative Reform, 2014).

In response to the above-mentioned challenges, Egypt unveiled its ambitious national development strategy in February 2016. The National Sustainable Development Strategy, known as *Egypt Vision 2030*, provides a comprehensive framework that outlines the nation's goals, initiatives, and directions to achieve sustainable development by 2030. The government has created the strategy as a comprehensive roadmap to address the above-mentioned problems and lead the country toward a more sustainable future. It has three major dimensions: economic, social, and environmental, which are divided into ten fundamental pillars.

A key goal of the strategy is to achieve *balanced* regional development in the country. Egypt's Vision 2030 clearly emphasizes the pivotal role of *innovation* in driving regional development: it aims to achieve balanced regional development through an *innovation-driven regional development policy*. As the main element of this new regional development policy, Egypt has decided to create new urban centers. These new urban centers are commonly called *fourth-generation cities*, referring to the latest generation of new cities in Egypt. The creation of the fourth-generation of new cities is currently underway. Egypt's Vision 2030 envisages the establishment of fourth-generation cities in *different regions of the country*, including Greater Cairo, Alexandria, the Suez Canal, the Delta, and the southern regions of Upper Egypt. As a first step in this ambitious undertaking, the government has initiated the construction of 14 new urban centers in different governorates across the country. The total area of these fourth-generation cities amounts to approximately 380,000 acres, which represents 50% of the total area of urban settlements implemented in the previous 40 years. It is planned that once these new urban centers are fully developed, they will accommodate around 14 million people and provide approximately 6 million direct job opportunities (Abbas, 2021). This new generation of cities, also known as *smart cities*, differs from the previous generation of Egyptian new cities in that they place a strong emphasis on innovation, sustainability, and the use of ICT (Mostafa & Beshir, 2023; Waisová, 2022). According to official visions, Egypt's fourth-generation smart cities will be technologically advanced, seamlessly integrating technology into urban life to enhance residents' experiences and promote innovation and sustainability. These new cities will have plenty of green space, parks, and gardens emphasizing the significance of a healthy environment and enhanced quality of life. Innovative buildings will use renewable energy, waste-to-energy technologies, and sustainable practices, lowering the city's ecological impact dramatically. To generating international interest, the Egyptian government showcases promotional videos highlighting these modern cities of the future[1].

The creation of Egyptian new cities can be divided into three phases. The first phase entails the construction of essential infrastructure such as roads, utility networks, ICT, power plants, and water supply systems. The second phase concentrates on the construction of residential areas and planned land uses (institutions, universities, schools, government agencies, etc.). Finally, the third stage is the start of the cities' operation, when residents begin to move in and settle in the new cities (NUCA, 2023). In line with the expectations of the New Urban Communities Authority (NUCA), the entire infrastructure for all planned fourth-generation cities was successfully constructed between 2018 and early 2023. The second phase has already been completed in five cities (NUCA, 2023). Furthermore, nine cities are still in the second phase of implementation, working on finishing their residential neighborhoods, projects, and planned land uses. The most significant progress has been made in the New Administrative Capital (NAC), since the beginning of 2023, all ministries, the Prime Minister's Office, Parliament, and other government offices have moved to the NAC.

[1] Some examples: https://martinahauser.com/egypts-new-smart-cities-projects-that-will-be-totally-reliant-on-technology/ https://youtu.be/zTUAJp4dhgw (available 22nd December 2022)
http://www.newcities.gov.eg/know_cities/default.aspx (available 25th June 2023)

Recently, the smart city concept has moved beyond its original focus on addressing solely urban challenges through ICT and has taken a broader role. Smart cities are no longer simply about leveraging technology to plan and provide sophisticated urban services, but also serve as tools for promoting innovation and regional development (Appio et al., 2019; Kraus et al., 2015; Ratten, 2017). Consequently, according to Egypt's vision, fourth-generation smart cities will not only address the challenges posed by a growing population, but will also strive to become innovation hubs and support innovation-driven balanced regional development. Egypt Vision 2030 stresses that for these new cities to become true innovation hubs, they need to have a robust innovation ecosystem. Policymakers firmly believe that these new cities, equipped with state-of-the-art urban services thanks to cutting-edge technology, are expected to attract millions of educated and skilled people. The influx of people into new cities is a positive phenomenon in two respects. This, on the one hand, is expected to alleviate urban tensions in other big Egyptian cities, where they were formed due to rapid population growth, and to result in a more balanced spatial distribution. On the other hand, Egyptian policymakers recognized that a significant concentration of talented and educated human resources is essential for establishing new cities with a robust innovation ecosystem.

Thus, it is clear that the main goal of the Egyptian government is to achieve balanced development in the country through innovation. Nevertheless, theories that explain the spatiality of innovation emphasize that innovation's emergence depends on the characteristics of a region. This underscores the importance of location, physical proximity, and spatial factors such as unique local attributes, resources, and opportunities (Barca et al., 2012). Egypt's existing governorates and regions differ in terms of conditions, capacities, and potentials. For example, Khorshid et al. (2020) revealed significant differences in knowledge production and innovation output among Egyptian governorates, especially between the southern regions and the Greater Cairo area.

The Egypt Vision 2030 and other related planning documents clearly emphasize that the background conditions and endowments within the governorates of new cities are key to the success of Egypt's innovation-focused regional development policy cities (Ministry of Planning and Administrative Reform, 2014). There is no doubt that the current capabilities of the governorates serve as a primary source for the high-level innovation ecosystem of the planned smart cities. However, *the planning phase of Egyptian smart cities did not include a comprehensive assessment of the innovation capacity of the governorates hosting the new* *smart cities*. Consequently, in my dissertation, I examine **how fourth-generation smart cities are expected to contribute to the balanced, innovation-driven regional development of the country**. However, I do not evaluate how successful the Egyptian smart city program is or will be. This is not even possible, as the implementation is still in progress. I examine, however, **which Egyptian governorates are most likely to facilitate the successful implementation of the proposed innovation-driven smart city program.** The goal is to determine **which Egyptian governorates' Regional Innovation Systems (RIS) are prepared for policy implementation**. Merely developing roads, buildings, and institutions such as universities and research centers, and introducing advanced technologies like ICT and AI are necessary, but not sufficient for new cities to succeed as innovation hubs. The major factors here are the quality of human capital and the availability of knowledge – both inputs and outputs of innovation. Consequently, to comprehend these governorates' potential for success, it is essential to explore their inherent innovation capacity.

1.2 Research Questions

To understand and assess the feasibility of Egypt's new innovation-driven regional development policy, it is essential to examine the country's regional-level innovation performance. By assessing innovation capacity, which refers to a critical output and indicator of a Regional Innovation System, my aim is to determine whether Egyptian governorates are sufficiently developed and prepared to implement the goals of the current national development strategy. Therefore, my primary research question is as follows:

Do the Egyptian governorates have enough innovation capacity to foster a high-level innovation ecosystem in the new (smart) cities, thereby achieving a balanced regional development of the country?

More precisely, there are three groups of sub-questions (RQ1, RQ2, and RQ3) associated with the main research question that require attention:

RQ1: What is a Smart City (SC)? How has this concept evolved? What are its main components? What role can it play in regional development and how can it foster innovation? For what purpose and in what way is the SC concept used in developing countries?

- **RQ2**: How does Egypt intend to adapt the smart city concept to accomplish the balanced, innovation-driven development of the country? How Egyptian officials evaluate the new, fourth-generation (smart) city program?

- **RQ3**: What is the innovation capacity of the Egyptian governorates? Which Egyptian governorates have the most innovation capacity to foster innovation-driven regional development in new cities?

The third set of sub-questions relates to the empirical research. The conducted empirical investigation allowed for testing the following three hypotheses:

- **H1**: The innovation capacity of Egyptian governorates shows significant differences.
- **H2**: Egyptian governorates can be grouped into homogeneous clusters based on their innovation capacity, differing from each other along dimensions describing innovation capacity.
- **H3**: There is no spatial clustering or pattern of similarity in innovation capacity among neighboring governorates in Egypt.

Table 1 lists the examined research questions and applied research methods for each chapter.

Table 1. Research questions (RQs) and research methods

RQs	Research methods	Sub-chapter
RQ1	Systematic Literature Review (SLR)	Chapter 2.3
RQ2	Synthesizing policy documents *(Literature review)*, Narrative analysis (*Interviews* with officials)	Chapter 3.1 Chapter 3.2 Chapter 3.3
RQ3	Regional Innovation Capacity Index – RICI (*Composite indicator*), Spatial clusters of innovation capacity (*K-means cluster analysis*), Spatial similarity (*Spatial autocorrelation analysis*)	Chapter 4

Source: own edition.

1.3 Structure and Methodology

The dissertation is divided into four parts: a theoretical section (Chapter 2), analytical and empirical sections (Chapters 3 and 4), followed by the concluding theses of the dissertation (Chapter 5). As shown in Figure 1, these are followed by the practical implications, limitations, and future research directions (Chapter 6).

Chapter 2. Theoretical foundation

Since Egypt adopted a new development strategy in 2016 that prioritizes balanced regional development through *innovation-driven* regional development policy, I decided to start my research with **a systematic review of the literature and theories on innovation-driven regional development**. Consequently, in Chapter 2.2, I reviewed the theoretical basis for innovation-based regional development.

The Egyptian government has announced plans to build new cities with advanced *innovation ecosystems*. The government believes that by creating these new cities with strong innovation ecosystems, it can achieve a significant improvement in the country's innovation performance. Therefore, in Chapter 2.2, I have also examined **the Regional Innovation System (RIS)** approach to show how it can lead to high-level of innovation.

Building new cities is a key element of Egypt Vision 2030. However, building new cities is not a new concept in Egypt. The fourth-generation of new cities is currently underway. However, Egypt now aims to create *smart* cities. Accordingly, **the literature on smart cities,** including **definitions, components, requirements, and tools,** is thoroughly examined in Chapter 2.3. In addition, Egypt also considers the smart city concept as *a key part* of its innovation-driven regional development strategy. Consequently, in Chapter 2.3, I also explore the smart city literature to understand how smart cities can serve not only as a tool for urban planning and delivering advanced urban services through ICT but also to foster innovation.

Furthermore, I look at **smart city initiatives in developing countries** to understand better the reasons behind implementing smart city programs. My aim was to understand the reasons *why* and *how* these countries used SC approach. The aim of this chapter is not to analyze the results or success of smart city programs in developing countries. First, because there is no universally applicable evaluation model. For another, smart cities are still a relatively new concept, especially in developing countries. In my analysis, I examined the general objectives of the smart city strategies.

The second chapter concludes by providing an overview of the findings derived from the systematic literature review and case study analysis. In Chapter 2, I conducted a thorough literature review to evaluate the theoretical foundations of the above-mentioned topics (such as innovation-driven regional development, the RIS, and the smart city concept). **Systematic Literature Review (SLR)** is an effective method for identifying relevant literature. It necessitates thorough documentation of the whole search and selection process. I described the SLR method in depth in Chapter 2.1, outlining how I searched, selected, and appraised the most relevant literature. In Chapter 2, I provide an answer to the first group of sub-questions (RQ1).

Chapter 3. New Cities based on Egypt Vision 2030

The main purpose of Chapter 3 is to detail **the efforts that the Egyptian government intends to make towards balanced regional development**. This chapter aims to take a close look at Egypt's ambitious development efforts by **synthesizing key policy documents and seeking the views and insights of senior officials.**

First, Chapter 3.1 offers a comprehensive assessment of Egypt's social and economic conditions. This chapter also examines the evolution of innovation policies in Egypt and aims to shed light on the reasons for the country's need for a new innovation policy. Chapter 3.2.1 explores Egypt’s innovation-driven regional development policy based on Egypt Vision 2030. The chapter also offers an in-depth review of further key policy documents on new urban centers, describing the main components and crucial elements of innovation-driven regional development. These documents clearly underline that local conditions and capabilities are important for the success of innovation-driven regional development. For example, in 2019, the *National Strategy for Science, Technology, and Innovation 2030* (NSSTI) was launched in Egypt. This strategy lists the main input/output variables that should be considered when measuring the performance of the Regional Innovation System. Consequently, in Chapter 3.2.2, I collected the most up-to-date data of the suggested input/output variables outlined in the NSSTI. In Chapter 3.2.3, I present the results of interviews conducted with two high-ranking Egyptian government officials to gain valuable insights into their views on the ambitious development strategy of Egypt. The aim of the interview questions was to thoroughly explore and understand the government's vision regarding innovation-driven regional development policy.

Finally, in Chapter 3.2.4, I introduced the pioneer model of the New Administrative Capital (NAC), the new urban center in the Cairo Governorate. As a part of the Egypt Vision 2030, this new city will be the new capital of Egypt. The NAC has been under construction since 2015. In this chapter, I investigated the components of the NAC smart city program, and how high-quality urban services can foster innovation based on the expectations of Egyptian authorities. The chapter is based on interviews and data offered by the

Administrative Capital Company for Urban Development (ACUD) responsible for managing and developing the new capital city.

In Chapter 3, I use two research methods. Firstly, I **studied and synthesized policy documents** to gain a thorough understanding of the Egyptian state's development vision. Secondly, I **conducted interviews with senior officials** to gain insight into their views and perceptions regarding the proposed strategy. The third chapter addresses the second group of sub-questions (RQ2).

Chapter 4. Measuring Innovation Capacity in Egyptian Governorates

The literature review on innovation theory confirmed the importance of endogenous factors, such as local competencies, capacities, and the specific local/regional context for the success of innovation-driven regional development (Chapter 2). Furthermore, the Egypt Vision 2030 document and other policy documents, as well as insights from the interviews, also confirmed that regional economic development based on innovation is highly dependent on the existence of local and regional factors, competencies, and capacities (Chapter 3). Accordingly, in Chapter 4, I measure **the Egyptian governorates' innovation capacity**. Given the insights from Chapters 2 and 3, it can be assumed that Egyptian governorates with greater innovation capacity are (will be) in a better position to contribute to the creation of new high-level innovation hubs in their territories. In contrast, governorates with low innovation capacity can only contribute to a limited extent.

First, in Chapter 4.1, I provided an in-depth definition of innovation capacity based on the relevant literature. Second, I summarized the key elements of the conceptual framework, also used by Bajmóczi and Kanó (2009), to examine the performance of Regional Innovation Systems (RIS). In Chapter 4.2, I presented three empirical methods to measure the innovation capacity of Egyptian governorates. To begin, the innovation capability of Egyptian governorates was assessed by developing a composite indicator, **the Regional Innovation Capacity Index (RICI)** from three sub-indices. Composite indicators are frequently employed to evaluate the innovation performance of nations or regions. The three sub-indices correspond to the main elements of the conceptual framework presented in Chapter 4.1. These sub-indices describe the performance of knowledge creation, knowledge utilization, and the availability of so called "smart" infrastructure, which refers to the background factors necessary to operate the other two sub-indices. This analysis sheds light on the strengths and weaknesses of the Egyptian governorates by assessing the positive and negative aspects of the inputs pertaining to their innovation performance. As a next step, **K-**

means cluster analysis was performed to categorize Egyptian governorates based on their performance in terms of innovation capacity. The aim was to identify different clusters of Egyptian governorates: governorates with relatively higher innovation capabilities, as well as governorates with lower performance. Finally, **spatial autocorrelation analysis** was performed to identify **hot spots and cold spots for Regional Innovation Capacity** by analyzing the geographical structure similarity of Regional Innovation Capacity. Innovation hot spots have a significant impact on their neighboring locations. This means that some regions have greater potential than others due to their powerful innovation capacities, and their influence spreads spatially. In contrast, cold spots, or locations with weak innovation capacity, have little influence on both their own and surrounding locations' potential to innovate. As compared to hot spots, these governorates have a limited innovation capacity, resulting in a lower total capacity. As a result, their geographical impact on nearby regions is modest or even disadvantaged. The aim is to discover the governorates with significant innovation capacities that show a favorable impact on surrounding spatial units' innovation capacity. The findings of the second chapter's literature review highlight the geographical sensitivity of innovation. It underlines the importance of proximity to knowledge production locations in developing effective innovation policy (Lalrindiki & O'Gorman, 2021). This demonstrates the significance of taking the spatial distribution of innovation capacity into account when developing strategies to stimulate innovation and enhance regional development.

In Chapter 4.3, I present the results of the three empirical analyses described above. I comprehensively evaluate the complex innovation performance of Egyptian governorates by comparing their capacity for innovation using the composite indicator of RICI, categorizing governorates based on their capacity for innovation using K-means clustering analysis, and analyzing the similarities of spatial clusters of Egyptian governorates using spatial autocorrelation analyses. Chapter 4 concludes by synthesizing the assessments of the Egyptian governorates' innovation capacity, while Chapter 4.4 highlights their readiness to contribute to innovation-driven regional development. The fourth chapter addresses the third group of sub-questions (RQ3) and tests the three hypotheses of the dissertation (H1, H2, and H3).

Chapter 5. Theses of the doctoral dissertation

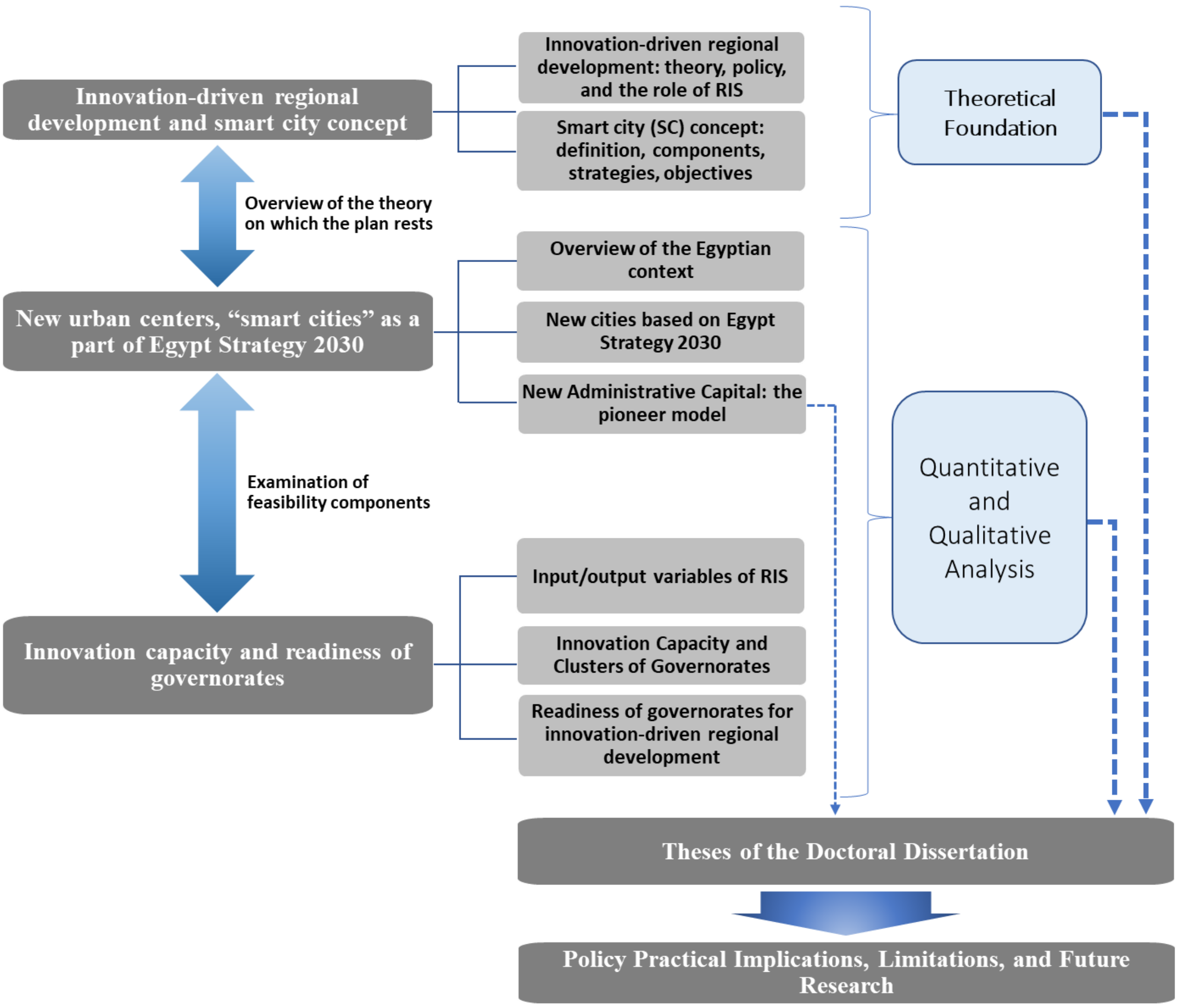
The previous chapters of the dissertation evaluate the applicability of the planned innovation-driven regional development strategy. The aim is to determine whether the

Egyptian governorates can use their innovation capacity to develop strong innovation ecosystems in new cities designated in their territories. In light of theoretical and empirical investigations, **I formulated three theses to answer my main research question and additional sub-questions** presented in the introduction chapter. Each thesis is structured as follows: (1) the thesis statement (THESIS 1, THESIS 2, etc), (2) related group of research questions and hypotheses (RQ1, RQ2, and RQ3; H1, H2, H3), (3) sub-chapters that provide evidence for the thesis, and (4) arguments and conclusions.

Chapter 6. Practical implications and limitations of research

Chapter 6.1 provides policymakers with practical implications for executing effective innovation-driven regional development policies based on the findings of the theoretical and empirical investigations of the dissertation. Finally, Chapter 6.2 highlights the limitations of the scientific research and proposes future research directions in relation to the topic.

Figure 1. The structure of the dissertation



Source: own edition.

2. Theoretical Foundation

Considering Egypt's strong commitment to innovation-driven regional development, it is essential to review the theory underpinning such development. Consequently, Chapter 2 aims to examine the theoretical foundations behind Egypt's innovation-driven regional development strategy. Chapter 2.1 provides a comprehensive overview of the Systematic Literature Review (SLR) process, detailing how the most relevant literature was identified, selected, and reviewed. In Chapter 2.2, I draw on the findings of the SLR to present various theories of innovation and their relevance in regional development, clarifying the theoretical foundation of innovation-driven regional growth. In addition, I examine the approach of Regional Innovation Systems (RIS) to understand how it explain high-level innovation. Chapter 2.3 examines the relevant literature of smart cities in depth, including concepts, components, circumstances, and strategies. I also look at why and how different developing countries use the smart city concept. Chapter 2.4 provides a summary of the main findings of the literature. The second chapter contributes to answering the first group of questions (**RQ1**):

What is a Smart City (SC)? How has this concept evolved? What are its main components? What role can it play in regional development and how can it foster innovation? For what purpose and in what way is the SC concept used in developing countries?

2.1 The Systematic Literature Review (SLR) Method

The literature relevant to the first group of sub-questions (RQ1) was identified using the systematic literature review (SLR) method. The SLR aims to identify, appraise, and synthesize available evidence for specific research questions. The SLR method is systematic, methodical, focused, and transparent. This clear, explicit, and rigorous research method provides evidence-based answers with well-defined and understandable steps (Booth et al., 2016; Gough et al., 2017). It follows a consistent methodology, comprehensively describes the review procedure, examines specified research questions, and offers detailed documentation of the whole process with clear inclusion and exclusion criteria and an explicit quality assessment method.

The systematic review process was divided into three stages. The first stage encompassed recognizing the need for a review, establishing preliminary research questions, organizing the scope search, and developing a research protocol. The second stage involved a literature review, i.e., identification, screening, selection, and evaluation of potentially relevant studies. While the third stage involved the extraction of relevant data and information from the studies considered relevant. For the SLR, two research topics have been identified: *innovation-driven regional development* and the *smart city* concept. Consequently, the findings of the literature review have been divided into two sections: Chapter 2.2 discusses the theoretical background of innovation-based regional development, while Chapter 2.3 deals with the literature on the smart city concept.

For SLR, it is important to clarify research question(s) clearly from the start, as clarity is seen as a significant aspect that leads to good findings (Booth et al., 2016). In the first case, I investigated **what are the main theoretical considerations supporting innovation-led regional development policy?** The CIMO method (**C**ontext, **I**ntervention, **M**echanism, **O**utcome) was used to identify primary keywords of the subject (Denyer & Tranfield, 2009), such as innovation policies, developing nations, and regional development. Synonyms of the keywords were acquired from Thesaurus.com. Using the identified keywords, search queries (SQs) were developed utilizing a mind map approach (see *Appendix 1* and *2*). Each search query included a keyword for each CIMO component.

In the second stage, I conducted searches in different e-journal databases using the created search queries to find journal papers that addressed the research question at hand. The search was done in 2019 and only English-language articles from 1995 to 2019 were included. Subsequently, additional searches were conducted, including what is commonly referred to as an "author search," to encompass published papers from 2020 to 2021. This involved selecting the most recent publications from relevant researchers in the fields of Regional Innovation Systems, innovation policy, and other related areas. Only journals with high impact factors (three or above according to the Academic Journal Quality Guide) and citation scores of at least 50 were included and evaluated. A minimum reference score of 70 was initially applied, but it was then dropped to 50 because the research topic focused also on case study papers regarding developing/lagging countries, which are not often highly referenced.

Three separate e-journal databases were used: (1) Web of Science (WOS), (2) Academic Search Complete (EBSCO), and (3) Business Source Premier (EBSCO). Following the predefined inclusion/exclusion criteria, the number of articles decreased from 4718 to 300. Duplicate publications were removed using reference management software, reducing the total number of research papers to 223. To assure the study's relevance and focus, additional exclusion criteria were used to identify irrelevant studies. Only papers in "economics," "regional economics," "urban economics," and "social sciences" were accepted, while papers in other disciplines were excluded. This painstaking screening procedure yielded a final selection of 170 articles that directly addressed the topic at hand. Next, additional classifications were used based on the level of relevance. After reading the papers, the level of relevance was determined depending on the content of each study. Studies that, upon reading, were found not to address or answer the research questions substantively were excluded. Consequently, due to this rigorous search and selection process, 32 *highly relevant* articles were identified. *Figure 2* shows each step of the systematic literature review process.

Figure 2. The stages of the SLR process

Source: own edition.

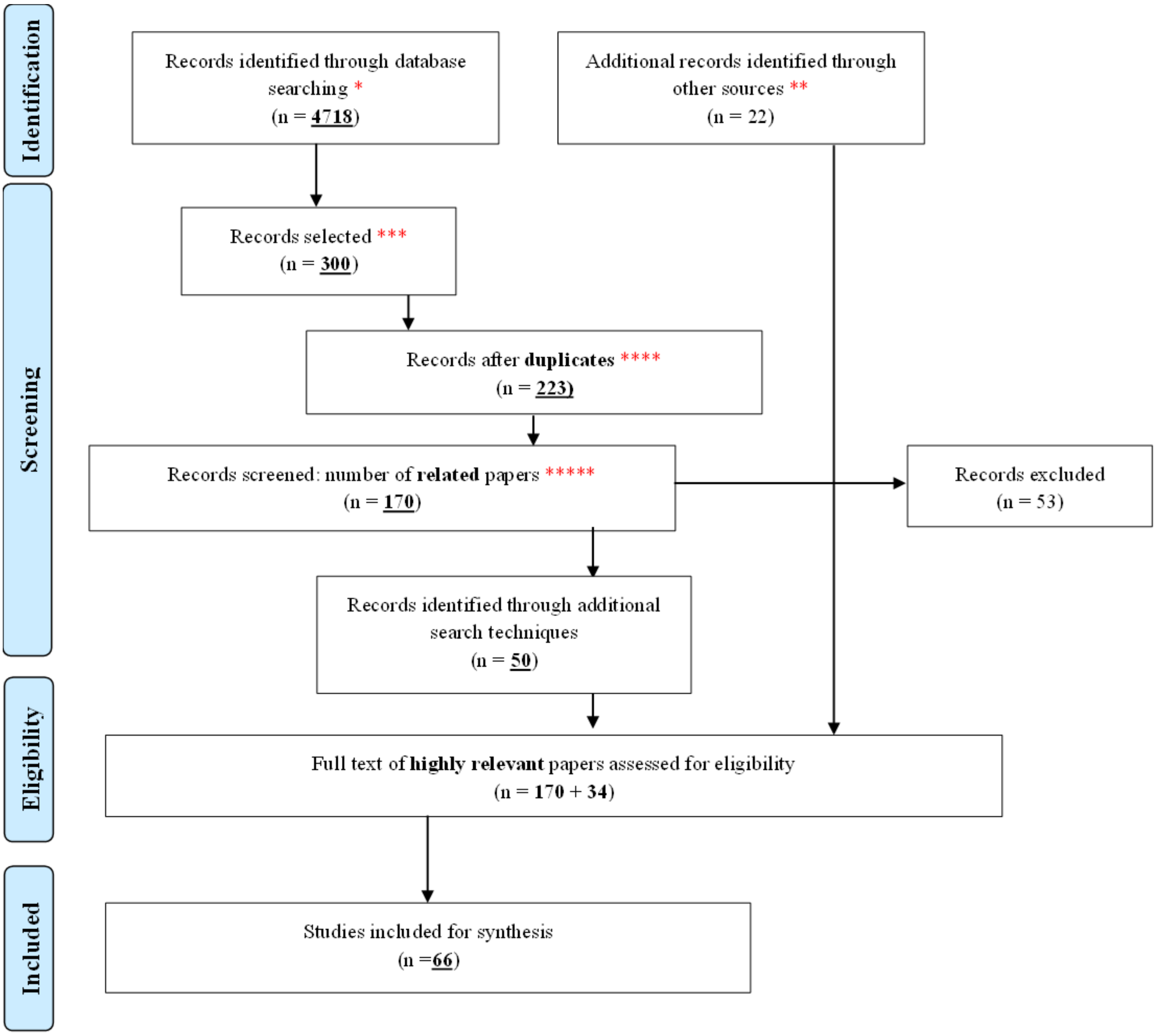
As a part of the additional search, several search approaches were used, including studying the reference lists of highly relevant articles, running “author search” of papers published by the top five most-cited authors, and employing additional keywords and reading papers suggested by the supervisors. These efforts resulted in the discovery of an additional 50 potentially relevant articles. As a next step, the titles, keywords, and abstracts of these additional papers were thoroughly assessed as well, resulting in the identification of 66 articles that were highly relevant (32 papers due to the first round and 34 due to the additional search). *Figure 3* shows the PRISMA Flow Diagram which depicts the complete identification and selection process in detail.

The second step of the research entails conducting comprehensive research on the concept of smart cities, with a particular focus on regional development and urban planning perspectives in developing countries. The analysis also looked at how smart city concepts are being implemented in various developing nations. The fundamental research question was the following: **For what purpose and how have smart city programs been implemented in developing nations?** In this case, the CIMO method was also used to identify relevant keywords such as smart city policies, developing countries, experiences, and case studies. Potential synonyms for the topics were identified, and search queries were generated by using the keywords (see *Appendix 3* and *4*). The inclusion criteria were chosen in consideration of the study's geographical scope, which encompassed not just smart city regions in developing countries, but also developing countries in general, with a special emphasis on Egypt.

This second literature review was carried out in early 2021, and it exclusively covered English-language publications published between 1995 and 2020. Academic journals, book chapters, and conference papers with at least 20 citations were favored, while the citation standards were considerably reduced because of the relative novelty of the smart city concept, allowing for the collection of a larger collection of possibly relevant studies. The SQs were applied allowing a range of methods, including case studies, literature reviews, and comparative studies. For the review, the following electronic journal databases were used: Academic Search Complete (EBSCO), Business Source Premier (EBSCO), Open Dissertations (EBSCO), Regional Business News (EBSCO), Web of Science WOS (Clarivate Analytics), and SCOPUS are just a few of the databases available (Elsevier). Of the 564 articles identified, 269 satisfied the predefined inclusion/exclusion requirements, and 211 papers remained after deleting duplicates. To assure the study's relevance and focus, additional exclusion criteria were used to identify irrelevant studies. Only papers in "urban planning," "cities," and "social sciences" were accepted. This screening procedure yielded a final selection of 173 articles that directly addressed the topic at hand. Next, additional classifications were used based on the level of relevance. After extensively reading the papers, the level of relevance was determined depending on the content of each study.

Consequently, due to this rigorous search and selection process, 50 highly relevant articles were identified. As a part of the additional search, several search approaches were used, including studying the reference lists of highly relevant articles, running “author search” of papers published by the top five most-cited authors, and suggesting relevant books. As a next step, the titles, keywords, and abstracts of these potentially additional sources were thoroughly assessed. These efforts resulted in the discovery of an additional 10 relevant sources. Also, resulting in the identification of a total of 60 articles that were highly relevant (50 papers due to the first round and 10 due to the additional search). *Figure 4* shows each step of the SLR process.

Figure 3. PRISMA Flow Diagram showing the different phases of a systematic review



* The number indicates <u>all records</u> derived from the different databases *ASC, BSP, and WoS.*

** The number of papers recommended by other sources (e.g., supervisor's suggestions).

*** Using different filters (time cited, date, relevance).

**** Using reference management software and removing duplicates.

***** Due to additional exclusion criteria.

Source: own edition (based on http://prisma-statement.org/prismastatement/flowdiagram.aspx). (available 1st July 2023)

Figure 4. Summary of the selection process stages for highly relevant papers.

Source: own edition.

2.2 Innovation-based Regional Development

Based on the studies identified by the SLR method, Chapter 2.2 presents the theoretical findings on innovation-driven regional development in three sub-themes. The first topic explores main *theories of innovation* (Chapter 2.2.1), while the second focuses on the *innovation-driven regional development policy* (Chapter 2.2.2). The final section (Chapter 2.2.3) examines the *Regional Innovation System (RIS)* approach.

2.2.1 Theories of Innovation in Regional Economics

In this section, I aim to demonstrate how different regional economics theories explain why innovation and knowledge are important for regional development. First, I define the term innovation and then I examine how it appears in different theories.

To define “innovation”, a variety of concepts have been developed. The concept of innovation was introduced by Joseph Schumpeter (1911, 1936, 1942), who defined it as *new combinations of five types of new approaches by entrepreneurs: new products, new production processes (technologies), new markets, new organizations, and new inputs* (Lambooy, 2005). The process through which an entrepreneur discovers new market opportunities takes place through trial and error, risk-taking, and the discovery of new niches that can be effectively exploited (Lambooy, 2005). Elaborating on how innovation could arise from existing systems was one of Schumpeter's key contributions (Witt, 2003). Mainstream economics did not emphasize the entrepreneurial function by assuming a world with comprehensive knowledge and rational economic agents, Schumpeter's intention was to incorporate the theory of innovation and entrepreneurship into the general theory of economic development. Nevertheless, it is difficult to apply his theory to policy since it highlights complexity and unpredictability (Lambooy, 2005).

Innovation, knowledge, and entrepreneurship have been buzzwords in many countries during the previous two decades. The majority of developed countries, including those in the European Union, have developed their innovation policies. Furthermore, other policies, such as those on employment, competitiveness, environment, industry, and energy, are all strongly linked to innovation policy which is therefore seen as a horizontal policy. Innovation is defined in the Fact Sheets on the European Union *as the process of translating research discoveries into new, better products and services to remain competitive in the global marketplace and improve the quality of life of European residents* (European Parliament, 2021). In 1992, the OECD developed the Oslo Manual to harmonize and ensure the quality of innovation surveys. The latest (fourth) edition of the Oslo Manual (OECD/Eurostat, 2018) introduced the term innovation to refer both to an activity and the outcome of the activity. It provides the following general definition: *"a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)"* (OECD, 2018, p. 20).

The significance of comprehending innovation, its role, and its impact on economic development has markedly increased in recent decades. It is not surprising, since one of the fundamental explanations for regional differences lies in the uneven geographical distribution of innovation activity. Local (partially culture-determined) intangible factors are crucial to determining the viability of local economies in times of high mobility of labor and capital (Capello, 2016). From this perspective, I introduce the four theories that discuss the importance of local factors and context to regional development.

The **technological (knowledge) spillover** theory, which emerged in the 1990s, looks at the relationship between the spatial concentration of activities and the increasing returns they generate. Agglomeration effects, also known as agglomeration externalities, can yield economic advantages that arise from the clustering or concentration of economic activities, firms and people in a particular geographic area. Technology spillovers are *"the effects of nonmarket interactions which are realized through processes directly affecting the utility of an individual or the production function of a firm"* (Fujita and Thisse, 1996). Concentrated locations make it simpler to take use of research institutions and universities' technical and scientific achievements, to get uncodified tacit information, and to have rapid access to skilled labor and advanced services (Anselin et al., 1997; Audretsch & Feldman, 1996; de Groot et al., 2001; Maier & Sedlacek, 2005; Varga & Schalk, 2004a). Concentrated places guarantee *physical proximity* of players and activities might promote knowledge transfer by enabling more frequent interactions and idea exchanges between various actors or organizations. As a result, research and innovation are becoming increasingly polarized, furthering the trend toward space-based innovation (Audretsch & Feldman, 1996; Capello, 2016; de Groot et al., 2001). According to this theory, concentrated locations yield greater returns on innovative activities. Mutual collaboration, dynamic exchanges between consumers and suppliers, and synergies between research institutes and local manufacturing units characterize the ecosystem of highly specialized metropolitan areas (Baldwin et al., 2005; Evenson & Singh, 1997). As a result, the company's research and development operations are not limited to its borders but are expanded into the surroundings, benefiting other businesses engaged in similar innovative activities (Audretsch et al., 2005; de Groot et al., 2001; Nie et al., 2022).

Knowledge can flow between local actors in a variety of ways (e.g., through organized learning at universities, purchasing of patents, R&D contracts between companies and universities, joint research projects, as a by-product through the sale of products and goods, unintended knowledge flows, informally between economic and other institutional actors, etc.). The type of knowledge influences the flow of knowledge. The educational framework guides codified knowledge, which includes research findings, publications, and study materials. Non-codified (tacit) knowledge may only be obtained through informal, human contacts and special relationships. However, partially codified knowledge occupies a middle ground, illustrated by competence gained through a job in a certain profession (Lengyel, 2021).

According to the **milieu innovateur** theory, local economic and social interactions are critical in shaping a region's innovation potential and economic performance (Camagni & Capello, 2002, 2005; Moulaert & Sekia, 2003). This theory goes beyond physical proximity, however, and argues that social and cultural coherence affects these relationships (Enrico & Grandi, 2005). The milieu innovateur concept, developed by French economist Michel Camagni in the early 1990s, provides a conceptual framework that sheds light on the potential of regional environment to foster innovation. According to Camagni (1991), the local milieu, which represents a firm's surroundings, is a crucial factor in lowering uncertainty. This milieu can be defined as "*a set of territorial relationships encompassing in a coherent way a production system, different economic and social actors, a specific culture and a representation system, and generating a dynamic collective learning process* (Camagni, 1991, p. 222)".

Camagni (2004) later clarifies the above statement by stressing the importance of *sociocultural proximity* beyond simple physical contact. Sociocultural proximity means a kind of social and cultural homogeneity, in the creation and maintenance of which social capital plays a crucial role. Social capital promotes the formation of social relationships and networks among actors. As a result, the sociocultural proximity of the actors leads to three key attitudes: (1) a sense of belonging, (2) trust that comes from knowing each other, and (3) cooperation that is based on trust. Places can benefit from these characteristics, leading to cooperative enterprises, shared knowledge, collective learning, and, eventually, creativity. In sum, such proximity encourages information sharing, cooperation, and collaboration.

Moreover, the milieu innovateur theory argues that innovation is generated through interactions between diverse entities within an area, such as enterprises, organizations, and institutions, rather than by individual firms or entrepreneurs (Camagni, 2004). These interactions establish a context that fosters creativity by incorporating aspects such as: (1) *Mutual trust* within a milieu innovateur which facilitates collaboration and the flow of critical information and knowledge, which is critical for innovation. (2) *Shared objectives*: Organizations in such a milieu have shared goals such as economic advancement and technical leadership (Camagni, 2004). These shared objectives give direction and inspiration for creativity. (3) *Supporting infrastructure*: The region has a supportive infrastructure that includes universities, research institutions, and venture capital businesses (Camagni, 2004). This infrastructure provides companies with the resources and help they need to drive innovation.

Furthermore, the notion of collective learning—a process through which enterprises, organizations, and institutions within a region learn from each other and their environment—is central to the milieu innovateur concept (Camagni, 2004). Collaborative learning is critical for innovation because it allows for the exchange of knowledge and skills, which frequently results in innovative ideas and solutions. Nevertheless, some argue that it oversimplifies problems by ignoring the importance of individual enterprises and entrepreneurs, while others argue that assessing collective learning is conceptually challenging (Boschma, 2005; Cooke & Schienstock, 2000; Saxenian, 1996). Notwithstanding these criticisms, the milieu innovateur theory contributes greatly to the innovation discourse. It shifts the focus of innovation research away from individual firms towards the regional context, resulting in a better understanding of the variables that drive innovation and influence policy decisions.

The **learning regions** theory differs from the above ones in that it emphasizes more the *institutional aspects* as well as social, economic, and cultural standards in the context of the region (Asheim, 1996; Cooke & Uranga, 1997; Morgan, 1997). According to this theory, the most valuable source of development is knowledge, the second is the ability to learn, which enables the acquisition of knowledge, and the third is the presence of an appropriate cultural, institutional setting that enables the learning process. (Cooke & Schienstock, 2000;

Landabaso et al., 2003). Informal learning mechanisms motivated by specific interests aimed at a particular market or its structure. These processes are based on firsthand encounters or individuals' shared experiences (Capello, 2016; Morgan, 1997).

Additionally, the notion of learning regions stresses the presence of trust-based relationships and supportive institutions that promote successful interactions and cooperations among local players. The learning capacity of an area is determined not just by physical proximity or agglomeration effects, but also by regional culture, local customs and routines, and institutional integration. Kulhanek (2007) introduced the term *institutional thickness* to explain a region's learning capabilities. Institutional thickness refers to the depth, complexity, and richness of a region's institutional framework. It shows how well a region's institutions are developed and how they contribute to the region's capacity to learn, adapt, and innovate. In general, regions with thicker, well-developed institutions are more conducive to learning. A region's institutional thickness is supported by numerous factors. The existence of well-established institutions in charge of regional planning and development. The foundation of high-quality interaction and collaboration among these organizations is adherence to both statutory and informal regulations. The exact definition of roles and financial resources inside and between these entities allows for working coalitions. Employees at these institutions should have a strong sense of place. A unified vision and regional development goals are critical (Kulhanek, 2007). In sum, according to this theory, institutions act as a cornerstone for cultivating a creative atmosphere in the region, as well as a critical catalyst for producing innovation in the region.

In this view, the learning region is defined as "*a socio-economic system that can build interactive learning methods through time, with this capacity being the key to a region's competitiveness*" (Capello, 2016, p. 246). According to this concept, competitiveness is more of a process (learning) than an end state (knowledge stock) (Cooke & Schienstock, 2000). Despite the need for abstraction, which makes empirical application difficult, the concept has gained widespread acceptance, not only in a specific scientific community, but also in the European Union's regional cohesion policy (Capello, 2016). However, the outcomes of translating the learning region concept into effective regional economic policy are confusing. Because the proposed interventions concern the formation of education and training solutions, learning incentives, the sharing of successful experiences in creating organizational forms that support interaction, and financial assistance to firms enduring restructuring process: all of these are well-known and previously implemented interventions in support of less developed regions (Landabaso et al., 2003; Moulaert & Sekia, 2003;

Simmie, 2012). While theory promises a system of homogenous social, political, and institutional conditions in regions, as well as collaboration and participation among actors, according to Capello (2016), its apparent fundamental shortcoming is notably non-spatial.

The **evolutionary economic geography** is another theory that explains economic progress through innovation. In the 1990s and early 2000s, a new stream of thought emerged called evolutionary economic geography (Boschma & Frenken, 2006; Boschma & Martin, 2007, 2010; Iammarino, 2005; Kogler, 2015). A historical-evolutionary view of the dynamics of local areas was one of its distinguishing aspects of this theory (Boschma & Iammarino, 2009; Neffke et al., 2011; Tödtling & Trippl, 2005). Per this theory, innovation and new knowledge development result from a process of discovery that builds on existing competencies, along with specific path dependency (Boschma & Frenken, 2006; Boschma & Martin, 2007; Kogler, 2015). In this theory, the idea of *cognitive proximity* is introduced as a critical component in explaining innovation capacity (Feldman, 1994). Similarities in the way actors see, interpret, perceive, comprehend, and assess the environment can be connected to this form of proximity. While physical proximity can facilitate face-to-face collaboration, cognitive proximity shows that actors with a similar knowledge base can collaborate successfully even when they are far apart. Developing a common language and mutual understanding by utilizing a common knowledge base is the first step towards this. Cognitive proximity is characterized by *dynamic evolution*, meaning that cognitive proximity is not fixed and can change over time. Actors can modify their knowledge base through learning, training, and new ideas, thus changing their cognitive proximity to other actors (Boschma & Iammarino, 2009).

As a result, the evolutionary economic geography approach shows that innovation is the outcome of a creative discovery process that is dependent on local capabilities. Furthermore, this approach is based on historical and evolutionary perspectives on the dynamics that occur inside the regions. The theory explains the unique development paths of regions with different resources, capabilities, and historical contexts that determine their socio-economic evolution and specialization.

Drawing from the above theories, Capello (2017) elaborated her conceptual approach to clarify conditions deemed significant in propelling the territory toward innovation. She argues that the type and extent of the knowledge flow is determined by the following intangible conditions such as territorial receptiveness, territorial creativity, and territorial attractiveness of the given area. The ability of a region to embrace and absorb external knowledge and information for achieving progress in research and science is referred to as *territorial receptivity*. Receptive regions have universities, research institutions, and a culture of collaboration. Spatial proximity is important because geographical closeness promotes overcoming obstacles, especially for tacit knowledge exchange. *Territorial creativity* is a process fueled by entrepreneurs who are able to access, absorb, and utilize global knowledge to generate new ideas, innovations, and knowledge internally. Regions that are receptive to innovation and have access to relevant external knowledge are fertile ground for imaginative applications. Usually technological proximity drives collaboration, typically facilitated by industry groups or external specialists who feed knowledge into the region (Cappello, 2017). While, *territorial attractiveness* refers to a region's ability to retain and attract talent, businesses, and investment. It facilitates the acquisition of innovation from external sources such as foreign direct investments (FDI). Territorial attractiveness is a prerequisite for regions to acquire innovation; a big final market (market-seeking) and/or labor cost competitiveness (efficiency-seeking) are prerequisites for regions to become attractive places for investments. Territorial receptivity, inventiveness, and attractiveness, in essence, affect the dynamics of information flows between areas, defining their collaborative potential and innovation-driven growth.

This chapter explores theories that aim to explain why certain regions exhibit greater entrepreneurial innovation than others. Physical proximity is important; however, the review of these theories reveals that a region's ability to innovate and foster knowledge exchange among its actors is shaped by various factors beyond mere geographical proximity. These factors include socio-cultural affinity among local actors, cognitive proximity, openness, and the richness (thickness) of local institutions, all of which play pivotal roles in determining the region's capacity for learning and innovation.

Understanding these theories has allowed me to comprehend Egypt's motivation for its pursuit of an innovation-led regional development strategy. On the one hand, these theories emphasize the importance of innovation in driving regional development; on the other hand, they emphasize the critical role of unique place-sensitive characteristics such as local capacities, skills, tacit knowledge, and the local-regional context. Consequently, an exante comprehensive examination of these unique local factors is essential for the successful development of an innovation-oriented regional development policy.

2.2.2 Innovation-driven Regional Development Policy

This chapter is to examine why innovation is so crucial in regional development. To answer this question, I first discuss the goals of regional development, then look at how regional development policy has evolved over time and how innovation has become a primary driver of contemporary regional development policies.

The objectives of regional development include improving the development of less developed areas, i.e., reducing regional disparities. Therefore, regional development programs and measures are primarily designed to promote employment, entrepreneurship and innovation (Šabić & Vujadinović, 2017). Regional development, according to Sengenberger (1994) should be *endogenous* (relying on the region's resources) and *balanced* (by coordinating the activities of nearby units in a mutually beneficial manner towards cohesion). It also must be *sustainable* (i.e., without causing injustice to the needs of future generations), and finally *comprehensive*, which includes not only quantitative goals (such as economic growth and employment) but also qualitative ones (participation in decision-making, equality, and the preservation of the environment, etc.). When these objectives of regional development are considered, it becomes evident that contemporary regional development is closely linked to the utilization of endogenous capacities and local factors, as the development of a region's capacity is the only means of regional development (Scott & Storper, 2003).

Regional differences can be seen in local innovation performance (Hu & Mathews, 2005; Rodríguez-Pose & Crescenzi, 2008; Zabala-Iturriagagoitia et al., 2007a), which can be explained by the different diffusion of knowledge spillovers (Ács & Varga, 2005; Fritsch & Franke, 2004; Simmie, 2003), and tacit knowledge for regions (Hanson, 2014). These differences necessitate the adoption of an innovation policy that supports regional development. However, each region is unique in its own way, consequently, differences are also possible due to uniqueness. Tödtling and Trippl (2005) emphasize that there is no regional development policy directly applicable to other regions which means *one size does not fit all* (Hanson, 2014; Nizalov & Loveridge, 2005; Schaefer et al., 2011). Regional development must therefore be tailored to local context. To address these differences according to different goals (equality, efficiency, sustainability) regions require *tailor-made policy* interventions (Rodrguez-Pose, 2013).

There has been a paradigm shift from a *classical* (traditional) to a *modern* model of regional policy. The shift was due both to the ineffectiveness of previous development approaches and to the emergence of new theories emphasizing the role of innovation and the importance of endogenous local factors in regional competitiveness.

Recognizing the importance of innovation in development is a clear driving force behind the paradigm shift in regional development policy. Therefore, it became necessary to create new policies for regional endogenous growth, knowledge-based development, and innovation (Barca et al., 2012; Etzkowitz & Klofsten, 2005). In this paradigm shift, there are new objectives, a new geographical scope, a new governance system, and new policy instruments for regional development. Regional development policy, according to this modern model, should be *"place-based, multi-level, innovative and geared to the needs of different types of regions"* (Vanthillo & Verhetsel, 2012, p. 4). In *Table 2,* conceptually, there has been a shift from industrial location theories, where regional attributes (such as production costs and availability of labor) were key, to learning regions theory, where regional capabilities (such as innovation milieux, clusters, and networks) are critical. Traditional policies have always grappled with the dilemma of efficiency against equity, whereas policy evolution has led to the simultaneous achievement of both efficiency and equity. Classic regional policies aimed to enhance regional investment and generate employment, but today's goals are to boost competitiveness (i.e., entrepreneurship, innovation, and skills). There has also been a change in the way policies work, as classical policies were always *reactive* to regional problems, but this has changed to policies based on *proactive* strategic planning and strategic action. A prominent example of this new model of regional policy is the EU cohesion policy, as well as its regional innovation plans (RTPs, RITTS, RIS)[2] (Bachtler & Yuill, 2001). Traditional (classic) regional policy focused on problematic regions and their treatment, while the new policy targets all types of regions. Development projects now stress bottom-up approaches and utilize regional resources through investments in local physical and social infrastructure to promote innovation, new technology, and products while also enhancing the quality of life (Šabić & Vujadinović, 2017). The traditional way of evaluating policies was ex-post evaluation, which simply meant checking whether policy objectives had been met or not. After the paradigm shift, policies are evaluated using a tripartite approach (ex-ante, interim, and ex-post). Measuring the effectiveness of a modern regional policy that puts innovation at the forefront is a challenging task, as it emphasizes the importance of soft factors that are difficult to measure, such as tacit knowledge, social capital, absorptive capacity, trust, etc.

[2] RTPs: Regional Technology Plans; RITTS: Regional Innovation and Technology Transfer Strategies; RIS: Regional Innovation Strategies.

Table 2. Shifting of Paradigm for Regional Policy

Criteria	Classical	Modern
CONCEPTUAL BASIS	Industrial location theories Key factors are regional attributes. e.g., production costs, availability of workers	Learning region theories Key factors are regional capabilities. e.g., innovative milieux, clusters, networks
POLICY CHARACTERISTICS		
Aim(s)	Equity ***or*** efficiency	Equity ***and*** efficiency
Objectives	Employment creation Increased investment	Increased competitiveness (e.g., entrepreneurship, innovation, skills)
Sphere of action	Narrow (economic/industrial)	Broad (multi-sectoral)
Mode of operation	Reactive, project-based	Pro-active, planned, strategic
POLICY STRUCTURE		
Spatial focus	Problem areas	All regions
Analytical base	Designation of indicators Regional exporting	Regional SWOT analysis
Key instrument	Incentive scheme	Development program
Assistance	Business aid Hard infrastructure	Business environment Soft infrastructure
ORGANISATION		
Policy development	Top down/centralized	Collective/negotiated
Lead organization	Central government	Regional authorities
Partners	None	Local government Voluntary sector, social partners
Administration	Simple/rational	Complex/bureaucratic
Project selection	Internalized	Participative
Timescale	Open-ended	Multi-annual planning periods
EVALUATION		
Stage(s)	Ex-post	Ex-ante, interim, ex-post
Outcomes	Measurable	Difficult to measure

Source: own edition based on Bachtler & Yuill (2001).

In sum, the emergence of innovation theories (which offered different explanations for the creation and diffusion of knowledge and innovation) changed the conceptual bases, objectives, methods of implementation, and structures of regional policies. It became evident that innovation was not an end, but rather a method of achieving long-term development goals in terms of economic, social, political, and environmental sustainability. As a result, policy dealing with the innovation process has grown into a comprehensive concept covering a variety of policies referred to as *innovation policy* which can be defined "*as a concept encompassing a wide range of policies targeting the different actors in the innovation ecosystem and a set of policy instruments that structure interaction*" (Reillon, 2016, p. 3). Several studies have emphasized the importance and uniqueness of local contexts in innovation policy because they are both determinants and opportunities in the overall development process, where determinants such as government contributions, R&D performance, and unequal inputs result in regional differences and influence innovation efficiency (Li, 2009). In regional development policies, *supporting institutions for* *innovation* play a significant role. These institutions (e.g., higher education institutions, public research institutes, government-sponsored research institutes, industries, S&T centers, and government) must participate in enabling innovation and play an important role in economic development (Caniëls & van den Bosch, 2011; Liu et al., 2011; Morgan, 1997; Rodrguez-Pose, 2013; Vale, 2011).

2.2.3 Regional Innovation System (RIS)

The interplay of many players and factors, as described in the theories above, governs the local environment and can boost regional innovation and economic growth. As a result, there is growing interest in exploring Regional Innovation Systems (RIS) as a conceptual framework. This paradigm accounts for the complex linkages and links among diverse players, including higher education institutions, organizations, networks, and resources, that collaborate within a defined geographic area. Their cumulative synergy creats an ecosystem that fosters innovation, entrepreneurship, and knowledge development.

The literature discusses the functioning of innovation systems at different levels (Carlsson, 2003; Lalrindiki & O'Gorman, 2021). Initially, studies focused on national innovation systems (NISs) to explain differences in technological development across countries (Lalrindiki & O'Gorman, 2021). However, the discovery in the 1990s that technological systems vary among regions in terms of interrelationships led to a reconceptualization of innovation systems (Carlsson & Jacobsson, 1994; Jacobsson & Carlsson, 1997). Some researchers emphasized the need for a sector-based approach to innovation systems, studying how companies develop and manufacture products, along with how they create and utilize sector technologies (Archibugi et al., 1999; Chung, 2002; Kubeczko et al., 2006). Regional Innovation Systems literature has been gaining popularity within the context of innovation systems literature (B. T. Asheim et al., 2011b; B. T. Asheim & Gertler, 2009; Cooke et al., 1998; Gertler, 2009; Uyarra, 2009; Zabala-Iturriagagoitia et al., 2007b) due to the recognition that the elements and processes that drive the system express themselves at the regional level (Cooke & Uranga, 1997; Gertler, 2009; Morgan, 2004; Tödtling & Trippl, 2005). The success of innovation systems is largely determined by national, technological, and sectoral systems, but the regional/local dimension has been argued convincingly to be of paramount importance since knowledge creation and diffusion are largely influenced by local/regional factors (Anselin et al., 1997; Feldman & Florida, 1994; Gertler, 2009; Morgan, 2004), Thus, the Regional Innovation System perspective sheds light on the regional dimension of knowledge production and exploitation, explaining why innovation capabilities differ across regions (Lalrindiki & O'Gorman, 2021).

RIS has been broadly defined and has multiple definitions, one of which is the following: *"the localized network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify and diffuse new technologies within and outside the region"* (Evangelista et al., 2002; Howells, 1999). *Table 3* shows that various definitions and concepts of the Regional Innovation Systems contain similar characteristics. They all refer to the interactive and dynamic nature of the RIS, where the interactions occur within the confines of the system. Generally, all of these definitions agree that Regional Innovation Systems are interrelated and that they aim to facilitate economic development based on knowledge and are characterized by competitiveness.

Table 3. The definitions of the Regional Innovation System

Cooke et al. (1998)	*"Regional system in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness." (p. 1577)*
de Bruijn & Lagendijk (2005b)	*"A set of interacting private and public interests, formal institutions and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use and dissemination of knowledge." (p. 1155)*
Tödtling & Trippl (2005)	*"That innovation should be seen as an evolutionary, non-linear and interactive process, requiring intensive communication and collaboration between different actors, both within companies as well as between firms and other organizations such as universities, innovation centers, educational institutions, financing institutions, standard-setting bodies, industry associations and government." (p. 1205)*
Harmaakorpi & Pekkarinen (2002)	*"A system of innovative networks and institutions located within a certain geographic area, with regular and strong internal interaction that promotes the innovativeness of the region's companies." (p. 13)*
Esparcia (2014)	*"As the group of elements which, by themselves and via mutual interaction, affect the introduction, the adoption and the development of different types of innovation at a given spatial scale." (p. 2)*
Varga & Sebestyén (2017a)	*"Innovation is indeed a collective process where the knowledge and expertise of partners and the intensity of collaborations among them determine the production of new, economically useful knowledge." (p. 2)*

Source: own edition based on (Cooke et al., 1998; De Bruijn & Lagendijk, 2005b; Esparcia, 2014; Harmaakorpi, 2006; Kaufmann & Tödtling, 2000b; Tödtling & Trippl, 2005; Varga & Sebestyén, 2017b).

Furthermore, these definitions agree that innovation in the regional system is an evolutionary, non-linear, and interactive process, and must be both strong and well-organized to enhance the development within the region. There are no fundamental differences among these definitions, but they differ in their concepts and their understanding of how knowledge and innovation are generated. For example, some definitions emphasize the role of companies, while others focus on universities, innovation centers, and educational institutions, while others emphasize the importance of financial institutions in financing innovation (De Bruijn & Lagendijk, 2005a; Esparcia, 2014; Hanson, 2014; Harmaakorpi & Pekkarinen, 2002; Kaufmann & Tödtling, 2000a; Varga & Sebestyén, 2017a). Thus, a successful Regional Innovation System depends on the existence of cooperative interactions of the regional actors (the so-called Triple Helix) (Leydesdorff, 2012; Leydesdorff & Etzkowitz, 1996).

The concept of the triple helix has received considerable attention in the literature on Regional Innovation Systems (RIS). It is used to dive into the complicated and multidimensional dynamics of the knowledge ecosystem, encouraging policymakers at all levels (national, regional, and local) to build new strategies for innovation and development (Lalrindiki & O'Gorman, 2021). The triple helix model of innovation provides a framework for understanding the relationships of three key actors: university, industry, and government (Asheim et al., 2011; Coenen, 2007; Leydesdorff, 2012; Leydesdorff & Etzkowitz, 1996; Saad et al., 2008; Shin et al., 2012). The university pillar represents knowledge-generating institutions such as universities and research institutes. The industrial pillar includes entities that use knowledge to innovate and generate new goods and services, such as enterprises and other organizations. The government pillar includes institutions such as government agencies and departments that are responsible for setting the rules and policies that regulate innovation (Leydesdorff, 2012; Leydesdorff & Etzkowitz, 1996). According to the triple helix concept, these three elements interact synergistically, resulting in a dynamic setting that encourages innovation. Universities, for example, may assist firms in developing unique technology, corporations can provide funding to support university research, and governments can develop regulations that encourage innovation (Leydesdorff, 2012).

The interconnection of the university, industry, and government institutions that drive innovation policy is detected through interactions both inside and across these institutions by using the triple helix or three-dimensional system (Borkowska & Osborne, 2018; Lukovics & Zuti, 2018; Saad et al., 2008; Shin et al., 2012). Notably, the triple helix model provides a useful framework for understanding the numerous interplays between many actors involved in innovation (Cooke & Uranga, 1997). As a result, the model emerges as a powerful tool for understanding and strengthening Regional Innovation Systems (Calignano et al., 2018; Esparcia, 2014; Kolehmainen et al., 2016). Thus, understanding how various actors in the system interact allows for the formation of a livelier and more productive environment for innovation.

In essence, the RIS approach can provide policymakers with a more comprehensive understanding of the complexities, capacities, and constraints of the local innovation ecosystem. By developing and implementing innovation policies, delving into and examining Regional Innovation Systems (RIS) will pave the way for implementing measures that are not only more effective but also more accurately targeted.

2.3 Smart City (SC) Concept

According to Egypt Vision 2030, the Egyptian government intends to build fourteen smart cities with sophisticated innovation ecosystems. Egypt sees the smart city concept as a critical component of its innovation-driven regional development strategy. Consequently, in Chapter 2.3, I examine how smart cities can serve not just as tools for urban planning and the delivery of improved urban services via ICT, but also as catalysts for innovation. The goal of this chapter is to provide a thorough grasp of the smart cities' literature, which includes definitions, influencing variables, enabling circumstances, and strategic approaches. The chapter also dives into the reasons *why* and *how* some developing countries utilized SC approach.

2.3.1 SC Definitions

Even though technology has long been used in urban planning and management, the concept of smart cities has only gained significant traction in the last three decades. Smart cities emphasize technological advances, community involvement, land-use planning, and other methods to achieve various urban development policy goals (Smith et al., 2019).

The global importance and overall attractiveness of smart cities has grown for several reasons. Not surprisingly, this surge is primarily attributed to the fast improvement of information and communication technologies (ICTs). Digitalization is a key enabler of economic growth by lowering transaction costs (World Bank, 2016), boosting productivity and efficiency (Hawash & Lang, 2020), and contributing to higher quality of life (Nevado-Peña et al., 2019). Digitalization, the Internet of Things (IoT), artificial intelligence (AI), data analytics, and improved connectivity have all made it easier to integrate urban systems and services. As evidenced by Batty (2013) and Orlando & De La Barrera (2020), this integration of urban systems and services due to ICTs has greatly helped to improve quality of life and maximize resource usage. For example, smart city applications have helped to reduce traffic congestion, improve public transportation efficiency, reduce energy consumption, and improve waste management.

However, the integration of ICTs into urban systems, i.e., the creation of smart cities, has occurred for different reasons in developed and developing countries. Increasing urbanization caused by population growth has strained existing urban infrastructure in developing countries. As Orlando and De La Barrera (2020) point out, this situation highlights the critical significance of smart city initiatives in orchestrating sustainable urban growth in such areas. In general, for developing countries, digitalization, ICTs, and their integration into urban systems offer a promising opportunity to accelerate economic development (Lwoga & Sangeda, 2019; Solomon & van Klyton, 2020).

In addition, smart city concepts are gaining traction in developed countries as well, especially in bustling metropolises such as megacities and capitals. These metropolitan areas, which serve as incubators for new ideas, aspire to realize the full potential of digital technology. Their goal is to profit from these advancements while also extending the benefits of digital technology. In developed countries, the use of digital technologies offers a great chance to promote sustainable development (Mishakov et al., 2021) and high business agility (Škare & Soriano, 2021). However, the picture is not so uniform in developed countries, e.g., rural areas face different challenges. In developed countries, the problem of depopulation in the rural peripheries between modern and vibrant urban centres is a major concern. Torre's (2022) observations highlight how outlying locations in developed countries frequently have little ability for technological innovation, which is a key component of smart cities. As a possible solution, these outlying areas might embrace innovation not just in the technology sphere but also in organizational, social, and institutional aspects. Organizational innovation is one strategy for embracing innovation. New methods of managing resources and personnel are needed for this. For instance, remote regions might establish novel collaborations involving the public sector, private sector, and nonprofit sector to promote innovation. They might also come up with novel approaches to serve locals and businesses. Social innovation represents an additional approach to embracing innovation. This entails finding novel solutions to social and environmental problems. For instance, remote locations could generate new community-based programs to support societal cohesion, economic growth, and environmental sustainability. Finally, institutional innovation can help remote areas adopt innovation. This calls for innovative approaches to developing and carrying out laws and regulations. For instance, remote regions could generate new legal frameworks to encourage innovation in the fields of technology, society, and business. They might also spend money on brand-new capacity-building initiatives to support local players in creating and putting into practice novel ideas. This points out that the applicability of the smart cities concept requires place-specific tailored policies.

In sum, the promise of economic development, environmental sustainability, and greater connectivity (due to effective resource management, data-driven decision-making, government backing, and increased public involvement) is contributing to the growing popularity of the smart city concept (Barsi, 2018; Caragliu & Del Bo, 2019; de Falco et al., 2019). According to Orlando and De La Barrera (2020), the goal is to support the building of sustainable, efficient, and fascinating cities that resonate with the ambitions of future generations. As a result, governments throughout the world are increasingly embracing the smart city idea to handle various urban concerns comprehensively.

Figure 5 shows a chronological list of countries where the most well-known smart city initiatives have been implemented. In the mid-1970s, the Los Angeles big data project pioneered the use of information technology and big data to analyze city issues. The project aimed to address urban problems and improve decision-making through data-driven solutions. The project sought to identify patterns and trends in vast amounts of data on transportation, demographics, crime, housing, and social services in order to make informed policy choices for the city's development and the well-being of its residents, laying the groundwork for the integration of big data and information technology into urban planning and governance (Orlando & De La Barrera, 2020). During the mid-1990s, Amsterdam was managed by the utilization of digitization and the internet, creating the concept of a “digital city Amsterdam”. The aim of the program was to bring together IT innovation (i.e., digitalization, internet) and urban development and to showcase how smart technologies can be used to improve the quality of life in cities. Projects included smart transport solutions, energy efficiency initiatives, waste management improvements, and digital community platforms. It was one of the world's first attempts at establishing a virtual community and digital city. This initiative established a virtual community and digital infrastructure, giving citizens the ability to utilize online services, discussion forums, and interactive spaces, fostering civil participation and communication among residents in a pioneering experiment of creating an internet-based digital representation of the city (Mora & Bolici, 2017). As part of their efforts for research into smart cities, large technology companies such as Cisco and IBM developed the concept of a smart city in the first decade of the 2000s. In 2005, Cisco launched a massive research project for smart city research and applications called Smart Connected Communities program. The Ciso program used a variety of smart devices and sensors to optimize urban infrastructure and services, including transport, energy efficiency and public safety. While IBM launched its Smart Planet project in 2008. IBM has provided cities with technology solutions to manage and harness data efficiently, helping cities to better understand urban processes and the needs of their residents. By using the information from the data, cities could plan their infrastructure and services more effectively. Moreover, in 2009, the European Union established smart meter projects, while the United States started smart grid projects, both aimed at improving urban infrastructure management.

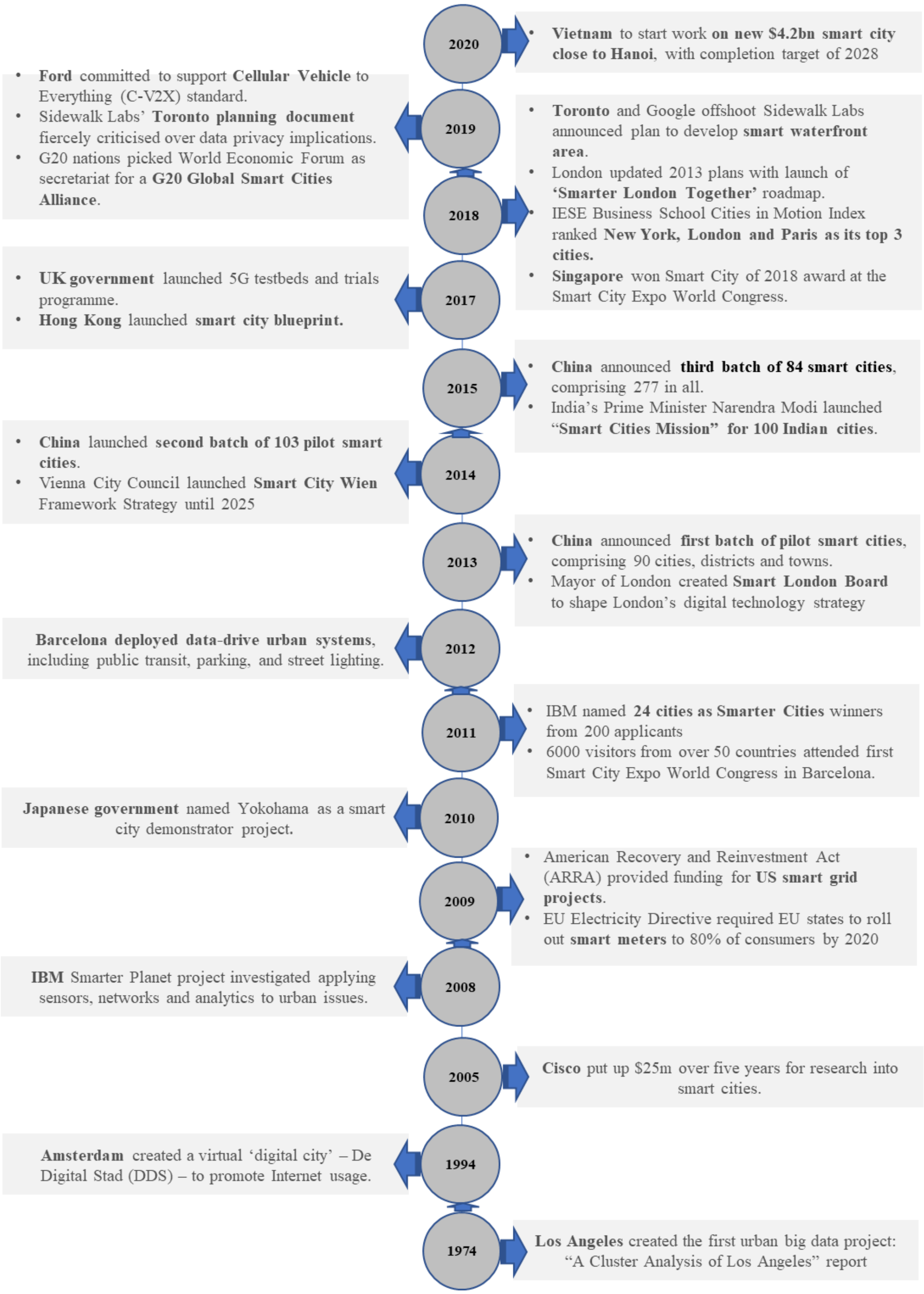
These initiatives attempted to upgrade the energy infrastructure and increase energy efficiency by allowing users to monitor and regulate their energy consumption more efficiently. Citizens and businesses managed energy more efficiently by installing smart meters and monitoring energy consumption in detail. Smart meters have made it possible to reduce energy waste, to time consumption to periods of lower energy demand, to make energy consumption more transparent and manageable, and promoted the incorporation of renewable energy sources into the grid (GlobalData, 2022).

Yokohama Smart City Project was launched by Japan in 2010. The project was motivated by the need to solve cities' expanding energy and environmental impacts, particularly following the 2011 Great East Japan Earthquake and Tsunami, which severely damaged Japan's energy infrastructure. The project's major goal was to develop and implement innovative solutions for urban energy management, encouraging energy saving, renewable energy use, and smart grid technology (Suwa, 2020).

The first Smart City Exhibition World Congress was held in Barcelona in 2011. In defining the smart city, 24 cities were identified out of 50 developed countries as Smarter Cities through the exhibition. To address urbanization issues, the city of Barcelona created and deployed data-driven urban systems in 2012. The smart city project in Barcelona was prompted by obvious shortcomings in prior strategic planning in the areas of housing, environmental challenges, water, energy, and transportation. Through its smart city program, the city aimed to use ICT to transform public administration, making it more usable, efficient, effective, and thorough, with the utmost objective of encouraging the city's competitiveness, encouraging innovation, enhancing communication, and improving the efficiency of public services through its smart city program. The program is considered a success. Coordination between urban sectors and the use of smart technologies have contributed to more efficient urban operations and sustainable development (Bakıcı et al., 2013).

London's digital technology strategy was launched by the City of London in 2013 with the launch of the Smart London Board. London's digital technology plan intended to solve urban concerns such as climate change with technology and data-driven solutions, resulting in a smarter, increasingly connected city. The program's major aim was to enhance public services, improve the quality of life for inhabitants and tourists, and foster innovation through collaboration between the public and commercial sectors coordinated by the Smart London Board (Appio et al., 2019). By several strategic measures, London effectively implemented its digital technology strategy. These projects included important endeavors, most notably the increased investment in digital infrastructure, as emphasized by the Smart London Board (2021). This included a broad reach to increase high-speed internet coverage, improve mobile connections, and develop a citywide Wi-Fi network. Another critical aspect was the emphasis on open data. London made a commitment to this cause by publishing a wide range of data sets on subjects ranging from transit and traffic to air quality. This plethora of data finds use in the hands of businesses and organizations, stimulating the development of innovative goods and services while also improving the city's own services. Furthermore, the amicable cooperation of the public and private sectors has emerged as a major accelerator of growth. The establishment of the Smart London Board encouraged the collaboration of governmental, corporate, and academic partners, promoting a collaborative atmosphere that accelerated the evolution and integration of cutting-edge technology. Additionally, increasing citizen interaction was a critical component of London's plan. The city was devoted to integrating its inhabitants in technological use. This showed itself through public consultations, ensuring that individuals had a voice, as well as the development of accessible tools and resources to assist them in properly grasping and utilizing technology.

Figure 5. The major milestones in the smart city concept



Source: Own edition based on the Smart cities – Thematic Research report produced by GlobalData Thematic Research (Verdict, 2020).

Developing countries also adopted the concept of smart cities from the beginning of the 2010s. From 2013 to 2015, China launched the ambitious phased project of building smart cities. By exploiting the concept of smart cities based on information technology, the project aimed to confront development issues in the country, particularly regional development. Further, in 2015, a project called Smart City Missions was launched in India to establish 100 smart cities. Hong Kong unveiled its Smart City Strategy in 2017 to address urbanization concerns. The Blueprint comprises 76 initiatives organized into six categories: smart transportation, smart living, smart environment, smart people, smart governance, and smart economics (Innovation and Technology Bureau, 2020). Among the efforts that have been executed is: (1) The Faster Payment System, which enables consumers to pay fast and easily using their mobile phones, (2) The deployment of free public Wi-Fi hotspots around the city, (3) The creation of the one-stop tailored digital services platform "iAM Smart", (4) Building information modeling is used to increase the efficiency of building projects, (5) Improving smart tourism platforms to attract more tourists to Hong Kong. These programs are intended to employ technology to improve Hong Kong's efficiency, sustainability, and livability. Similarly, Singapore was recognized with the World Conference Award at Smart Cities Expo 2018 for its successful application of big data, smart applications, and information technology. Thus, the above examples also clearly indicate, smart cities have become increasingly popular in both developed and developing countries in recent years.

According to the purposes, tools, and goals of these early smart city initiatives, we can conclude that they sought in many ways to use technology, data-driven actions, and ICT to address various urban challenges, such as improving the quality and accessibility of public services, promote energy efficiency, encourage sustainability, and improve the overall quality of life for residents and visitors. These early programs established a foundation for the incorporation of smart technology into urban planning and administration, with the goal of making cities smarter, more sustainable, and more connected.

During the past three decades, various terms have been used to describe the concept of integrating ICTs and digitalization for city development and management, including the term “digital city” which was widely used in the early 1990s. Several other terms, including “virtual cities”, “information cities”, and “sustainable cities”, reflect the use of IT and innovation as a basis for managing and utilizing a city's resources as well as dealing with its challenges to improve the quality of life for its residents. It has therefore become increasingly popular in the literature to refer to these synonymous concepts as smart cities (Orlando & De La Barrera, 2020).

The concept of smart cities has been characterized by various definitions in the literature. Despite its widespread usage, the term does not have a universally accepted definition. The comprehensive literature review revealed that **there are several definitions of smart cities** (see *Appendix 5*). As one of the first attempts, Hall et al. (2000) formulated the concept of the smart city. They define the smart city as:

"A city that monitors and integrates conditions of all of its critical infrastructures including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens" (Hall et al., 2000, p. 1).

In their definition, a smart city was defined in terms of its ability to monitor and manage its infrastructure as well as its resources in an efficient manner. After Hall et al.'s initial definition of smart cities was published in the first decade of the 2000s, several attempts have been made to define the concept (Hollands, 2008a; Paskaleva, 2011; Washburn & Sindhu, 2010). These definitions highlighted the importance of information and communication technology and knowledge-based methods as critical elements of smart cities. Hollands (2008), for example, defines which cities should be classified as smart as follows:

"(1) An SC is one that makes high use of ICTs; (2) an SC is one that has a strong entrepreneurial spirit; (3) an SC is one that cares about social and environmental sustainability; (4) an SC is characterized by the three T's: tolerance, technology, and creative talent. In short, SCs involve a very diverse range of elements (ICT, business innovation, government, communities, and sustainability). An SC uses ICTs to improve economic and political efficiency and enables social and environmental development" (Hollands, 2008a, p. 304).

Washburn and Sindhu (2010) defined it as follow:

*"An SC is one that uses ICTs to make the critical infrastructure components and services of a city (which include city administration, education, healthcare, public safety, real estate, transportation and utilities) more intelligent, interconnected and efficient." (*Washburn & Sindhu, 2010, p. 2)

During the past decade, we have seen **a new wave of definitions** of what constitutes a smart city. The definitions **go beyond the integration of ICT into operation of cities** to include other aspects, such as the human component and the social dimension. Furthermore, they are based on the principle that a smart city should improve the quality of life and well-being of its residents. Researchers in this field, such as Batty (2013), Caragliu and Del Bo (2012), and Schaffers et al. (2012), supported this perspective. For instance, Caragliu and Del Bo (2012), determined the smart city as follows:

"*A city is smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources through participatory governance"* (Caragliu & Del Bo, 2012, p. 100).

In recent years, a significant number of researchers have provided a comprehensive definition of smart cities emphasizing its **multidimensional nature** (Angelidou, 2014; Anthopoulos, 2017; Bibri, 2018; Caragliu & Del Bo, 2019; Chang et al., 2018; Gil-Garcia et al., 2015; Lombardi et al., 2012; Mora et al., 2019; Yigitcanlar et al., 2019). It is evident from these research that while ICT as a component is essential, but it is not the only determinant. **Smart cities should rather be seen as multidimensional and embrace diverse systems that consider the human component.** Lombardi et al. (2012) offers an example of a definition of a smart city that considers its multidimensional nature:

"Smart Cities incorporate the following clusters: smart governance (related to participation); smart human capital (related to people); smart environment (related to national resources); smart living (related to the quality of life); and smart economy (related to competitiveness)" (Lombardi et al., 2012, p. 134).

The concept of the smart city is multidimensional, which is why Lombardi et al. (2012) propose **six dimensions** that define a smart city as a concept. In terms of urban development and growth, these dimensions are based on traditional regional and neoclassical theories, specifically theories of regional competitiveness, transportation, the economics of information and communication technology, natural resources, human and social capital, quality of life, and citizen involvement (Lombardi et al., 2012). According to Lombardi et al. (2012), *"smart governance"* refers to the relationship between the government and the citizens of a city. The city government uses new channels of communication, such as e-government, to facilitate communication and promote resident participation in city management by leveraging information technology. Another dimension is *"smart human capital"*, which refers to the use of information technology to enhance teaching and learning, improving the skills and academic qualifications of residents, and ultimately forming a “*smart social capital”*. Among the important components of a smart city is the *“smart environment”*, which involves a wide range of aspects related to the environment and natural resources of a city, as well as the extent to which information technology is applied to achieve environmental sustainability and the use of efficient and sustainable energy sources.

Moreover, the definition introduces the concept of *“smart life”*, which refers to a city's quality of life. Transportation technologies include information and communication technology, as well as intelligent transportation systems, which allow traffic to be managed more efficiently and the population to move more efficiently, resulting in an improvement in quality of life. Finally, *„smart economy”* is defined as utilizing the elements of a smart city, namely ICT, to create an economic and industrial infrastructure that is based on them. ICT is utilized both to develop new industries, as well as to integrate ICT into existing industries to improve production processes. Moreover, a smart economy includes business complexes or areas within smart cities that are home to companies in the ICT industry.

Nowadays, it is widely understood that a smart city is more than an efficient management of its various components, including infrastructure, networks, buildings, and economic activities. A **data-assisted decision-making process** is used to propose and implement effective solutions based on the findings of data science. Accordingly, Rotunăet al. (2019) defined the term smart city as follows:

“It must include key components that allow data centralization, components that can take many forms, starting from a simple website to complex applications, supported by specialized hardware. The accessibility of the data should be guaranteed in a way that the system can be freely accessed by citizens, allowing them to propose changes and corrections interactively” (Rotuna et al., 2019, p. 42).

Marsal-Llacuna et al. (2015) define a smart city asdefinesto “*provide more efficient services to citizens, to monitor and optimize existing infrastructure, to increase collaboration amongst different economic actors and to encourage innovative business models in both private and public sectors*” (Marsal-Llacuna et al., 2015, p. 618). The relevance of this definition emphasizes the ultimate purpose of smart cities, which is to improve local communities' competitiveness through innovative practices. Simultaneously, smart cities aspire to improve people's quality of life by improving public services and encouraging environmental sustainability. As a result, this concept encompasses the new function of a smart city. According to Marsal-Llacuna et al. (2015), smart cities serve as platforms for fostering collaborative communities capable of encouraging innovation, including the development of novel business models. As a result, the city becomes increasingly competitive and capable of providing increasingly greater services, resulting in an improved quality of life for its residents. It is important to emphasize, however, that establishing a collaborative community of this type demands adequately furnished human capital.

As a result of the literature review findings, I have identified a range of definitions for smart cities (see *Appendix 5*). Despite there is no widely agreed-upon definition, if we look at their content, most of them emphasize similar characteristics as the following:

- The importance of **ICTs as a component** of smart cities is stressed in all definitions.
- Many definitions of smart cities emphasize the importance of integrating **human and social components**.
- Currently, most definitions of smart cities emphasize its **multidimensional nature**, characterized by a number of components.
- **Free acess to data** for people (citizens, entrepreneurs, innovators, etc.) Free acess of data by people (citizens, entrepreneurs, innovators, etc.) allowing them the opportunity to propose changes, improvements.

In their paper, Echebarria et al. (2020) conducted a comprehensive literature review and classified smart city definitions into three perspectives: technological, humanistic, and collaborative. A *technological perspective*, introduced by the American School, emphasizes the importance of technology in smart city definitions (Angelidou, 2014; Batty, 2013; Bibri, 2018; Townsend, 2013). Those who adopt this perspective believe that ICT can facilitate productivity by automating processes, enhancing decision-making, planning, and controlling. The *humanistic viewpoint*, on the other hand, principally espoused by the European School in the first decade of the twenty-first century, focuses on the premise that technology alone is unable to handle the issues faced by cities experiencing substantial changes in population lives (Caragliu et al., 2011; Hollands, 2008a; Kourtit et al., 2012; Lombardi et al., 2012). Conversely, this viewpoint highlights the necessity of investing in human capital as a critical component in the development of a smart city. While technologies are considered enablers, they are not sufficient to establish a smart urban setting on their own. Lastly, the *collaborative perspective* emphasizes the productive linkages that exist between diverse urban actor networks (government, business sector, and civil society) (Chang et al., 2018; Chourabi et al., 2012; Gil-Garcia et al., 2015; Lombardi et al., 2012;

Yigitcanlar et al., 2019). This approach values collaboration and believes that social change should be achieved largely through a combination of "top-down" and "bottom-up" strategies and endeavors, demonstrating the interrelatedness of the innovation dynamics that comprise a smart city.

Although smart cities have gained significant attention from academics and government officials alike, a clear definition of what constitutes a smart city has yet to be established. The subject has been disputed by various stakeholders since some works fail to provide a comprehensive description that includes more than the technical components (Caragliu & Del Bo, 2020). Consequently, **the subject has been viewed differently by different stakeholders**. As complex systems encompassing multiple facets, smart cities are viewed differently by technologists than by architects and planners from an urban and spatial planning perspective. According to government officials, smart cities provide opportunities for economic growth and modern city services, which lead to improved urban development indicators (Bholey, 2016). These varied perspectives result in a lack of a universal, accepted, or commonly agreed-upon definition of smart cities. A more comprehensive and nuanced understanding of smart cities is provided by Echebarria et al. (2020) by incorporating these three perspectives. Based on the review of the relevant literature on smart cities, we can state **that technology, human capital, and collaboration are indispensable for implementing sustainable and inclusive smart cities**. To develop a clear vision of what a smart city entails, **it is critical to consider all perspectives and engage with stakeholders**. As a result of this collaborative approach, the needs of all members of the community are met, as well as a sustainable, inclusive, and beneficial development of the city is ensured.

In summary, according to the various definitions and concepts of smart cities, the concept varies depending on many factors, including first, the perspective of development (cooperative, technology-centric, human, and social); second, the point of view of stakeholders involved in developing the model (technicians, architects, and planners, sociologists, and governments); and third, the applied approaches to the smart city (comprehensive or sector-based, i.e. primarily ICT).

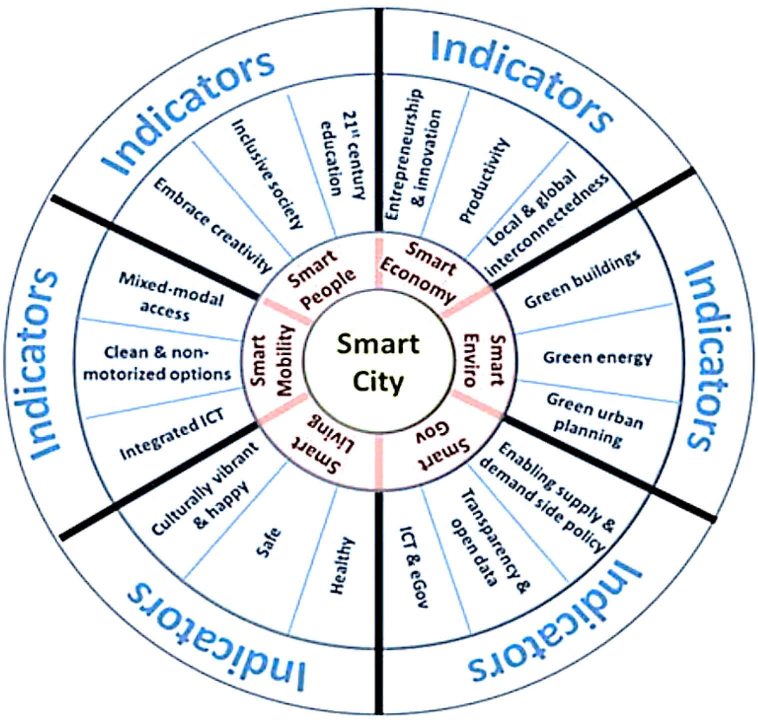
2.3.2 SC Pillars

Even though there is no unified concept of smart cities, there are several dimensions that are regarded as the fundamental pillars of smart cities based on the findings of the systematic literature review. Cohen (2012) developed the *Smart City Wheel* containing six elements (Alderete, 2020; Virtudes et al., 2017) such as smart

economy, smart people, smart mobility, smart governance, smart living, and smart environment (
Figure **6**).

The smart economy is distinguished by a spirit of innovation and entrepreneurship, high productivity (in terms of both quantity and quality), and labor market flexibility achieved by lowering trade barriers and opening local and worldwide markets. The smart economy gets its name from its dependence on digitalization and modern technology to drive economic development, improve efficiency, and stimulate creativity. Digitalization, which smoothly integrates technology into all industries and activities, is at the heart of a smart economy. This revolutionary force reshapes existing sectors and reveals new development opportunities. Digitalization empowers decision-makers, improves resource allocation, and boosts productivity by allowing the gathering, analysis, and usage of massive amounts of data (Kitchin, 2014). Moreover, digitization offers automation, networking, and real-time monitoring, allowing businesses and governments to function more efficiently and effectively. Digitalization expands beyond specific sectors or industries in the framework of a smart economy, penetrating the whole economic ecosystem. It includes a wide range of transformative technologies such as the Internet of Things (IoT), artificial intelligence (AI), cloud computing, blockchain, and data analytics (Vinod Kumar & Dahiya, 2017). A smart economy fosters an ecosystem ripe for innovation, promotes entrepreneurial activities, drives competitiveness, and supports long-term economic growth by embracing digitalization and utilizing the power of sophisticated technology. **Smart people** through increasing educational investment, supporting lifelong learning with e-skills through the use of ICT, organizing people and assuring their connectedness, permitting quick information interchange between cities' governments and their population, and stimulating creativity through knowledge sharing. To ensure **smart governance**, cities should continue to maintain online services for the management of their authorities, make use of technology as an open data set that can be accessed by the public, promote greater responsibility on the part of users, and promote transparent practices. To achieve **smart mobility**, a comprehensive transportation system must be established together with ICT on the infrastructure, and vehicles must be converted to free-consuming vehicles (electric vehicles). To increase the capacity of this system, increase the number of people taking automated metro subways, or promote soft mobility options such as cycling, walking, and car sharing. **Smart environment**, which includes energy conservation, water efficiency, and CO2 emission reduction as well as finding green sources of energy that are more suitable for natural conditions, supported by green urban planning. A smart environment is one that integrates digitization and sophisticated technology to encourage sustainable practices, effective resource management, and improved quality of life. By employing technology to monitor, evaluate, and improve numerous environmental factors, digitalization plays a critical role in establishing a smart environment (Ahad et al., 2020). The collection of real-time data from sensors, remote monitoring systems, and linked devices is made possible by digitalization, offering significant insights into environmental variables such as air quality, water quality, energy usage, waste management, and more (Hassanein, 2017). This data-driven strategy enables educated decision-making and proactive interventions to successfully address environmental concerns. The creation of technologies that enable people to live properly is referred to as **smart living**. Cities may become more appealing to inhabitants and visitors by investing in public services such as education and health care, while also increasing security and safety for certain categories of people such as children and the elderly (Virtudes et al., 2017).

Figure 6. Smart City pillars based on the "Smart City Wheel" framework developed by Cohen (2012)



Source: The author's editing is based on Virtudes et al., 2017, p. 5.

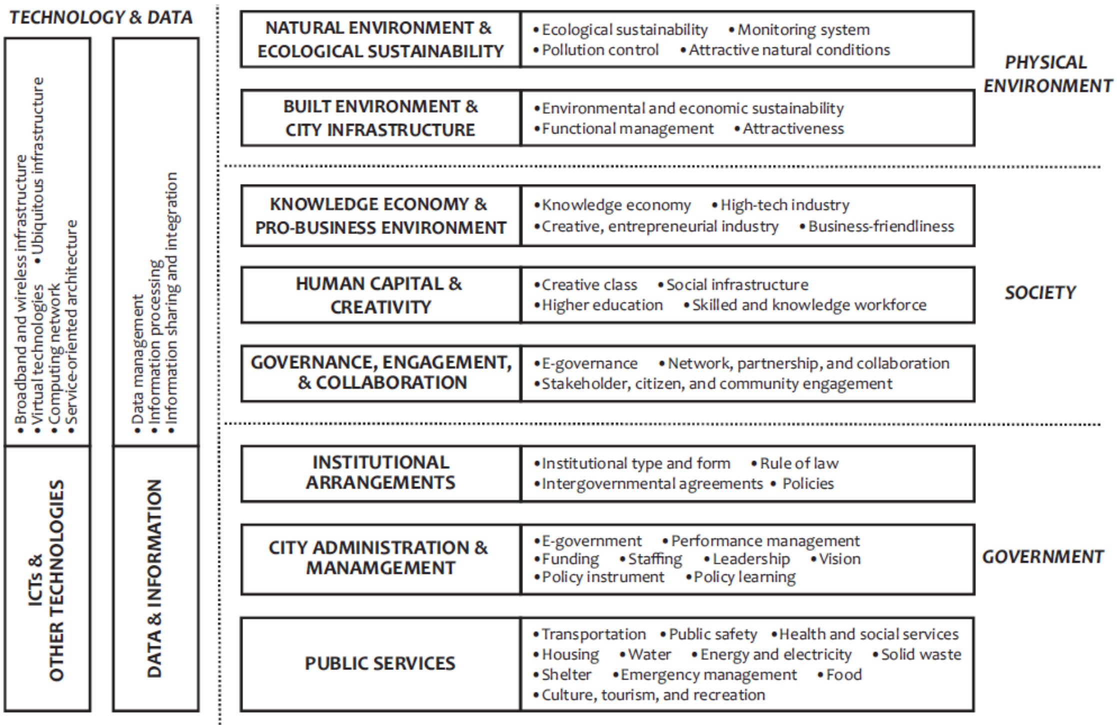
According to the Singapore-ETH Center for Global Environmental Sustainability, eight pillars define smart city (Ela, 2016). Water, materials, energy, finance, density, social inclusion, information, and space are these pillars. The components have been filtered into three main dimensions: (a) the *technology dimension*, which focuses on infrastructures that improve and modify the workplace and life in the smart city, (b) the *human dimension*, based on education, people, knowledge, and learning, focusing on the concept of the city of knowledge and learning, and (c) the *institutional and governance dimension*, which is relevant for collaboration between stakeholders in a smart city (Ela, 2016). Moreover, Gil-Garcia et al. (2015) discussed the smart city components as a comprehensive view based on the literature and a practical perspective. According to them, there are three main pillars which are *government*, *society*, and *physical environment*. The components of government pillar: (1) administration and management of the city, (2) public services, and (3) administration and management. The components of the society pillar are (4) governance, engagement, and collaboration, (5) knowledge economy, and pro-business environment, and (6) human capital. There are two components of the physical environment pillar: (7) natural environment and ecological sustainability, and (8) built environment and city infrastructure. In addition, there is a (9) data and information pillar, as well as (10) ICT and other technologies. The components have sub-elements that are used for evaluating the smartness of the city, as shown in

Figure 7 (Gil-Garcia et al., 2015).

Numerous studies have demonstrated the significance of **smart services and governance** in the development of smart cities (Anthopoulos, 2017; Emerson et al., 2012; Errichiello & Marasco, 2014; Oktaria et al., 2017; G. Pereira et al., 2017; G. V. Pereira et al., 2018; Tan & Taeihagh, 2020). In Oktaria et al. (2017), the definition of smart city services is debated, with economic interests, service providers, and community groups participating in the discussion. The priorities of smart services vary among regions or countries, with European cities such as Amsterdam, Stockholm, London, and Barcelona placing a great deal of emphasis on transportation and energy services. In contrast, American cities such as San Francisco place a great deal of importance on transportation, whereas Seoul, Korea, emphasizes public services management as well as transportation. In this respect, the interest of cities in smart services is heavily influenced by their unique characteristics, needs, and priorities from a spatial perspective.

Smart city governance is a crucial component of smart city operation. Pereira et al. (2017) distinguish between two perspectives on collaboration between the actors in smart city governance: *smart electronic government* and *smart governance*. In smart electronic government, technology is used to enhance public service delivery, while in smart governance, all stakeholders are involved in the decision-making process as a means to determine what services the city should provide (Pereira et al., 2017). Hence, smart governance plays a vital role in ensuring that all parties can participate in the development of their cities. Meanwhile, the literature seems to indicate that smart cities are governed differently: first, from the perspective of governing a city that supports smartness; and second, from the perspective of planning, operating, and implementing smart city projects (Anthopoulos, 2017).

Figure 7. A comprehensive view of Smart City components and elements



Source: Gil-Garcia et al. (2015, p. 78).

According to Anthopoulos (2017), there are three types of smart city governance: (1) smart city owned by the city government, in which the government governs the smart city project; (2) collaboration between the city and several stakeholders (PPP), in which the partners have shares in the smart city project; and (3) the city as a manager, in which the city imposes, standardizes, and supervises a smart city project implemented by stakeholders, frequently utilized for the creation of a new smart city.

It is apparent from reviewing the literature on the components of smart cities that a wide range of factors contribute to the development and operation of smart cities.

Consequently, smart cities can be viewed as a **multidimensional concept** that comprises a variety of elements.

Based on the definitions, smart cities are viewed as prosperous cities with highly educated population, knowledge-intensive industries, innovative planning systems, and sustainability initiatives. Given these features, several indicators and criteria must be devised to assess the effectiveness of the production process as well as the overall performance of these cities (Kourtit et al., 2012). Performance measurement research focuses on assessing the performance of current smart cities and determining which cities successfully integrate smart city components and use smart city methodologies and solutions (Barsi, 2018).

Although, the current doctoral thesis focuses on the study of newly created smart cities in Egypt, most of which are still under construction, it is interesting to highlight some of the evaluation methods that measure the performance of already established smart cities. Barsi (2018) conducted research that identified four essential ways for measuring smart city performance: 1) using modeling techniques such as cluster analysis, factor analysis, four helices (Lombardi et al., 2012), and spatial autoregressive models that go beyond indicators; 2) the creation of indexes and ranking them based on indicators, similar to that conducted by Giffinger et al. (2007); 3) analyzing specific smart city initiatives and projects (Manitiu & Pedrini, 2015); and 4) using surveys to assess the quality of life and measure happiness. The production process includes numerous factors that must be measured in terms of quality, such as the use of ICT, sustainability, and people's quality of life. While evaluating smart cities, Barsi (2018) underlines the significance of analyzing human well-being and fulfillment dynamically and comparatively.

Lombardini et al. (2012) and Yigitcanlar (2015) also suggested numerous key metrics for measuring smart city performance, including human capital, governance, living conditions, and the environment. Furthermore, Vinod Kumar and Dahiya (2017) highlighted 19 important features of smart city performance, with an emphasis on university-supported innovation, entrepreneurial leadership, and various economic prospects. The participatory economy is particularly important because it allows residents to access a variety of economic possibilities while simultaneously contributing to the creation of a sustainable and vibrant city. Ultimately, these factors are critical for developing and sustaining smart cities capable of providing high-levels of well-being and happiness to their residents.

According to the literature review, there are numerous techniques and methodologies for assessing smart cities' performance. This variety originates from the multidimensional structure of smart cities, which involves measuring numerous components' performance before analyzing the city's overall performance. Assessing the performance of smart cities in absolute terms is difficult owing to the diversity of components and their interconnectedness, which might impact the assessment process's success. Nevertheless, the literature review findings suggest that the comprehensiveness and diversity of smart cities' integrated components, spanning from ICT to sustainability and citizens' quality of life, may be used to assess their level of success. Furthermore, measuring the population's well-being dynamically and continuously might give useful insights into smart city performance. While measuring smart city performance is challenging, studying **the variety of interconnected components and their interaction may reveal a thorough knowledge of the smart city's performance.**

The literature review provides insight into the assessment of smart cities' performance, definitions, concepts, and components. Some studies also highlight critiques, potential pitfalls to be avoided, and lessons learned when building and implementing smart cities (Cassandras, 2016; Chourabi et al., 2012; Galdon-Clavell, 2013; Greenfield, 2013; Grossi & Pianezzi, 2017; Hollands, 2008b; Kitchin, 2014, 2015; Lam & Ma, 2019; Townsend, 2013). These criticisms and lessons gained can help guide the creation and implementation of smart cities, allowing them to be carried out more successfully. It is feasible to uncover best practices and areas for development by reviewing the problems and failures of previous smart city programs. This can contribute to the creation of smart cities in a sustained and equitable manner, taking into consideration the requirements and preferences of all stakeholders.

Kitchin (2015) found that there is a substantial shortage of thorough empirical studies on smart city programs, as well as a comparative analysis of such projects across different regions. Furthermore, the study reveals that stakeholder cooperation in smart city programs is insufficient. According to Holland (2008), certain smart cities promote informational commercial interests, masking rising social division. Several smart city challenges can be attributed to their success, including social polarization and widening inequality. Notwithstanding the admirable intentions of investing in ICTs, human capital, social learning, and smart communities, the use of IT can lead to the gentrification of areas and the marginalization of traditional communities and disadvantaged citizens. Nevertheless, there is no assurance that these objectives will be realized, and investment in public-private partnerships may backfire because capital may leave these sectors to take advantage of other opportunities (Hollands, 2008b). Moreover, some academics have disputed the notion of smart cities, stating that it is an urban labeling phenomenon that is used inconsistently (Chourabi et al., 2012).

Although some academics recognize the value of human capital in smart city programs, others are worried about the pitfalls and consequences of technological solutions. According to Greenfield (2013), the success of a smart city is dependent on emphasizing the people whose talents undergird the success of any city, since their skills count. Smart solutions, on the other hand, frequently disregard social, ethical, and human rights implications and concerns, and may not include empowering, participation, and bottom-up methods (Galdon-Clavell, 2013).

Researchers such as Galdon-Clavell (2013) express worry that smart cities are being classified as such without sufficiently examining issues such as security, law, and ethics and that technological solutions are being implemented without enough critical evaluation. Kitchin (2014) examines big data and smart city problems in five new areas: large urban data politics, technocratic governance, corporations for city development, technology lock-in, bugged, fragile, and hackable cities, and panoptic cities. Additionally, Lam and Ma (2019) identified four significant stumbling blocks for smart city initiatives: system information vulnerability, personal privacy leaks, information islands, and the digital divide. Resolving these difficulties is critical for smart city programs to succeed.

In addition to the aforementioned critics, Cassandras (2016) challenged the restricted approach to smart cities, emphasizing their very dynamic and multifaceted nature. Cassandras (2016) underlines the importance of using a multidisciplinary approach that incorporates the fields of engineering, computer science, and sociology to effectively solve the various difficulties confronting smart cities. Moreover, Grossi and Pianezzi (2017) investigate whether smart cities are utopian ideas or neoliberal instances. They assess the relationship between neoliberalism and the smart city model, with its emphasis on privatization and power wielded without democratic representation. One major source of worry is that private companies may compete with governments for contracts to deliver public services, negatively impacting the public interest (Grossi & Pianezzi, 2017).

According to the conclusions of the literature analysis, it is critical to learn from previous examples, from success stories and failures, and **prioritize the role of human capital over emphasized dependence on information technology to develop an efficient smart city program.** Smart cities that focus on people and their interactions have the potential to alter and enhance communities by empowering and educating people and encouraging them to engage in discussions about their cities (Hollands, 2008). Further, Chourabi et al. (2012) emphasize the significance of a thorough understanding of smart city projects in addition to information technology. Smart cities' sustainability and livability may be determined by using a framework that incorporates various factors including management and organizational performance, technologies, policy and governance, people and communities, the economy, physical infrastructure, and the environment. Greenfield (2013) and Townsend (2013) suggest that if such rigorous evaluations are not conducted, smart cities would likely represent restricted business and governmental ideals rather than societal aspirations. As a result, smart city projects must prioritize people over technology and take a comprehensive approach to serve the community's different needs and interests.

In summary, the evidence presented in the current chapter demonstrates smart cities' comprehensive and multidimensional nature. By the application of smart economy, smart environment, smart mobility, intelligent people, and smart governance, ICT has been accepted as a key driver to address urban growth concerns and improve people's quality of life (Anttila & Jussila, 2018; Caragliu et al., 2011; Gil-Garcia et al., 2015; Lombardi et al., 2012; Lukovics & Zuti, 2018). **Although technology, especially ICT is necessary, it is not sufficient alone**. Smart cities must also include their people and human capital in the planning, development, and implementation processes to guarantee that their requirements are met, resulting in livable and prosperous communities for citizens. This chapter gives an overview of smart city pillars, as well as the prerequisites for cities to be designated smart. The factors of multiple definitions of smart cities were found by the literature analysis, encompassing the key components such as the population, environment, economy, governance, society, and smart transportation.

2.3.3 SC Strategies

The purpose of this sub-chapter is to look at different strategies for developing smart cities. Given that the Egypt Vision 2030 aspires to develop *new* smart cities, it is useful to undertake a critical evaluation of the pros and cons associated with different smart city strategies and identify potential challenges, particularly in the case of strategies introducing newly constructed smart cities. Smart city strategies are tailored policies based on regional features and long-term development goals. According to Angelidou (2014), smart cities are developed and implemented according to four strategic patterns: (1) national versus local strategies, (2) building new smart cities versus adapting existing ones to be smart, (3) soft versus hard infrastructure-based strategies, and lastly, (4) geographic versus sector-based strategies.

In the case of *national vs. local strategies,* implementation level is a determinant of smart city strategy. Local strategies refer to the city or county strategy embracing the notion of smart cities in order to promote the growth of a city or a certain region. The national strategies for smart city initiatives, on the other hand, include the implementation of the national government's overall strategy for the development of several cities as part of a broader national development plan. Urban problems are known to the local community and are a priority for them. Consequently, they become easier to manage at the local level. In the meantime, local strategies suffer from the competition for resources among small and medium-sized metropolitan areas and megacities. Furthermore, usually more efforts must also be made from the local level to align its strategy with the complex national policy agenda. Contrary, in the case of the national-level strategies, the state is supported by various resources and a comprehensive viewpoint. In this case, top-level management clarifies roles and responsibilities, which facilitates the effective implementation of strategies. The ineffective use of local resources is one of the disadvantages of this solution, because of national-level top-down implementation, the proper identification of opportunities and barriers may be doubtful (Angelidou, 2014). Singapore is considered one of the most famous cases of national-level strategies (Bris et al., 2019; Tay et al., 2018).

Instead of adapting the smart city concept to existing cities, *one possible strategy is to build entirely new ones*. This New Smart Cities (NSC) strategy is frequently adopted by rising and developing countries. Cyberport Hong Kong (China), Songdo International Business Area (South Korea), Cyberjaya (Malaysia), and Skolkovo Innovation Center (Russia) are examples of NSCs (Angelidou, 2014). The creation of NSCs is an ambitious strategy involving considerable building, land use, and infrastructure construction. One benefit of this approach is that it allows for the creation of a smart city strategy from the ground up, with specific criteria and development goals. From the design stage through the implementation and follow-up stages, this approach enables the development of a modern vision of smart infrastructure based on high-tech solutions. Furthermore, the placement of NSCs might be chosen strategically to meet the goals of the national urban system (Angelidou, 2014). The NSC approach, on the other hand, has been criticized due to the large expenditure necessary for its implementation. Furthermore, Townsend (2014) also criticizes the assumption promoted by firms such as Cisco and IBM that newly formed smart city programs can be copied and expanded smoothly throughout any city. According to

Townsend (2014), it is critical for emerging smart cities to promote spontaneity, creativity, and social engagement in addition to efficiency. Moreover, as Angelidou (2014) and Tödtling & Trippl (2014) highlight, the same new smart city model or strategy may not be adaptable to all cities within a particular country (2005).

Thirdly, there are *soft infrastructure vs. hard infrastructure-placed strategies*. The hard infrastructure consists of physical assets such as roads, bridges, and buildings, whereas soft infrastructure refers to intangible resources such as education, healthcare, research and development, and other human capital investments. Policymakers and planners must determine whether to prioritize physical infrastructure or soft infrastructure in the context of smart cities. The first prioritizes high-tech infrastructure such as smart grids, sensors, and data analytics, whereas the latter promotes the value of talented employees and an innovative community. Soft infrastructure strategies tend to take a more holistic approach and prioritize innovation, knowledge, and qualified professionals (Angelidou, 2014; Baldascino & Mosca, 2016; Caragliu et al., 2011; Joia & Kuhl, 2019). However, there is criticism that policies focused on physical infrastructure may result in socioeconomic gaps and inequalities in how ICT is used, and knowledge is disseminated across regions (Angelidou, 2014; Caragliu & Del Bo, 2012). Ultimately, soft infrastructure is an important component of smart cities, and policymakers must take a balanced approach that incorporates both hard and soft infrastructure development to ensure that all people benefit from the benefits that smart cities can offer.

Finally, smart city strategies could also be adapted based on *geographically based strategies vs. economy sector-based approaches*. This last approach aims to make specific economic sectors of the city smarter by enhancing smart city housing, business, education, and governance by adapting smart city platforms and programs (Angelidou, 2014; IBM, 2019). In contrast, geographically based SC strategies focus on the development of specific locations, such as CBDs, attractive tourism areas (NEOM Company, 2021), or especially rural areas (villages) for research and development (WIRED, 2000), which are determined by the user group.

Furthermore, some research reveals that choosing an effective smart city development strategy necessitates considering diverse approaches to strategic concepts. In smart city research, there is a *dichotomy* defined by distinct views such as technology-led vs. holistic strategy, top-down vs. bottom-up approach, and mono-dimensional vs. integrated logic (Mora et al., 2019). A *technology-led strategy*, on the one hand, stresses the relevance of high-tech infrastructure and focuses on technical advances such as smart grids, sensors, and data analytics. A *holistic strategy,* on the other hand, prioritizes soft infrastructure, such as education and healthcare, and takes a more complete approach that takes into account social, economic, and environmental concerns. Similarly, whether *a top-down* or *bottom-up* strategy is more effective is debatable. A top-down method involves centralized decision-making by government or private entities, whereas a bottom-up approach stresses citizen and local community engagement in decision-making. Lastly, the debate surrounding *mono-dimensional* logic relates to whether it is more appropriate to address a single issue in isolation, or whether it is more appropriate to adopt a broader, *integrated perspective*.

In sum, we can conclude when selecting a smart city development strategy, **it is important to maintain a balanced approach that considers all these divergent viewpoints**. During the decision-making process, policymakers and planners must take into **account the unique needs and priorities of their cities and regions** and must consider both hard and soft infrastructure investments. Moreover, they should ensure that citizens and local communities are involved in the decision-making process.

2.3.4 SC for Fostering Innovation

The role of smart cities is multifaceted. This role includes not only promoting modern urban planning and addressing challenges such as population growth, sustainability, and environmental issues, but also catalyzing innovation. Smart cities aim to boost their competitiveness by stimulating innovation, while improving the quality of life of their inhabitants through improved urban services and a more sustainable environment (Appio et al., 2019; Errichiello & Marasco, 2014; Kraus et al., 2015; Leydesdorff & Deakin, 2011; Neirotti et al., 2014; Paskaleva, 2011; Ratten, 2017; Schaffers et al., 2012).

Several studies indicate that smart cities can foster innovation by being positioned as centres of innovation and learning (Kraus et al., 2015). Kouta and Ketikidis (2019) suggest that smart cities can provide a *"favorable environment"* that encourages innovation, fosters collaboration between numerous actors, and facilitates knowledge dissemination. Additionally, Caragliu et al. (2011) stressed the potential for smart cities to stimulate innovation across several domains, including transportation, energy, and communication. The authors also highlighted numerous essential features that lead to innovation, such as technology adoption, stakeholder collaboration, and active public involvement (Caragliu et al., 2011). Lee and Kim (2018) investigated the role of smart cities as a mechanism for fostering innovation in an economy that is highly reliant on innovation. They conclude that the role of smart cities as innovation hubs can be facilitated by providing a *"platform"* for experimentation, co-creation and knowledge exchange. The European Commission has also proposed that smart cities could act as "*testing grounds*" for innovation by providing a *"conducive environment"* for experimenting with innovative solutions based on cooperation among citizens, businesses, and universities (Errichiello & Marasco, 2014; Schaffers et al., 2012).

These statements are clearly supported by Barcelona's and London's smart city programs. Several studies have indicated that the smart city initiatives of Barcelona have had a considerable impact on its innovation ecosystem (Bakc et al., 2013; Capdevila & Zarlenga, 2015; Gascó, 2016; Zygiaris, 2013). Barcelona's smart city program has fostered collaboration among local businesses, universities, and research institutions, supporting a vibrant local innovation ecosystem (Bakıcı et al., 2013; Zygiaris, 2013). The city's focus on sustainable growth has additionally contributed to its achievement in attracting new businesses and expertise, thus further enhancing its innovation ecosystem (Gascó, 2016). In a smart city, investing in modern digital infrastructure and open data initiatives enabled seamless data exchange, allowing for the creation of smart apps and services based on real-time urban data. Barcelona has adopted open data initiatives, providing vast quantities of urban data to the public, researchers, and businesses. This proactive approach has effectively spurred developers and entrepreneurs to generate inventive solutions (Zygiaris, 2013). The Smart City Lab was established as a collaborative environment for government agencies, corporations, startups, and academic institutions to co-create and test new smart city solutions (Capdevila & Zarlenga, 2015). This collaboration encouraged the sharing of ideas, knowledge, and resources, which resulted in the development of new innovations and solutions (Bakıcı et al., 2013). Barcelona's Smart City Challenges and entrepreneurial programs provided external stakeholders the opportunity to actively engage in the city's innovation ecosystem. The city promoted active engagement in its smart city vision by hosting contests and encouraging entrepreneurs and digital businesses to submit solutions to urban concerns (Gascó, 2016). With programs such as co-working spaces, incubators, and financing possibilities, the city also offered critical support and resources for entrepreneurs and start-ups working on smart city solutions, fostering, and advancing creative innovations (Bakc et al., 2013). Smart city projects in Barcelona emphasized citizen involvement and co-creation, fostering a culture of innovation and responsiveness to the demands of its residents, and allowing them to actively participate in defining the city's future (Capdevila & Zarlenga, 2015). Barcelona's desire to act as an innovation hub by developing and piloting new technologies and solutions developed an ecosystem receptive to experimentation, boosting creativity and innovation even further. The city's success in executing smart city initiatives, coupled with its commitment to innovation, gained international acclaim and acknowledgment, drawing talent, investment, and partnership from global technology businesses and academic institutes (Bakc et al., 2013; Zygiaris, 2013).

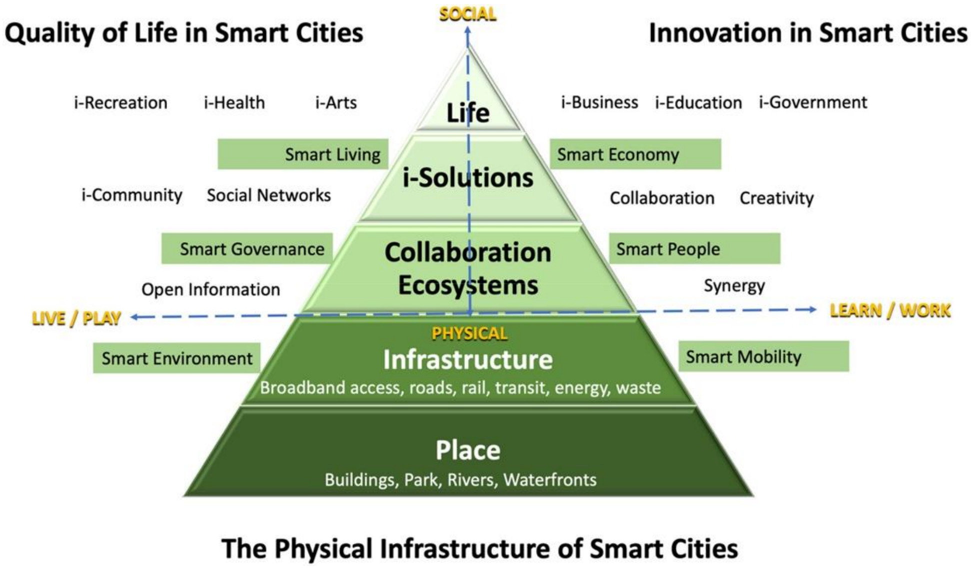
London's smart city projects are a good example of this as well. These initiatives have helped develop the city's innovation ecosystem by focusing on four key dimensions: encouraging technological innovation, embracing open data and transparency, encouraging cooperation and participation, and improving efficiency and resource management (Appio et al., 2019). The city's smart city strategy, illustrated as the “Here East” initiative at Queen Elizabeth Olympic Park, made use of emerging technology to better serve London and its citizens (Angelidou, 2015). This project created a digital area, integrating business, technology, media, education, and data to establish a local innovation system, providing a framework for start-ups, education, and postgraduate research, and demonstrating the spatial convergence of urban futures and the knowledge and innovation economy (Angelidou, 2015). The objective of London's smart city plan was to promote information dissemination, stakeholder collaboration, and urban innovation to actualize future urban improvements and establish a flourishing innovation ecosystem. In sum, Barcelona and London, as smart cities are using innovative means to increase their competitive advantage, while improving the well-being of their inhabitants by providing excellent public services and promoting a more liveable environment.

Appio et al. (2019) provides a framework model that explains the multifaceted role of smart cities (*Figure 8)*: on the one hand, urban residents are users of improved urban services, but on the other hand, their role can go beyond that, as they can also be involved in creating new innovative solutions that ultimately contribute to the city's long-term development. The model developed by Appio et al. (2019) combines two other models: it integrates Giffinger’s smart city framework with the Hutchison's i-COA framework.

Giffinger et al. (2007), in their model, classified six key dimensions of smart cities (see summary about the dimensions in chapter 2.3.2). A major criticism of this model is that while it identifies critical components/dimensions of the smart city, it lacks structural perspective. On the other hand, Appio et al. (2019) also adapted the Hutchinson's i-COA (intelligent community open architecture) (Hutchison et al., 2011) framework which delineates the primary components of an intelligent community and assumes a hierarchical, pyramid-like structure between the elements. By combining these two models, the new framework of Appio et al. (2019) goes beyond relying only on the development of *hard* *factors* (e.g. smart building, smart energy management, smart transportation) through *advanced ICT solutions* (e.g. fiber optic networks, sensors, interconnected devices, open data analytics, IoT, AI), as it also includes *soft factors* (e.g. human and social capital development through education, culture, collaboration beween actors). According to this framework, *"smart cities are perceived above all as "Intelligent Communities", collaborative ecosystems that facilitate innovation, by creating linkages among citizens, government, businesses, and educational institutions. These innovative clusters foster the development of high added value activities of the "knowledge economy."* (Appio et al. 2019, p. 2)

Appio et al. (2019) pyramid model explains how a smart city can encourage innovation through the hierarchical interconnectedness of its various dimensions. Technology is used in smart cities to improve urban settings' sustainability, efficiency, and all-around quality. The smart city model proposed by Appio et al. (2019) asserts that smart cities are made up of interconnected dimensions: smart environment, smart economy, smart living, and smart governance.

Figure 8. A framework for combining smart cities and innovation ecosystems.



Source: Appio et al., 2019, p. 3.

According to this pyramid model, smart city efforts begin with the development of the physical environment – *places* (e.g., buildings, parks, rivers, waterfronts) and *infrastructure* (e.g., broadband access, road, rail, transit, energy, and waste) – through modern technologies. Using advanced ICT technologies, both *Smart Environment* and *Smart Mobility* dimensions can improve different aspects of urban living, including waste disposal, pollution control, housing quality, transportation and facility management, etc. The challenges of rapid urbanization call for smart solutions to issues such as housing, electricity, heating, education, and job creation. Big data networks, enabled by ICT infrastructure, allow for the real-time analysis of a vast amount of data. The Internet of Things, combined with big data and artificial intelligence, presents an opportunity to create and operate more efficient, sustainable infrastructures, and thus create a more livable living environment. For example, smart energy grids may reduce energy use and greenhouse gas emissions, and intelligent transportation systems can improve air quality and reduce traffic congestion, while smart healthcare technologies enable remote patient care and early disease detection, and smart homes offer energy-saving features and security monitoring. In addition, smart cities also can alleviate urban congestion by improving mobility through the use of autonomous vehicles, sensors in critical infrastructure, and vehicle social networks (VSNs).

Building on this smart infrastructure, smart cities can foster a highly collaborative ecosystem in which diverse actors such as citizens, businesses, universities, research centers, and government agencies can cooperate to develop novel products, services, and solutions. However, creating such a collaborative ecosystem requires significant human and social capital (Smart people). Places where local actors (universities, business, civil society, and government) can work together for the sake of creativity and innovation, can create a more competitive, resilient, and attractive local economy (Smart economy). The importance of human capital in boosting economic growth and promoting innovation is well recognized, as well as the key role of universities and research institutions in boosting human capital. However, cities must not only create, but must also retain and attract talent by offering an inclusive and attractive living environment. Open, tolerant communities are essential for attracting diverse and creative people and for nourishing social capital (Florida, 2002). The model also underlines the relevance of physical proximity between skilled and talented people, companies and government agencies in promoting social networks of trust, sharing and learning. Consequently, these cities usually set up research centers, start-up incubators, accelerators and innovation parks that offer the possibility of collaboration for knowledge sharing. Smart cities serve as magnets for open innovation projects, enabled by advanced IT infrastructures developed through public-private partnerships.

The ICT infrastructure of smart cities opens up opportunities for new business models, its public availability reduces barriers to entry for businesses and start-ups, and at the same time supports the testing of innovative solutions for the well-being of citizens, as the collaborative approach allows that users can participate as “prosumers” and play an active role in the development of the products, services, and processes. In sum, the complex interactions between the smart environment, mobility, and people is the foundation for innovative business models in the smart economy. Effective coordination between the various actors within smart cities is also supported by an ICT system that increases mutual recognition and understanding of each other's activities and allows for active involvement and mutual support. Citizens can gain online access to government services thanks to e-government platforms (*Smart governance*). The ultimate goal of smart city initiatives is to achieve improved well-being for citizens (*Smart Living*). According to the OECD's Better-Life Initiative framework, Smart Living includes initiatives to improve health, education, social services, environmental sustainability, safety, employment opportunities, housing, and infrastructure.

To summarize, Appio et al.'s (2019) smart city model suggests that a strong economy and a high quality of life are built on a smart environment. For example, access to secure drinking water, clean air, and efficient transportation encourages productivity and innovation. A smart environment is essential for attracting and keeping residents, which is essential for economic success. Cities that attract and retain talented residents are those whose services and amenities improve their quality of life. In order to invest in smart infrastructure and services that benefit both citizens and businesses, a smart economy must have the resources to do so. For smart city efforts to be implemented successfully, governments must collect and analyze data to identify and address urban concerns. The model emphasizes the importance of public participation in the development of smart cities. Citizens may contribute to all parts of the concept, from improving performance to inventing innovative solutions. Residents can take part in smart grid programs, for instance, by producing their own renewable energy or reducing their energy usage. Cities can construct a more sustainable, livable, and inventive future for their inhabitants by investing in all aspects of the model and promoting public engagement.

The following example illustrates how a smart city can foster innovation based on the model presented above. For example, a city may decide to introduce a new intelligent transport system that uses sensors to collect data on traffic trends. This data can be used directly to optimize traffic signals, reduce congestion, improve air quality, and ultimately improve the livability of the city. In addition, smart transport systems can boost economic growth by simplifying the flow of goods and people (cheaper, more efficient solutions). Data from the smart transport system may potentially be used by the local administration to develop new policies and services. This information might help identify locations that need new public transport lines or inspire incentive programs to encourage inhabitants to utilize public transit or bicycles. Therefore, the smart transport system (smart environment) improves air quality and livability (smart living), supports economic growth (smart economy), and allows creative government policies and services (smart governance) in this scenario. According to smart people, the city can use the data from the smart transport system to develop new educational programs and training opportunities for its residents (smart people). For example, the city could offer courses on how to use data analytics to develop new transportation solutions or how to design and implement sustainable transportation modes. The city could also provide financial support to entrepreneurs who are developing new transportation technologies or services. As a result, the city would be fostering a more innovative and skilled workforce, which would lead to new ideas, products, services, and business models in the transportation sector.

In sum, Appio et al.'s (2019) smart city model provides a complete framework for illustrating how many aspects of smart cities may be combined to produce a more sustainable, livable, and innovative future for citizens. In conclusion, it has been demonstrated that smart cities, as favorable testing grounds for experimentation, can contribute to urban and regional development by fostering a collaborative ecosystem of innovation. Nevertheless, it is important to acknowledge that innovation is not solely dependent on infrastructure or the usage of ICT technology. **For innovation to flourish, it is also necessary to develop, attract or retain human resources and establish effective collaboration among diverse stakeholders**.

2.3.5 SC Experiences in Developing Countries

Several countries have embraced the smart city concept. In my thesis, I have taken several factors into account while selecting specific instances of smart cities. Firstly, only smart city programs in developing countries were considered, as Egypt is also a developing country. The second criterion involved choosing countries where smart city policies are integrated into the national strategic plan, as in Egypt, which also follows a top-down strategy. Third, a pivotal focus was placed on smart city programs geared towards transforming current cities into smart cities, given Egypt's intention to introduce smart city initiatives in its existing urban areas in the near future. Considering these criteria, three cases of smart city implementation were selected: India, China, and Indonesia.

The ambitious Smart City Mission (SCM) was launched in 2015 by the government of **India**. The aim is to transform 100 existing cities across the country by 2030, into sustainable and citizen-friendly smart cities (Vu & Hartley, 2018). Each city was selected in a competitive process and needed to prepare and implement a comprehensive smart city proposal, identifying local challenges, priorities, and solutions. The program encourages collaboration between the government, the private sector, and citizens. The government intends to connect smart cities with larger cities or mega metropolitan regions. The program recognizes the *rapid urbanization* taking place in India and seeks to address the challenges this poses. Smart Cities Mission (SMC) aims to solve the *inadequate infrastructure in urban areas* which decreases the quality of life for residents and prevents sustainable growth of cities. Using technology, data, and creative solutions, the program aims to enhance different aspects of urban life, including governance, urban planning, infrastructure, energy management, transportation, and public services. The goal of the SCM is to encourage economic growth in the designated existing cities and improve people's well-being by supporting local development by harnessing technology. The emphasis on area-based development is to rehabilitate existing regions, including slums, and turn them into well-planned and enhanced places, so improving the existing cities' overall livability. In addition, additional regions near cities, known as greenfield areas, will be developed to accommodate the expanding urban population. This comprehensive approach to development will result in a better quality of life, more job possibilities, and higher earnings for all inhabitants, including the economically poor, encouraging inclusive cities (Bholey, 2016; Ministry of Housing and Urban Affairs, 2015).

The Indian model of smart cities revolves around addressing *overpopulation* and their subsequent urban development implications (Bholey, 2016). Smart cities in India are defined as having a basic infrastructure, decent living conditions, a clean, sustainable environment, and smart solutions for city management. Six fundamental principles describe the smart city concept in India: (1) communities are at the center of planning and implementation; (2) the ability to achieve greater results with fewer resources; (3) cities selected for implementation through completion, and flexibility in implementation. Additionally, (4) innovative approaches, integrated and sustainable solutions, (5) carefully selected technologies that are relevant to the context of cities, and (6) sectoral and financial convergence are essential (Ministry of Housing and Urban Affairs, 2015). According to the most recent information available on the Smart City Mission official website, 74% of the target has been completed, with the remaining 24% still in the process[3]. Bhattacharya et al. (2020) notes that the application of sustainability to smart city models in India, or any rapidly developing or emerging economy, must consider the following factors:

1) Efficient *city planning*, it has been stated that planning is crucial to the success of the model.
2) A smart city provides a good quality of life, due to offering efficient *urban transportation*, through improvements to public transport, improvements in vehicle infrastructure, and improvements to infrastructure for pedestrians, cycling, etc.
3) Effectively *managing consumer demand*, especially using urban intelligence in managing energy demand.

The **Chinese smart city model** emphasizes both constructing new smart cities and converting existing ones into smart, sustainable, and livable urban centers (Angelidou, 2014; Vu & Hartley, 2018). The Smart City Development Initiative (SCDI), China's comprehensive smart city initiative, was launched in 2013 as part of the country's broader urbanization and sustainable development efforts. Local and national governments collaborated with IBM to adopt policy initiatives aimed at boosting smart city development (Bris et al., 2019). The major goal of China's smart city effort is to promote *balanced regional development* by eliminating regional economic, social, and environmental disparities. The country confronts regional imbalances, which can contribute to social instability, resource inefficiencies, and environmental deterioration (Deng et al., 2022). To address these concerns, China intends to use smart cities to increase the quality of urban services, foster innovation and competitiveness, and ultimately improve the overall well-being of citizens in lagging regions (Deng et al., 2022; Zeng et al., 2023). As a pioneer in smart city technology, IBM presented the "Smarter Planet project"[4] in 2008 to examine how sensors, networks, and analytics can be applied to urban issues. Consequently, China sought to incorporate those experiences into its smart city program (Angelidou, 2014; Yao et al.,

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[3] https://smartcities.gov.in/ (available 30th June 2023)

[4] IBM's Smarter Planet vision was driven by three I's—instrumentation, interconnectedness and intelligence. It showed a way for industries, infrastructures, processes, cities and entire societies to be more productive, efficient and responsive—particularly as many economies around the world were slowing and governments were looking for ways to rebuild their infrastructure.
https://www.ibm.com/ibm/history/ibm100/us/en/icons/smarterplanet/ (available 20th June 2023)

2020). The actual number of new smart cities varies depending on the source, but China is said to have planned and built about 500 new smart cities, as it worked to establish "Smart City Clusters" such as the Yangtze River Delta and the Pearl River Delta, where this last stage of development involved an emphasis on informatics, modernization, smart technology, innovation, and security of data (Angelidou, 2014; Vu & Hartley, 2018; Yao et al., 2020). These cities are intended to incorporate sophisticated technology, data-driven processes.

In addition to the establishment of new smart cities, China has conducted several efforts, a total of 311 cities, to modernize and smarten existing cities (Vu & Hartley, 2018). These projects entail the use of cutting-edge technology, digital infrastructure, and smart solutions to improve urban administration, public services, and the overall urban environment. Overall, China's SCDI is a broad and ambitious attempt to use technology and data for urban and regional development, with an emphasis on both constructing new smart cities and converting existing ones into smart, sustainable, and livable urban centers.

Considering the evolution of the implementation of the SCDI, according to a Deloitte report[5], China is the global leader in smart city building. In 2018, China accounted for 48% of worldwide smart city pilot projects. The value of China's smart city business increased from $30.4 billion in 2018 to $59.9 billion in 2023. China has been actively executing various smart city pilot projects, the number of which is growing. By 2021, China has over 900 pilot programs, with roughly 290 cities participating, including large cities such as Beijing and Shanghai (Sukwanto, 2023).

As defined in the plan for 2015-2020, smart cities in China are built on five key pillars: (1) ICT infrastructure development, (2) smart governance in city management, (3) service quality enhancement, (4) attracting ICT companies to establish bases in smart cities, and (5) providing enhanced digital and information security (Bris et al., 2019). ICT infrastructure and ICT companies setting up operations are the main goals of smart cities. Three features distinguish smart cities, for example, the city of Chongqing in southwest China. The first is that the municipal government outlined a smart city blueprint. Second, it aims to develop high-tech industries and IT infrastructure (Liangjiang New District). Third, it encourages public-private partnerships to develop smart city initiatives (Bris et al., 2019). Seeing smart

[5] https://daxueconsulting.com/chinese-smart-cities (available 20th June 2023)

cities as *a new approach to urban planning*, the Chinese state believes eco-cities[6] will be replaced by smart cities since they not only promote sustainable and livable cities, but also *spurs urban economic growth and improves the quality of urban workers* (Bris et al., 2019). Additionally, using data analysis and future development strategies, *future urban crises* (including overpopulation problems, environmental crises, and traffic flow problems) can be anticipated (Bris et al., 2019; Sha et al., 2006; Yao et al., 2020). In short, smart cities are more comprehensive than cities that concentrate only on the environment, as *they can also promote regional development*.

Zeng et al. (2023) performed a recent study on the impact of smart cities on regional development in China. The study looks into how the construction of smart cities affects regional innovation in various Chinese regions. It demonstrates that the eastern area, in particular, gains the most from smart city construction, resulting in significant influence on regional innovation. According to the research, smart city construction greatly boosts regional innovation, with investments in science, technology, and human capital in smart city ecosystems serving as critical transmission channels for this influence. Utilizing cutting-edge information technologies such as the Internet of Things, cloud computing, big data, artificial intelligence, and blockchain, these advances expedite information transmission and processing for enterprises, lowering transmission costs and asymmetry of information. Smart cities stimulate innovation by giving chances for technology and knowledge-intensive businesses to produce new goods and extended services that fulfill individualized and diverse customer expectations. Moreover, smart cities' superior business environment lowers the cost of innovation and improves firm productivity (Zeng et al., 2023).

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[6] The term "eco-cities" in China refers to a sort of urban development project that strives to construct environmentally sustainable and ecologically friendly cities. These cities are planned with the purpose of reducing their environmental effect, fostering green technology, and providing citizens with a good quality of life. In China, the notion of eco-cities arose in reaction to the country's fast urbanization and the attendant difficulties of pollution, resource depletion, and urban sprawl. As part of their larger urban planning and environmental protection efforts, the Chinese government recognized the need for sustainable urban development and established many eco-city programs. China's building of eco-cities has been a major endeavor, with numerous prominent projects around the country. Tianjin Eco-City, Dongtan Eco-City, and Caofeidian Eco-City are some well-known examples. These projects serve as examples of sustainable urban development, demonstrating new ideas and technology for attaining environmental sustainability and increasing the urban quality of life.

https://www.bbc.com/future/article/20120503-sustainable-cities-on-the-rise (available 25th June 2023).

The Indonesian smart city program addresses *urban planning issues and environmental concerns* in existing cities, like in Jakarta. The state has begun smart city initiatives to improve city services and infrastructure by using ICT (Oktaria et al., 2017). In 2015, the country launched the "Garuda Smart City Framework" (GSCF), which was updated in 2017 as the development framework for smart city initiatives. By addressing the challenges associated with urbanization, the project also addresses environmental challenges linked to geographical locations (Bris et al., 2019). The city of Jakarta is vulnerable to natural hazards such as earthquakes and tidal floods during the monsoon season, which are exacerbated by urbanization. The urban area also faces challenges associated with traffic congestion, air pollution, inadequate water and sewer systems, and garbage disposal. Like most developing cities, Jakarta continues to struggle with corruption, especially at the legislative and administrative levels. By utilizing a smart city approach, the government has sought to find the best solution to all of the above challenges (Bris et al., 2019). The challenges are multifaceted, which makes financial and investment commitments necessary for sustainable solutions. To find low-cost, effective solutions, the state has been implementing smart initiatives. First, there is the Indonesia Broadband Plan and the Smart Cities Program. In 2014, the Indonesia Broadband Plan (IBP) was launched as the central infrastructure development for a smart city set of solutions. The Jakarta Smart City hub provides storage and big data analytics capabilities. In addition to tying the city together with fiber optic lines, private sector organizations have also been able to participate in data collection by providing data feeds and creating Wi-Fi hotspots throughout the city (Bris et al., 2019). City residents were included in the information-gathering system for effective city management. The second is flood monitoring and management, which can provide residents with information. It collects data daily at flood gates in Jakarta, using water level recorders and sensors, allowing it to create a risk evaluation matrix (REM) along with a smartphone application. In addition, other initiatives include traffic management using ICT, as well as street lighting that enables illumination to be controlled depending on traffic density and the time of day (Bris et al., 2019).

By taking these initiatives, Jakarta was able to address urban challenges. Moreover, the government sought to establish policies and involve the private sector. Six pillars were adopted by the partnership to guide its policy agenda. Among its objectives are improving the environment, improving quality of life, enhancing mobility, bringing about better city governance, supporting economic growth and diversification, and improving connectivity with citizens. The partnership between the government and the private sector has two purposes: first, it reduces the cost of dealing with urban challenges through government budgets; second, it utilizes the expertise of the private sector in ICT to overcome these challenges and improve the urban environment (Tan & Taeihagh, 2020).

In the Indonesian model, the Jakarta case study illustrates the importance of an enabling environment to continuously improve the quality of life in a city and promote urban intelligence. Local government authorities, for example, have made it possible for businesses and individuals to connect with citizens by providing basic infrastructure. To improve urban challenges, citizen activism can be greatly enhanced by using mobile networks, interactive apps, and a centralized hub. Integration of data from multiple sources can be used to resolve traffic congestion using analytical techniques. Furthermore, the proliferation of interactive apps that allow citizens to communicate with local authorities has a positive impact on citizens' perceptions of efficient government. Importantly, implementing efficiency measures for city services remains key to creating an enabling environment (Oktaria et al., 2017).

In comparing the three smart city models in developing countries, some common characteristics emerge (e.g., utilizing ICTs), but there are differences in the problems, goals, and tools used to implement the policies (see *Table 4*). In terms of concept, the smart city can be defined as providing basic infrastructure and a decent life for its citizens with a focus on sustainability (as in the case of India). While in the case of China, it is a smart city based on smart governance and a focus on regional development. The Indonesian smart city model indicates that it relies on smart technology, sustainability issues, governance, and human factors. Comparing the concepts and models reveals that despite their differences, sustainability and the use of information and communication technology infrastructure are common.

A smart city approach involves a variety of objectives, such as responding to overpopulation and development concerns in India and improving city services and infrastructure using ICT (as in Indonesia), while the Chinese model emphasizes "smart cities" as an alternative to "eco-cities" in urban planning in China. To achieve its development goals, India chose to establish new smart cities. As a contrast, China combined both strategies, developing existing cities as well as creating new smart cities. Indonesia, meanwhile, focused on developing its existing cities. Based on a comparison of smart city programs, the Indian model of smart cities takes a social-centric approach to address social and demographic issues. As a contrast, the Chinese model emphasizes a technology-centric approach, while the Indonesian model incorporates sustainability principles while addressing urban challenges.

Finally, my analysis of smart city experiences in developing countries found that most of these countries rely substantially on technology and information, but they employ different tools depending on their development goals, financial resources, and local context and challenges. Based on these case studies, we can state that **smart city concept has the potential for dealing with a wide range of urban challenges, even regional development**.

Table 4. A comparative analysis of the SC concept in developing countries

	India's Model	China's model	Indonesia's model
Concept	A city that offers a basic infrastructure, decent quality of life for its citizens, a clean, sustainable environment, and the application of smart solutions to city management.	The city adopts ICT infrastructure development, promoting smart governance in city management, improving service quality, attracting ICT companies to establish bases in smart cities, and providing enhanced digital and information security.	The city adopts smart technology aspect, focusing on sustainability issues, and the governance and human aspect.
Development goal	Smart cities respond to *overpopulation* and consequent urban development issues.	A new approach aims to urban planning in China to replace "eco-cities" to enhance *balanced regional development*.	To improve city services and infrastructure using ICT in order to handle *environmental problems*.
Spatial development strategy	Establishing *new* smart cities.	Combination of *new* smart cities and developing *existing* cities based on urban intelligence.	Developing existing cities to be cities based on urban intelligence.
Development approach	A sociological approach targeting social and demographic issues.	A technology-centric approach.	A sustainability approach takes into account the human aspect.

Source: Own construction based on Angelidou, 2014; Bhattacharya et al., 2020; Bholey, 2016; Bris et al., 2019; Vu & Hartley, 2018; Yao et al., 2020.

2.4 Conclusions of Literature Review

Based on the systematic literature review (SLR) in Chapters 2.2 and 2.3, the following conclusions can be drawn:

- Different theories of innovation (knowledge spillovers, milieu innovateur, learning regions, and evolutionary economic geography theories) all support the idea that innovation plays a crucial role in regional development. Innovation theories provide explanations that **help to understand the different mechanisms that influence the innovation processes**, the dynamics of technological development and the socio-economic impact of innovation. Furthermore, based on these theories, there is a consensus that **local endogenous factors** such as local resources, capabilities, and intangible ("soft") competencies **play an essential role in innovation**. The different forms of proximity (physical, socio-cultural, cognitive) generate attitudes (cohesion, belonging, trust, openness, etc.) among actors and institutions, which impacts the dynamics of relationships, collaborations, and networks within a given place and with actors in other regions. These interactive relationships and collaborations can be seen as resources, i.e., territorial capital specific to the territorial unit, which support the creation and flow of knowledge and continuous collective learning. The concept of a Regional Innovation System (RIS) provides a conceptual framework for decision-makers to understand the networks between actors (businesses, research institutes, universities, government, and civil society) that are key to generating innovation in a given territory or region. RIS is designed to promote and boost innovation capacity within a region by fostering collaboration and knowledge exchange. Innovation policy is intended to stimulate innovation at different levels, whether national, regional or local. The RIS approach can help policy makers to better understand the dynamics, strengths, and weaknesses of the local innovation ecosystem. Analyzing and considering RIS in innovation policy design and implementation will allow for more effective and targeted measures.
- There are **several definitions** of a smart city, indicating that the **concept is extremely complex**. It is worth noting that while there is **no universally accepted definition**, **the majority of definitions emphasize similar characteristics**. We can observe that they typically highlight the following characteristics:
    - All definitions lay a strong emphasis on improving the quality of life for residents.

- All definitions emphasize the significance of **technology, particularly Information and Communication Technology (ICT)**, as a fundamental component of smart cities.
- However, recent definitions of smart cities also point to the **multidimensional nature** of the concept, characterized by a set of pillars, dimensions including smart governance, smart human capital, smart environment, smart living, smart economy, and smart mobility. According to these new views, **ICT is necessary, but it is not sufficient alone**. Smart cities must also **include other important factors such as human capital** in the planning, development, and implementation processes to guarantee that their requirements are met, resulting in livable and prosperous communities for citizens.

▪ The literature points out that smart cities, through the use of ICT, are not only a new way of urban planning and delivering advanced urban services, but can also **serve as a means to foster innovation**. However, it is important to stress that the innovation-generating capacity of smart cities does not depend solely on ICT. **For innovation to flourish, it is also necessary to develop, attract or retain human resources and establish effective collaboration among diverse stakeholders**.

▪ Looking at case studies of smart city initiatives, I discovered that although SC programmes in different developing countries **have similar goals**, namely, to improve the quality of life of urban citizens, however, **smart cities are used to address very different challenges**. For instance, in China, smart city approaches have been applied to enhance balanced regional development, while India uses it to solve the problem of overpopulation, whereas in Indonesia, it is primarily aimed at addressing sustainability and environmental issues.

3. New Cities based on Egypt Vision 2030

The main objective of this chapter is to summarize and explain the key characteristics and components of Egypt's innovation-driven regional development strategy. This chapter addresses the second group of questions (**RQ2**): *How does Egypt intend to adapt the smart city concept to accomplish the balanced, innovation-driven development of the country? How Egyptian officials evaluate the new, fourth-generation (smart) city program?*

First, chapter 3.1 offers a comprehensive assessment of Egypt's social and economic conditions from various perspectives. Chapter 3.2 explores the innovation-driven regional development policy of Egypt based on Egypt Vision 2030. Finally, in Chapter 3.3, I offer an evaluation of the interviews and a review of the additional policy documents for the new cities.

3.1 Overview of the Egyptian Context

The purpose of this chapter is to offer a comprehensive overview of Egypt taking into consideration the geographical, economic, and social context of the country. Additionally, the overview aims to provide insights into the evolution of innovation policies in Egypt, as well as an examination of the administrative and urban structure of the country. I discuss the Egyptian context from various viewpoints to gain a deeper understanding of *why* innovation-driven regional development is essential in a country with substantial regional differences.

Geographically and historically, Egypt is a Middle Eastern country influenced by Arab, Islamic, African, and Asian cultures. It is situated in the extreme north of Africa, near the eastern Mediterranean and the Red Sea. One of the most significant waterways for world trade from north to south and vice versa is the Suez Canal, which connects the two seas. Throughout history, Egypt has been a country of cultural, linguistic, and racial diversity. In 7000 BC, Egyptian civilization arose on the banks of its Nile River, and the Assyrians, Greeks, Romans, Copts, and Muslims succeeded it, all contributing to its cultural diversity and making Egypt a special country, deeply rooted in history.

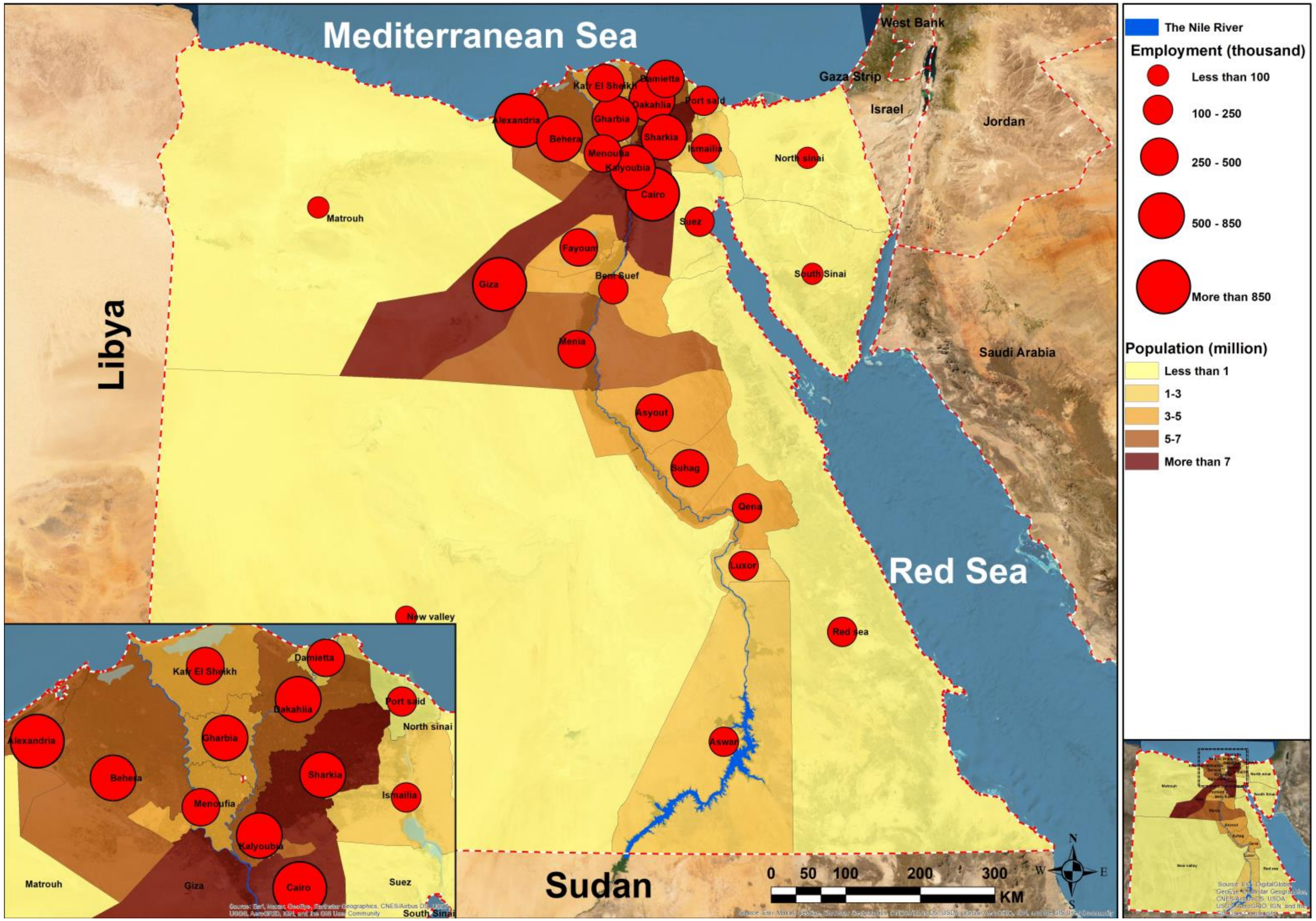
Administratively, there are three levels of administrative/regional division in Egypt; first, there are the seven economic regions, then there are the 27 governorates (22 rural-urban governorates and 5 governorates without any rural areas), and municipalities, which are either *Markaz* or *kism*[7] (see *Figure 9*). According to different geographical characteristics, four types of governorates can be distinguished: (1) urban governorates; (2) Lower Egypt governorates; (3) Upper Egypt governorates; and (4) frontier governorates. Approximately 78,990 km2 of Egypt's total area (1,1 million km^2) is occupied, only 7.8 percent. Near the Nile River is the most populous area, while the rest is desert.

In terms of urban settings, Egypt's urban and rural populations are approximately equally divided, with an estimated 102 million residents in 2020, 45% living in urban areas. Cairo is Egypt's largest city, with a population of over 9 million. Alexandria, the second largest city, has about half of Cairo, with 5 million. Another city, Al Jizah, has a population of 5 million, making three Egyptian cities with populations exceeding 19 million, this is equivalent to 48% of the total urban population. Egypt has 263 cities (existing and new cities that have already started attracting a population). There are seven sizes of cities; very small cities are less than 50 thousand people (126 cities), small cities are 50-100 thousand (75 cities), medium cities are 100-250 thousand (33 cities), minor cities are 250-500 thousand (11 cities), major cities are 500 thousand to 1 million (6 cities), metropolitan cities are 1-5 million (2 cities), and finally mega / megapolis cities are 5-10 million (one city). According to the hierarchy of city size within the Egyptian urban system, there appears to be an imbalance between the size and number of cities within the Egyptian urban system (Bayoumi, 2020).

Egypt's population and employment are concentrated in the governorates of Cairo region (Cairo, Giza, Kalyoubia), their surroundings, and Alexandria in the north, as shown in *Figure 9*. The reason is due to employment agglomeration, development components, and investment opportunities. In response to this agglomeration, the government began encouraging investments and developing new communities in the governorates of Upper Egypt, hoping to increase inhabited and developed areas to 10% in the short term, and 20% by 2050. Consequently, infrastructure projects and comprehensive development initiatives were launched, not only in the governorates of the north but also in the governorates of the

[7] In rural governorates, the *Markaz* is a geographical area consisting of a group of rural villages and a city (or two in limited cases) where the villages are administered and serviced from the city, whereas in urban governorates the *kism*: it represents the administrative neighborhood, usually divided according to city size.

Figure 9. Population and employment in economic activities for Egyptian governorates, 2020



Source: (Ali, 2021a, p. 5)

south (Ministry of Planning and Administrative Reform, 2014). In his speech at the fourth World Youth Forum, which recently took place in Sharm el-Sheikh, President al-Sisi revealed that the Egyptian government has invested approximately six trillion Egyptian pounds (approximately 400 billion dollars based on January 2022 exchange rate) in infrastructure and development projects for the entire country in the past seven years (Al-Sisi, 2022).

Based on socioeconomic indicators (*Table 5*), Egypt has the highest population density in the Middle East, with an average annual growth rate of 2.06% from 2014 to 2021 (The World Bank, 2021a). From the events of the 2011 revolution until the 2013 revolution, when unemployment reached a record high of 13.15 %. The Egyptian government has worked to benefit its citizens with more employment opportunities in the construction, infrastructure, and industrial sectors, consequently, the unemployment rate has decreased to 7.5% in 2021. The inflation rate peaked at 29.5% in 2017. Following that, it started to decline steeply, and by 2020, it was only 6%. Then it started falling, reaching a record low of 5.04% in 2021. Following the political changes in 2011, the annual GDP growth rate recorded a slight upward trend, reaching its highest point of 5.56% in 2019, but then declining under the Covid-19 epidemic, remaining positive at 3.3% in 2021 (The World Bank, 2021a). Egypt is a lower-middle-income country. It had a GDP per capita of $3,563 in 2015, which dropped as a result of changes in 2016 but then improved somewhat in 2021, to $3,698.8 (The World Bank, 2021a).

According to the most recent edition of the Global Innovation Index (GII), which rates countries based on their innovative capabilities, Egypt ranked 94th out of 132 countries in 2021, marking a 13-place improvement from 2016. For 2019, Egypt's Global Competitiveness Index (GCI) score was 54.54. Egypt's GCI ranking has risen by 25 since 2015, and it reached the 94th place in the rankings by 2020 (WEF, 2021). Global Competitiveness Report 2020 revealed that companies' perceptions of digital skills increased by 1.8% in emerging and developing economies. According to the report, one of the biggest improvements regarding this indicator was seen in Egypt (Schwab & Zahidi, 2020, p. 23).

Table 5. The socioeconomic indicators for Egypt (2015-2021)

Year	GDP growth (annual %)	GDP per Capita (US $)	Population (million)	Unemployment (%)	Inflation rate (%)	Innovation Index Rank *	Global Competitiveness Index rank (GCI) **	Network readiness Index rank (NRI) ***
2015	4.37	3562.93	92.443	13.05	10.37	100	119	94
2016	4.34	3519.87	94.447	12.41	13.81	107	116	96
2017	4.18	2444.29	96.443	11.74	29.51	105	94	100
2018	5.31	2537.13	98.424	9.82	14.40	95	94	96
2019	5.56	3019.09	100.388	9.73	9.15	92	93	92
2020	3.57	3569.21	102.334	10.45	5.04	96	94	84
2021	3.33	3,698.83	109.3	7.5	6.2	94	na	77

Source: The author's construction is based on the world bank data (The World Bank, 2021a).

*****: Based on Global Innovation Index reports (GII), WIPO

**: Based on Global Competitiveness Reports- WEF, source: https://www.weforum.org/reports/

*******: Based on the Network readiness index full annual reports, different perspectives of the index caused different acceleration scores after 2016, https://networkreadinessindex.org/country/egypt/

Network Readiness Index (NRI) is one of the leading global indicators of the impact and application of information and communication technology (ICT). The evaluation is based on four key pillars: Technology, People, Governance, and Impact. Among the 130 economies included in the NRI report 2021, Egypt ranked 77th. Egypt is ranked 5th among lower-middle-income countries in 2021. On each of the four pillars, its score is higher than the average of other lower-middle-income countries. Egypt has demonstrated a notable improvement in its index ranking since 2017, advancing by approximately 23 positions until 2021 (NRI, 2021).

The Egyptian economy is considered one of the oldest economies in the world. It has gone through various stages of development and decline until the beginning of the Republican era and the July 1952 Revolution. During that period, the Egyptian state began to carry out economic reform and development in several areas. This period depended on a high degree of centralization. The Egyptian economy flourished dramatically and headed towards a set of new policies in the eighties, and these reforms continued to grow until the first decade of the third millennium. The speed with which economic and developmental changes were implemented increased, drawing foreign investment and aiding GDP growth. Despite the relatively high levels of total economic growth (7.1%) in 2008 (The World Bank, 2021b), the social and economic conditions of the citizens continued to deteriorate.

These circumstances contributed to public discontent and were among the reasons that moved the Egyptian people into a popular revolution in 2011, one of the Arab Spring revolutions in the MENA (The Middle East and North Africa) region. This turmoil and political and economic changes prompted the Egyptian government to retreat from economic and development reforms. Government spending has increased dramatically to address these disturbances, causing instability. This period was followed by another revolution in 2013 against the ruling regime, a religious-political group that aimed to monopolize the power and state resources and exclude the other spectrums of society. A new phase of political and developmental change has begun in Egypt, following political changes that prompted the change of the ruling regime. Egypt's new constitution, which was adopted in 2014, marked the start of the so-called new republic.

Egypt has carried out comprehensive national economic reforms since 2016. The Egyptian government is continuously monitoring this reform, including its success rates, challenges, and roadmap. In August 2016, Egypt began negotiations with the International Monetary Fund (IMF) which led to economic and social reforms. Egypt signed an agreement with the IMF in exchange for a $12 billion loan over three years. The changes financed through this program were part of a broader set of reforms aimed at restoring macroeconomic stability and building a strong economic foundation. Fiscal and monetary policies were to be coordinated and integrated to stabilize macroeconomic indicators Furthermore, the objective was to establish a stable environment that would attract investments to Egypt's economy. This program provided an appropriate amount of financing to reduce public debt rates and finance private-sector projects and productivity. Foreign direct investment was restored, and the balance of payments gap was reduced. Moreover, the program aim was to enhance the Egypt's Central Bank's capacity to effectively handle flexible exchange rates, gradually transitioning away from an inflationary framework to maintain Egyptians' real incomes and the country's competitiveness (UNDP, 2021).

In comparison to the 2013/2014 figures, real output growth escalated by 2.9%, as depicted in Table 6, and further advanced to 5.3% in 2017/2018, followed by a 5.6% improvement in 2018/2019 subsequent to the implementation of reform measures. From 2013/2014 to 2018/2019, the unemployment rate decreased from 13.3% to 7.5%.

Shifting government subsidies towards energy, exercising financial control, and efficiently implementing value-added tax resulted in reducing the budget deficit from 12% in 2013/2014 to 8.2% in 2018/2019. The inflation rate declined from 24.4% in 2016 – owing to economic reforms and the control of inflation by monetary authorities – to 5.3% in 2019/2020.

Table 6. Trend of Economic Indicators (2013-2022)

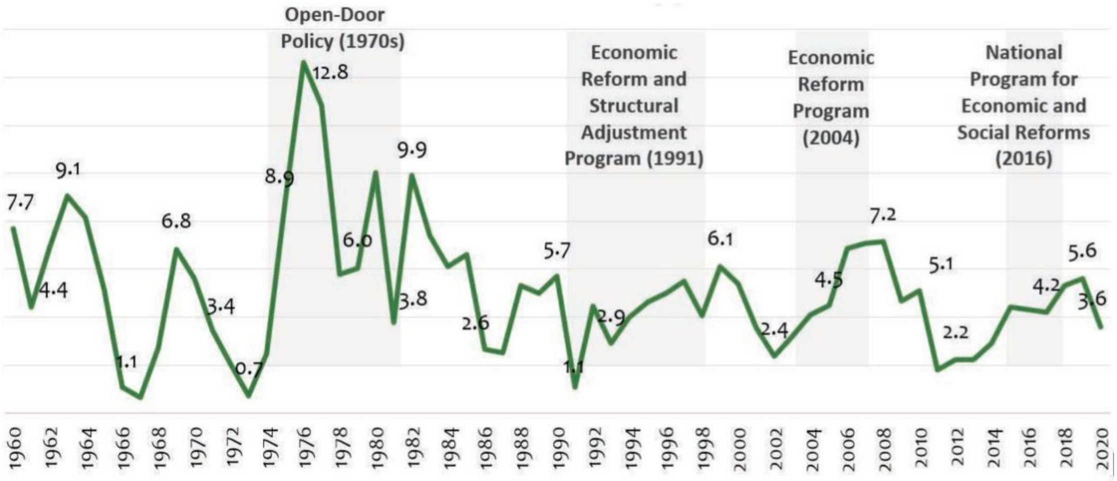
	2013/2014	2017/2018	2018/2019	2021/2022
GDP Growth Rate (%)	2.9	5.3	5.6	5.9
Unemployment Rate (%)	13.3	10.78	7.5	9.3
Budget Deficit (% of GDP)	12	10.6	8.2	6.1
Inflation Rate (%)	24.4	21.95	5.3	7.5

Source: own edition based on MPED, 2021.

The Economist, in collaboration with the US Agency for International Development (USAID), conducted a study to assess how Egypt's economy would fare after COVID-19. Under the study's baseline scenario, the GDP growth rate in 2025 is estimated at 5.28 percent, 5.7 percent under the optimistic scenario, and 5.22 percent under the pessimistic scenario. According to all three scenarios, unemployment will decline; in the base scenario, it will reach 9.9% by 2025, while in the optimistic scenario, it will reach 8.1 percent (USAID, 2020). Overall, it can be said that Egypt's large-scale reforms have resulted in increasing growth rates and lowering unemployment rates.

Egypt's economic reforms have been discontinuous in the past. It resulted in repeated crises, which were followed by programs to achieve economic development stability, as illustrated in *Figure 10*. Thus, the Egyptian government insisted on the continuation of reforms through supply-side policies. The Egyptian government later emphasized the need to continue the structural reforms it had initiated with IMF and the OECD. Rather than national issues, the unprecedented global pandemic (Covid-19) affected the course of economic reform. Despite the pandemic, the Egyptian government responded quickly and proactively to preserve the gains made during the reform process (MPED, 2021).

Figure 10. GDP growth rate for the Egyptian economy from 1960-2020



Source: Ministry of Planning and Economic Development based on World Bank Data of 2020 (MPED, 2021, p. 20)

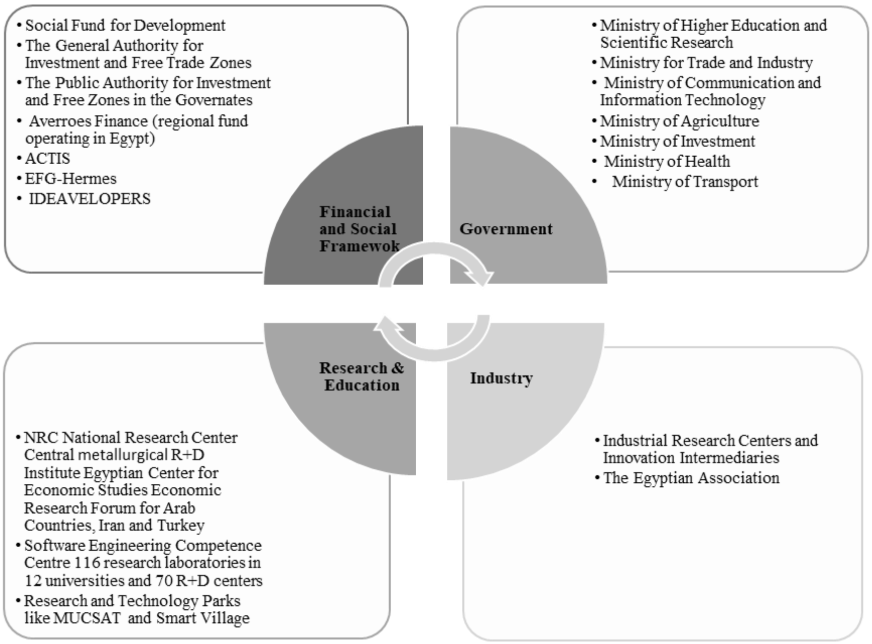
Therefore, these reform policies of the Egyptian government, in particular coordination between monetary and financial measures, led to a real positive growth rate of 3.5 percent in 2019/20 and a predicted growth rate of approximately 2.8% percent in 2020/21. Egypt ranked first among emerging economies and North Africa in 2019/20 (Mabrouk et al., 2020; UNCTAD, 2019). Since 2016, Egypt, according to a Morgan Stanley report on emerging markets, has led the way toward the best reform scenario in the Middle East or even in any emerging market (Sharma, 2019). All of Egypt's above-mentioned economic measures during the past ten years have been intended to increase the country's adaptability and its capacity to absorb challenges and transform the economy into a knowledge-based economy.

In the context of development based on knowledge and innovation, the Egyptian government recognized the importance of long-term innovation policies between 1985 and 2005. Egypt's innovation policy was described as clear but incomplete in the Annual Innovation Policy Trends Report for Countries – supported by the European Trend Chart on Innovation (MEDA-Zone, 2005). In Egypt, several government policies have encouraged innovation, including venture capital, business incubators, industrial modernization, entrepreneurship, and SME development. However, an official coordination mechanism was not in place. Innovation policy was implemented through programs of relevant ministries, often with the assistance of donor organizations. In Egypt, the Social Fund for Development (SFD) was a major reference point. Besides financing business centers and incubators, SFD finances programs such as IMP (Industrial Modernization Program) and GAFI (General Authority for Investment). In these programs, a wide range of government agencies worked together (Hahn & Meier zu Köcker, 2008). Therefore, the Egyptian Cabinet's Information and Decision Support Center presented a technological development program in 1990, which served as the basis for the establishment of the "Technological and Scientific Studies and Research Program". This project aimed to accelerate technological development and develop national infrastructure using state-of-the-art information technology. In 1993, the Information and Decision Support Center launched the Technology Development Programme (Hahn & Meier zu Köcker, 2008). Transferring technological expertise from the academic to the industrial sector was facilitated by this tool. According to the Egyptian Industrial Development Strategy, the national innovation system began to emerge in Egypt at the beginning of the 2000s (Hahn & Meier zu Köcker, 2008). It consists of four main dimensions: the financial framework, industry, research and education, and the government. Based on Freeman's (1987) concept of innovation, it is viewed as a network of interactions among different government and private institutions.

Figure 11 shows the main dimensions of the innovation policy of Egypt. The framework highlights a set of networks among different institutions. First, the *governmental framework* refers to the ministries of higher education and scientific research, commerce and industry, communications and information technology, agriculture, investments, health, and transportation. Second, the *research and education* dimension are represented by national research centers, research laboratories in universities, research and development centers, and research and technology parks, in addition to smart and technological villages. Third, the *industrial dimension* of the framework consists of industrial research centers and innovation

Finally, the *financing dimension* is set up through the Egyptian Social Fund for Development, investment agencies, and regional investment funds (Hahn & Meier zu Köcker, 2008). Despite offering this framework, neither the research community, nor the industry has been very effective at interacting. In addition, projects that were financed by the Social Fund for Development tended to be commercial products projects centred around consumer products rather than industrial R&D projects (Hahn & Meier zu Köcker, 2008).

Figure 11. Innovation policy pillars for the Egyptian context



Source: own edition based on (Hahn & Meier zu Köcker, 2008)

Thus, the Egyptian industry had to import technology and innovative products from abroad. Egypt's Technology Transfer and Innovation Centers (ETTICs) were established as part of the program to encourage local innovation rather than simply adapting foreign technology. As a result of the challenges faced and the changes in the political and economic climates during the past decade, Egypt realized that **a comprehensive national vision of knowledge and innovation policy is necessary**, as well as **the integration of regional development**. In summary, the previous innovation policy and measures were characterized by having distinct components, but they were criticized for lacking integration and cooperation. Consequently, Egypt developed a long-term strategy for science, technology, and innovation in 2016 called National Strategy for Science, Technology, and Innovation 2030 (NSSTI) (Ministry of Higher Education and Scientific Research Egypt, 2019).

In sum, considering the above evidence of the current social and economic situation and the major trends, it has been concluded that **Egypt faces a number of challenges**. First, there is an **unbalanced distribution of economic activities and population** throughout the country. Second, the Egyptian government faces a significant challenge due to a **high rate of population growth**. Third, there is a **limited number of habitable lands**, highlighting the need to establish new cities to address the vast regional differences. Fourth, **previous economic reform programs have failed** repeatedly because of a lack of a clear vision and strategy. To achieve a comprehensive economic development plan, these programs should encompass all the dimensions and frameworks related to it. Finally, prior initiatives and programs relating to innovation-based development **lacked coordination and integration among different stakeholders**. **To address these challenges and problems faced by the Egyptian state, the government has developed the National Sustainable Development Strategy (SDS), so called Egypt Vision 2030**.

3.2 Innovation-driven Regional Development of Egypt

This chapter provides a comprehensive overlook of Egypt's ambitious strategy, Egypt Vision 2030, which aims to achieve balanced regional development through innovation-led regional development. The subchapter also presents further strategy documents on urban development, innovation, and digitalization, which are aligned with the objectives of the new comprehensive national development strategy (sub-chapter 3.2.1). In addition, considering the findings of Chapter 2, which highlight the significance of local context, competencies, capabilities, and their impact on the success of innovation-driven development, this chapter also examines policy documents that consider the important components of innovation (sub-chapter 3.2.2). This picture is enriched by interviews with two senior Egyptian officials with experience in regional development. Their insights shed light on the potential components of innovation within the proposed new cities, including the NAC model (sub-chapter 3.2.3 and 3.2.4). The findings in subsections 3.2.1 and 3.2.2 are based on an analysis of policy documents, while the analyses in subsections 3.2.3 and 3.2.4 are based on interviews.

3.2.1 Reviewing Policy Documents for New Cities

The **National Sustainable Development Strategy** (SDS), also known as **Egypt Vision 2030**, was launched in 2016 and is the most comprehensive planning document outlining the aims, reasoning, and expectations for new urban growth. In this new strategy of Egypt, the creation of fourteen new urban centers was proposed. These new cities are in fact the fourth-generation of new cities in Egypt. The new cities are currently under construction. The Egypt Vision 2030 clearly sets out the main objectives of these cities:

- **Redistribute the population from the Nile Valley**. The Nile Valley is a narrow strip of land where most of Egypt's population lives. New cities are being built in other parts of the country, which will help to relieve the present pressure on the Nile Valley and promote *balanced* regional development of the entire country.
- **Create new urban and cultural centers**. New cities will offer modern infrastructure and amenities and will be home to a range of cultural institutions. This will help to create new economic opportunities and improve the *quality of life* for Egyptians.
- **Create new production centers for knowledge and innovation**. New cities will be home to research and development centers, universities, and other institutions that will foster *innovation* and economic growth (Abbas, 2021).

According to Khaled Abbas, the Deputy Minister of Housing, Utilities, and Urban Development, the new cities will accommodate 30 million people and alleviate congestion and urban challenges generated by population growth in Cairo and Alexandria. To achieve the above goals, around 57 billion Egyptian pounds (equivalent to 5 billion USD) will be invested in infrastructure, services, and roads in new urban centers (Abbas, 2021). Egypt's overall objective is to boost national economic growth by building innovative urban centers (*efficiency goal*) and by geographically spreading its population (*equity goal*), which would alleviate the high concentration of people in certain regions. The government hopes to promote fairer and more balanced regional development by spreading these cities across Egypt's governorates. However, this latest generation of cities will significantly be different from the previously established cities, as they will also be smart cities. Smart cities also utilize technology developments to improve urban living (*sustainability goal*).

However, in addition to the Egyptian Vision 2030, three important strategy documents were released between 2009 and 2015, setting out objectives, policy actions, and initiatives. These policy documents did not particularly discuss the construction of new smart cities; rather, they dealt with broader perspectives such as urban development, innovation policy, and digitization. No policy documents specifically addressed smart cities' potential role as innovation and knowledge hubs. Even though these documents do not contain explicit references to the concept of a smart city, they contain policy measures and objectives in related strategic areas (urbanization, innovation, and digitalization) that formed the basis of the Egypt Vision 2030. Only in the Egypt Vision 2030 program is specifically mentioned the function of the new (smart) cities as innovation-driven centers. The new cities are included in three other strategy documents in various contexts.

National Urban Development Plan 2052

This plan as an urban development policy, formulated by the Ministry of Housing, Utilities, and Urban Development was released in 2014, aimed to propose new urban centers to accommodate population growth, boost economic activity, and provide new economic opportunities for Egyptian governorates outside the Nile Valley and Delta areas. The goal was to address issues in regional urban development across the country. New Alamein City envisioned as a worldwide tourism center along the Mediterranean coast's northern edge, was one of the planned new cities in the National Urban Development Plan 2052. Additionally, a new urban center in eastern Cairo has also been suggested (later integrated into Egypt Vision 2030 as the New Administrative Capital). This urban area was proposed to serve as a hub for government services, enterprises, and activities, therefore alleviating population pressures on Cairo and Giza. Furthermore, new urban centers in southern Egyptian governorates were suggested to alleviate Nile Valley land constraints. While the concept of new urban centers was recognized in this national plan, the concept of smart cities was not included.

National Science, Technology, and Innovation Strategy 2030

This strategy, launched in 2015 by the Ministry of Higher Education and Scientific Research, as the country's innovation strategy, sought to implement knowledge and smart city concepts in new communities. The strategy encouraged environmentally friendly and intelligent designs to establish scientific cities and technology/science clusters, fostering international investments in science, technology, and innovation. Adapting architectural designs and green urban planning to Egypt's unique environment was also highlighted in the strategy. As a result, a review of the National Science, Technology, and Innovation Strategy emphasizes the significance of envisioning future urban centers as knowledge, scientific, and technology centers. This approach entails leveraging big data, technology, artificial intelligence, and the Internet of Things.

As part of the country's digitization strategy, the Ministry of Communications and Information Technology released **the Regulatory Framework for Provision of Internet of Things Services** in 2021. This framework underlines the need to incorporate IoT into the new fourth-generation cities outlined in Egypt Vision 2030, which are aligned with the fourth industrial revolution. The framework promotes information and communication technology, digital services in Egypt Vision 2030 cities, smart transit via digital apps, and digitization of management methods within suggested cities. Its digitalization enables sound and long-term resource management. As a result, this framework lays a strong emphasis on ICT as an essential component of implementing the smart city idea in the planned new cities. This is consistent with what preliminary studies of the smart city idea have revealed, which focuses on the adoption of ICT before the evolution of the concept, as stated in the thesis' theoretical framework in the second chapter.

Consequently, the three strategic documents describe the framework conditions for the Smart City program and how to construct them. Although the aforementioned documents did not particularly discuss the construction of new smart cities, they include policy measures and goals in the strategic areas of urbanization, innovation, and digitalization that serve as the broad foundation for the Smart City program as stated in Egypt Vision 2030.

Egypt Vision 2030, announced in 2016, integrates the goals of the abovementioned strategic plans and serves as a comprehensive development framework for guiding the country's progress. Consequently, Egypt's regional development strategy is a part of the Egypt Vision 2030. A key goal of the strategy is to achieve regional development in the country. The new strategy underlines the crucial role of *innovation* in promoting regional development in the country: it aims to achieve balanced regional development through an *innovation-driven regional development policy*. In accordance with Egypt's overall efforts and commitment, as defined in Egypt Vision 2030, the country acknowledges higher education and scientific research, industry, government, and the social dimension as critical components of its Regional Innovation System. As a result, the strategy has identified the following specific goals to enhance effective collaboration among the above-mentioned components of RIS:

(1) Creating fourth-generation universities, cities of knowledge, financial, and business centers.
(2) Reviewing and developing laws and legislation related to the empowerment of knowledge and innovation.
(3) Developing and restructuring the knowledge and innovation system.
(4) Adopting a comprehensive program to instill an innovation and knowledge culture in society.

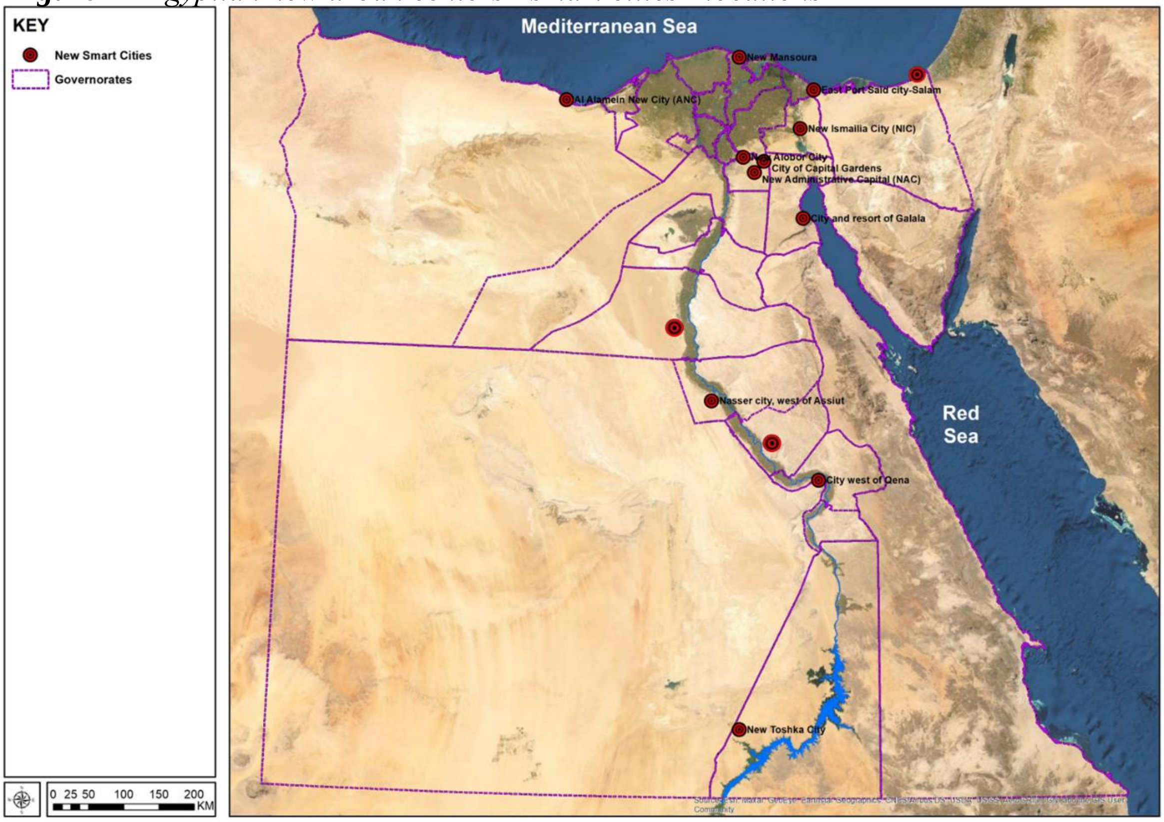
(5) Develop a comprehensive program to encourage small and medium-sized enterprises to innovate.
(6) Activating the state and private sector partnership in supporting and motivating innovation (Ministry of Higher Education and Scientific Research Egypt, 2019).

As the main element of its new regional development policy, Egypt has decided to create 14 **new urban centers** (*Figure 12*). These new urban centers are commonly called *fourth-generation cities*, referring to the latest generation of new cities in Egypt. The role of innovation in promoting economic growth and development is emphasized in Egypt's Vision 2030. According to the strategy, an innovative-driven regional development policy is the most effective way for Egypt to fulfill its development goals. An innovation-driven regional development path assumes that investment **in research and development, education and skills, and infrastructure** will lead to the creation of new businesses and jobs, which will in turn stimulate balanced economic development. The strategy envisions the development of a new generation of cities that will function as **innovation hubs with enhanced innovation ecosystems** having the potential to stimulate cooperation, experimentation, innovation, and risk-taking. Policymakers desire to encourage **equitable and balanced regional growth** by strategically dispersing these fourth-generation cities throughout various regions such as Greater Cairo, Alexandria, the Suez Canal, the Delta, and the southern governorates of Upper Egypt.

The Egyptian government is intended to encourage the development of critical components of the innovation ecosystem in these new cities. These components encompass financial and business centers, government institutions, knowledge, and innovation centers. The strategy also emphasizes the construction of other essential components of this ecosystem, notably fourth-generation universities. These universities' specific mode of operation in altering the surroundings distinguishes them from traditional institutions of higher learning. Their approach is distinguished by proactive initiatives aimed at increasing knowledge and creativity (Lukovics & Zuti, 2018). The Egyptian government intends to create a new generation of cities that go beyond the creation of basic infrastructure such as public buildings, housing, and roads.

These cities will be technologically advanced **smart cities**, utilizing digital technology, information technology, artificial intelligence, and big data to address urban difficulties and improve citizens' quality of life. These innovation hubs have the potential to play an important role in developing new ideas and technologies, attracting, and maintaining people, enabling job creation, increasing corporate productivity, and driving economic growth.

Figure 12 *Egyptian new urban centers "smart cities" locations*



Source: Own edition using ArcGis software based on (MoHUUC, 2020)

According to Egypt Vision 2030, these new smart cities will be able to foster innovation through **their multi-layered operation**. The three layers of smart cities are the followings:

- **Layer 1: Smart living – The attractiveness of high quality of life**

  Thanks to the modern urban services enabled by ICTs (smart environment and smart infrastructure), smart cities attract people and concentrate them in one place, which is a necessary condition for collaborations that stimulate innovation. According to the definitions, the major purpose of such cities is to eventually improve the quality of life for citizens by integrating ICTs into local operations. This is attractive to people since many people want to live in such liveable cities. Consequently, decision-makers expect that **advanced urban services (smart environment and smart infrastructure) will attract many people into these cities (smart people)**. In chapter 2.2, I demonstrated the need for physical proximity, which supports the sharing of (tacit) knowledge by facilitating cooperation mechanisms between people and is thus a fundamental condition for grassroots innovation. ICTs are integrated into smart city operations to provide people with modern urban services such as:

- *Transportation*: ICTs are used in smart transportation systems (ITS) to increase the efficiency and safety of transportation networks. ITS may be used to regulate traffic flow, eliminate congestion, and improve public transit, for example.
- *Energy*: Smart grid technologies leverage ICTs to improve the energy grid's efficiency and reliability. Smart grids, for example, can be utilised to decrease energy usage, incorporate renewable energy sources, and control peak demand.
- *Utilities*: ICTs are used in smart water and waste management systems to increase the efficiency and sustainability of these critical services. Smart water meters, for example, can measure water consumption and detect leaks, whilst smart waste management systems may optimize waste collection and disposal.
- *Public safety*: Smart public safety systems leverage ICTs to improve inhabitants' safety and security. Smart cameras, for example, can be used to monitor crime and traffic, while smart emergency response systems can improve emergency service coordination.
- *Healthcare*: ICTs are used in smart healthcare systems to improve the quality and accessibility of healthcare services. Telemedicine, for example, allows patients to consult with doctors from a distance, and electronic health records (EHRs) facilitate care coordination among healthcare professionals.

In sum, smart environment and smart infrastructure can make smart cities attractive and advantageous for many people which contributes to the concentration of them. Such **concentration of people and their activities is an essential condition for innovation**, as due to physical proximity, entrepreneurs have easy access to a pool of talent, resources, and customers.

- **Layer 2: Smart environment/Smart infrastructure – Unlocking business opportunities**

  Smart cities use **advanced digital technologies** in their infrastructure and environment. This intelligent infrastructure and environment provide multiple opportunities and attract investors, entrepreneurs, and innovators from a variety of sectors. Smart buildings, for example, provide the potential for firms that develop and construct smart building technology. Companies that develop and build renewable energy technology and energy management systems will benefit from smart grids.

Companies that develop and install ITS technology benefit from smart transportation networks. Companies that develop and create water and waste management technology benefit from smart water and waste management systems. Companies that develop and deploy public safety technology benefit from smart public safety systems. Smart cities are constantly looking for better and more efficient ways to provide a high quality of life for their citizens. This approach can create a wealth of opportunities and, as a result, stimulate entrepreneurial activity in many industries, attracting investors, entrepreneurs, and innovators to cities (smart economy). An attitude of continuous sustainable and resilient development of the city **creates opportunities for exploring new entrepreneurial ideas**, leading to the creation of new products, technologies, and processes that meet the needs of the city and improve the quality of life of its citizens.

- **Layer 3: Collaborative ecosystem - Openness**

  The integration of ICT into all aspects of city functioning creates **an enormous amount of data**. Sensors, gadgets, and systems in smart cities create massive amounts of data. Smart cities share this data with citizens, innovators, and entrepreneurs to build **creative solutions that improve city operations** and quality of life. Smart cities, for example, may collaborate with entrepreneurs to build new transportation solutions, energy management systems, and public safety technology by sharing data on traffic patterns, energy use, and crime rates.

Smart cities can foster an entrepreneurial climate through supporting activities (Layer 1-3) that stimulate the growth of new firms and technology. To summarise, smart cities foster innovation by fostering a milieu conducive to experimentation and collaboration among stakeholders. However, according to the Egypt Vision 2030 and other strategic documents, Egyptian smart cities also create **physical infrastructure**, such as CBDs, knowledge centers, and fourth-generation institutions, to enhance direct collaboration between stakeholders (Layer 3). The collaboration contributes to the development of platforms for experimentation and innovation. CBDs, for example, offer a location for enterprises and startups to co-locate and work with stakeholders (industry, scientific community). Access to research and development facilities is provided through knowledge centers, whereas fourth-generation institutions focus on innovation and entrepreneurship. Therefore, smart cities foster innovation by using physical infrastructure as well as measurements and incentives to provide platforms for experimentation. This comprises open data and physical infrastructure to improve actor collaboration: This gives innovators access to the data and tools they need to design and test new ideas, therefore speeding up the innovation process.

In summation, Egypt Vision 2030 argues that the formation of new smart cities may make a substantial contribution to supporting innovation-driven regional development. Beyond delivering top-tier services, smart cities, as perceived by the Egyptian government, have the potential to foster innovation by facilitating the establishment of a collaborative innovation ecosystem. A review of the strategy documents, in particular Egypt Vision 2030, clearly shows that **the Egyptian government attributes a multifaceted and complex role to smart cities, with similar expectations regarding their role in fostering innovation as those implied by the smart city literature** (chapter 2.3.4).

3.2.2 Regional Innovation Components in Egyptian Governorates

The previous chapter outlined Egypt's innovation-driven regional development policy based on Egypt Vision 2030. The chapter also offered an in-depth review of further key policy documents on new urban centers, describing the main components and crucial elements of the innovation-driven regional development. These documents clearly underline that internal factors and local capabilities of the Egyptian governorates are important for the success of innovation-driven regional development.

The *National Strategy for Science, Technology, and Innovation* 2030 (NSSTI) was launched in 2019, building on the objectives outlined in Egypt's Vision 2030. The primary goal of NSSTI is to strengthen the Regional Innovation System across Egypt's numerous regions. This strategy lists the main input/output variables should be considered when measuring the performance of the Regional Innovation System. Consequently, in present chapter, I collected the most up-to-date data to assess the performance of the Regional and Innovation System (RIS) in the Egyptian governorates based on the suggested input/output variables outlined in the NSSTI. According to the strategy, innovation components include **higher education**, **R&D inputs**, and **R&D outputs**.

Over the past 50 years, the **higher education** landscape in Egypt has witnessed significant growth. It has expanded from having only one public university and one private university to a total of 52 universities by 2018. Out of these, approximately 50% are privately owned, while the remaining 50% are under government ownership. Within governmental universities, academic specialization is distributed as follows: 51.6% of students pursue scientific disciplines such as medicine, natural sciences, agronomy, engineering, and social sciences, while the remaining 48.4% opt for theoretical disciplines. Egypt has accomplished steady improvement in the quantitative aspects of higher education in recent years. According to World Bank data, Egypt's gross tertiary enrolment percentage for people aged 18 to 24 was 22% in 2000. This proportion steadily rose to 36.3% by 2016 and further climbed to 39% by 2020. These figures clearly show a constantly rising trend in Egypt's gross tertiary enrollment ratios, with a 17% growth from 2000 to 2022. Further, the percentage of government expenditures on education as a percentage of GDP has fluctuated over time. During the period 2010-2016, it increased from 3.5% in 2010 to 4.1% in 2016. Due to economic reforms and increased spending on major projects and infrastructure, this percentage declined in 2019 to 2.6 percent.

According to the Global Talent Competitiveness Index 2021 (GTCI), Egypt received a score of 40.39 in the *vocational and technical skills* pillar, surpassing the average of 34.34 for low-middle income countries. This achievement is noteworthy, particularly considering the significant decline in the indicator measuring the *relevance of education system to the economy*[8], which stood at 53.26. In terms of quality, Egypt demonstrates prominence in the *Global Knowledge Skills*[9] pillar of the Global Talent Competitiveness Index 2021 report. Egypt achieved a ranking among the top 10 regional countries in the North Africa and West Asia region (comprising 19 countries), as well as among lower middle income countries globally (36 countries). Globally, Egypt secured the 65th position in this pillar (the report assessed a total of 132 countries in 2021). As well, the *"Attract" talent* pillar[10] of the Global Talent Competitiveness Index demonstrated improvements, with Egypt ranking 77th globally with a score of 26.17. Additionally, the *Brain Gain*[11] pillar ranked 67th globally at 47.11, a remarkable improvement. Despite this, the indicator of *women's contribution to*

[8] *Relevance of education system to the economy*: (average answer to the question) In your country, how well does the education system meet the needs of a competitive economy? [1 = not well at all; 7 = extremely well]. Source: World Economic Forum, Executive Opinion Survey 2020–2021.

[9] *Global Knowledge Skills* (GK Skills), it “deal with knowledge workers in professional, managerial, or leadership roles that require creativity and problem solving” (GTCI 2022, p. 15)

[10] The pillar contains three main variables: the Presence of Forbes Global 2000 companies (HQ presence, % of population), Foreign-born population (% of total), and FDI projects (% of population).

[11] *Brain Gain*: (Average answer to the question) To what extent does your country attract talented people from abroad? [1 = not at all; 7 = to a great extent—the country attracts the best and brightest from around the world]. Source: World Economic Forum, Executive Opinion Survey 2020–2021.

higher education[12] showed a slight decline, ranking 89th globally with a score of 57.4, while the indicator of *leadership opportunities for women*[13] showed a remarkable improvement, ranking 26th globally with a score of 67.9 (Lanvin & Monteiro, 2021).

In Egypt, **R&D inputs** are divided between the public and private sectors. According to the NSSTI strategy, more than 138.5 thousand researchers were distributed in 56 public and private institutions in 2019. There were also 25 research centers, institutes, and entities affiliated with ministries, as well as specialized civil society institutions. Further, the number of researchers per million Egyptians has been continuously growing in recent years. Egypt had 672.9 researchers per million people in 2015, compared to 770.7 researchers per million people in 2021 (UNESCO, 2023a). This reflects a 15.5% gain in the last six years. As compared to other MENA nations, Egypt has a comparatively low number of researchers per million residents. In terms of this criterion, Egypt placed seventh out of ten nations in the MENA area in 2021 (average researchers per million population is 789.1). Egypt's ranking, on the other hand, has progressively improved in recent years.

According to the NSSTI strategy, the Egyptian government has made many commitments to expand the number of researchers in the country, with the goal of reaching 1,000 researchers per million people by 2030. Among these initiatives is the government's increased funding in R&D. Egypt's expanding number of universities and research centers. The growing number of international research collaborations (Ministry of Higher Education and Scientific Research Egypt, 2019). According to the Global Information Technology Report, Egypt's technology absorption indicator at the company level has declined from 4.7 in 2012 to 3.84 in 2016. As a result, the Global Innovation Index 2021 report for Egypt shows that global corporate R&D investment is a serious weakness (WIPO, 2021). Egypt's Gross Domestic Expenditure on R&D (GERD) as a proportion of GDP has steadily increased in recent years. In 2015, GERD accounted for 0.54% of GDP; by 2022, it had climbed to 0.71%, a significant 31.4% growth in just seven years (UNESCO, 2023b). While Egypt's GERD remains low in comparison to other countries across the world, it exceeds the average for both Africa and the MENA region. In 2022, Africa's average GERD was 0.63%, and the

[12] Women enrolled in tertiary education (%) refers to the percentage of female students officially registered in an educational program at the tertiary level, regardless of age. population).

[13] The indicator is the average answer to the question: In your country, to what extent do companies provide women with the same opportunities as men to rise to positions of leadership? [1 = not at all; 7 = to a great extent]

MENA region was 0.66%. The Egyptian government is putting its sights on increased progress in GERD in accordance with the NSSTI strategy. The objective is to raise GERD as a proportion of GDP to 1% by 2030 (Ministry of Higher Education and Scientific Research Egypt, 2019).

R&D outputs include internationally published research papers and patents. The university research production includes more participation than research centers, especially those affiliated with the Greater Cairo region. The number of patent applications submitted to the Egyptian Patent Office (EPO) has steadily increased over the last several years, with the number increasing from 2136 in 2014 to 3187 in 2020, with companies filing the greatest number of patent applications, followed by individuals, and then research centers. Concerning links with industry, the Academy of Scientific Research and Technology (ASRT) launched the Intelaq national program in 2015 (Ministry of Higher Education and Scientific Research Egypt, 2019). The program aims to establish and manage technological incubators for innovation and entrepreneurship, resulting in the establishment of 18 business incubators until 2018 (EIB, 2020).

Next, the analysis of the performance of the RIS components indicates that there are significant disparities among innovation components within the Egyptian context. Accordingly, it is necessary to discuss the components of innovation on a regional level.

According to *Table 7*, **the Greater Cairo region** (GCR) consists of Cairo, Giza, and Qalyubia, and is the main center of economic activity and innovation. The Cairo region concentrates 25% of the country's total population. Furthermore, the region employs 80% of the national total of those working in high-tech industries such as electrical and optical goods, electronic components and boards, and communication equipment (Capmas, 2021). In addition, the region hosts more than half of the universities, 43% of research centers, 24% of all scientific research, invention, and patents workers, and 50% of all business incubators within Egypt. Thus, Egypt’s innovation system is completely controlled by this region in terms of its components and factors of innovation. 42% of universities, 80% of government institutes, 69% of business incubators, and 81% of start-ups can be found in Cairo and Giza governorates. Moreover, three smart cities are proposed in the GCR region, including the NAC, whose first phase has been completed.

Innovation indicators and components in **the Alexandria region** are declining in terms of business incubators (11% of the total) and innovative industries’ employment, which is less than 1%. However, research and development, inventions, and patents make up 10 percent of state-level employment in these sectors within this region. Alexandria Governorate contains 8% of the state's universities, making it the dominant center for research and innovation in the Alexandria region. It also contains 9.1% of start-up companies, as well as 25% of the total research and development centers in the Alexandria governorate. In the region, three smart cities are planned, including one whose first phases have already begun. El Alamein is a new city that houses several universities, institutes, and technology centers.

North Upper Egypt, **Central Upper Egypt**, and **Southern Upper Egypt regions**, regions, which represent ten governorates out of 27 governorates, each have only 1% of the total knowledge and innovation-based industries of Egypt. Meanwhile, it owns 19% of the total number of universities and 23% of the total number of research centers. There is 18.4% of the scientific research, inventions, and patents workforce located in these three regions. Furthermore, these three regions together contain only 2.2% of the total number of startups. The inefficiency of research centers and universities reflects the lack (low level) of innovation and development efforts within the industrial sector. In the Egyptian south regions, there is a proposal for the establishment of five smart cities in the three regions.

In the **Delta region**, which is residence to 23% of the population, agriculture and associated logistics are the key economic activity. Despite having seven universities and 91 research institutions, there is a significant worker shortage in the knowledge and innovation-based industry. This is due to the region's economic structure, which lacks the formation of such companies and relies heavily on agriculture. Furthermore, the Delta region's closeness to Greater Cairo encourages talented professionals to go to the capital, where there are more employment possibilities. Due to the presence of some components and driving factors, the **Suez Canal region** is considered a nucleus for the implementation of innovation and development policies. About 10% of the workforce in this region is employed in research, development, and innovation, and 8% in innovative industries, which is the second largest after the GCR. Further, the Suez Canal axis development zone is proposing several industrial activities based on innovation, in addition to specialized universities serving the artificial intelligence, innovation, and technology sectors, such as Al-Galala University and King Salman University. Therefore, some smart cities are being proposed in the region, one of which has been implemented.

The national strategy operates under the assumption that the planned new urban centers will foster innovation within the cities, considering the presence of diverse elements and local expertise in innovation within the governorates. Given that these governorates represent the regional level of the planned urban centers, it is crucial to assess their capabilities and determine their potential contribution to the proposed regional development strategy. *Table 7* provides a detailed breakdown of each region in terms of innovation input and output indicators. Analysis of the innovation inputs and outputs mentioned in policy documents reveals that the Regional Innovation Systems (RIS) performance is strong in certain regions, while it is comparatively weaker in others. Notably, governorates such as Cairo, Giza, Alexandria, and those located in the Suez Canal region exhibit favourable RIS performance.

Table 7. Regional innovation components for Egyptian governorates

N	Economic Region	Govs.	Population	Pop. (%)	No. of Proposed Smart cities	Urban or Rural [14]	Startups[15]	Accelerators/incubators	Research &Innovation centers private sector-owned [16]	Academic sector[17]	TTOs/TICO (transfer tech. offices)	Number of Scientific & Research Centers by Governorate [18]	% Scientific Research, invention, and patents workers[19]	% High-tech industry workers [20]
1		Cairo	10 065 320	9.7	2	urban	205	9	6	15	6	135	23.17	26.95
2	**Greater Cairo**	Kalyoubia	6 007 371	5.8	_	urban/Rural	1	_	_	1	_	30	3.84	35.01
3		Giza	9 293 336	9.0	1	urban/Rural	47	4	2	10	4	80	12.98	18.59
		Total region	*25 366 027*	*24.5*	*3*		*253*	*13*	*8*	*26*	*10*	*245*	*39.98*	*80.54*
4		Alexandria	5 458 055	5.3	2	urban	29	2	3	5	1	24	7.91	5.43
5	**Alexandrea**	Behera	6 708 441	6.5	1	urban/Rural	4	_	_	1	_	13	2.32	0.25
6		Matrouh	508 553	0.5	_	urban/Rural	_	_	_		1	9	0.29	0.02
		Total region	*12 675 049*	*12.2*	*3*		*33*	*2*	*3*	*6*	*2*	*46*	*10.52*	*5.69*
7		Port-said	782 634	0.8	1	urban	_	_	_	1	_	12	1.39	0.25
8		Suez	776 960	0.7	1	urban	_	1	_	1	_	7	0.75	0.02
9	**Suez Canal**	Sharkia	7 721 991	7.4	_	urban/Rural	3	_	_	2	1	22	6.51	7.18
10		Ismailia	1 418 121	1.4	1	urban/Rural	2	_	_	1	_	13	1.75	1.46
11		North Sinai	450 528	0.4	_	urban/Rural	1	_	_	1	_	5	0.36	0.08
12		South Sinai	112 835	0.1	_	urban/Rural	_	_	_		_		0.20	0.00
		Total region	*11 263 069*	*10.9*	*3*		*6*	*1*		*6*	*1*	*59*	*10.96*	*8.98*

Notes: [14] Egyptian governorates are classified as urban or urban/rural. Some governorates in Egypt are referred to as urban governorates since they do not include any rural communities within their scope. Governorates that encompass both rural regions and villages, as well as their connected cities, are classed as urban/rural governorates. Source: Central Agency for Public Mobilization and Statistics (CAPMAS), Census 2017

[15] The total number of startups in the governorate focusing on the knowledge and innovation-based sectors (e.g. healthcare technology, data analytics, software development). Source: EgyptInnovate official website https://egyptinnovate.com/en/innovation/map (available 25th July 2020)

[16] Egyptian private sector-owned research and innovation centers. Source: EgyptInnovate official website https://egyptinnovate.com/en/innovation/map (available 25th July 2020)

[17] Governmental and private higher education institutions, institutes and universities. Source: annual bulletin of higher education and higher degrees graduates, 2017, issue November, 2018, (CAPMAS)

[18] Research centers affiliated with ministries and government agencies. Source: Ministry of Higher Education and Scientific Research Egypt, 2019

[19] The percentage of employees in the ministries' connected research and scientific centers, which are national governmental research centers. Source: General Census for Population, Housing and Establishments 2017. https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials (available 10th April 2020)

[20] The percentage of employees in the high technology industry from industries such as electronic and optical products, electronic components and boards, communication equipment, irradiation, testing, and electromedical and electrotherapeutic equipment. Source: Egyptian Economic Census 2018, CAPMS. https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/405/download/840 (available 10th April 2020)

Table 7. Regional innovation components for Egyptian governorates (Cont.)

N	Economic Region	Govs.	Population	Pop. (%)	No. of Proposed Smart cities	Urban or Rural	Startups	Accelerators/incubators	Research &Innovation centers private sector-owned	Academic sector	TTOs/TICO (transfer tech. offices)	Number of Scientific & Research Centers by Governorate	% Scientific Research, invention, and patents workers	% High-tech industry workers
13	**Delta**	Damietta	1 590 104	1.5	_	urban/Rural	_	_	_	1	_	11	1.62	0.09
14		Dakahlia	7 916 763	7.6	1	urban/Rural	7	_	_	3	_	23	6.91	0.58
15		Kafr El Sheikh	3 727 427	3.6	–	urban/Rural	1	–	–	1	–	15	2.54	0.49
16		Gharbia	5 330 839	5.1	_	urban/Rural	4	_	1	1	_	17	5.72	0.33
17		Menoufia	4 628 408	4.5	_	urban/Rural	6	_	_	2	_	25	3.33	0.52
		Total region	*23 193 541*	*22.4*	*1*		*18*	*0*	*1*	*8*	*0*	*91*	*20.12*	*2.01*
18	**North Upper**	Beni Suef	3 482 188	3.4	1	urban/Rural	1	_	_	2	_	20	3.00	1.33
19		Fayoum	3 963 163	3.8	_	urban/Rural	_	_	_	1	_	15	0.98	0.22
20		Menia	6 102 418	5.9	1	urban/Rural	3	_	_	1	_	19	1.91	0.02
		Total region	*13 547 769*	*13.1*	*2*		*4*	*0*	*0*	*4*	*0*	*54*	*5.89*	*1.56*
21	**Middle Upper**	Asyout	4 879 025	4.7	1	urban/Rural	2	1	_	1	1	26	4.53	0.16
22		New valley	264 521	0.3	1	urban/Rural	_	_	_	_	_	6	0.75	0.00
		Total region	5 143 546	5.0	2		2	1	0	1	1	32	5.29	0.16
23	**South Upper**	Suhag	5 581 827	5.4	1	urban/Rural	_	1	_	1	1	13	2.74	0.43
24		Qena	3 549 747	3.4	1	urban/Rural	1	_	_	1	_	14	2.59	0.01
25		Luxor	1 371 816	1.3	_	urban/Rural	_	_	_		_	2	0.39	0.02
26		Aswan	1 639 498	1.6	_	urban/Rural	_	_	_	1	1	17	1.38	0.61
27		Red sea	395 124	0.4	_	urban/Rural	_	_	_	1	_	1	0.13	0.00
		Total region	*12 538 012*	*12.1*	*2*		*1*	*1*	*0*	*4*	*2*	*47*	*7.25*	*1.06*

Source: own edition based on the data of (CAPMAS, 2017; Capmas, 2021; Ministry of Higher Education and Scientific Research Egypt, 2019; MoHUUC, 2020)

3.2.3 Interview-Based Analysis of New Cities

The goal of the current sub-chapter is to report the findings of semi-structured interviews which have been conducted with two high-ranked Egyptian officials dealing with regional development to determine what the main objectives of the suggested program are and how these new cities might contribute to Egypt's innovation-driven balanced regional development policy.

In accordance with COVID-19 constraints, interviews were conducted online. In the first interview, *Eng. Wael Mousa*, Technical Advisor to the Minister of Housing, Utilities, and Urban Development (*Interviewee_1*), was interviewed using the Google Meet application on January 2, 2021. The interview lasted approximately one hour. The second interview was conducted via Zoom on January 3, 2021, with *Dr. Mohamed Khalil*, Chief Technological Officer of Administrative Capital for Urban Development (ACUD) (*Interviewee_2*). This organization is responsible for managing and developing the New Administrative Capital (NAC), which serves as a pioneering model for new urban centers.

Since semi-structured interviews were conducted, an outline of the topics discussed was developed beforehand. The policy of the new urban centers, their purpose, objectives, and role in achieving balanced regional development were all included as topics of the interviews. The interviewees also discussed how the new urban centers promote innovation policy, as well as the fundamental components of these smart cities. In addition, the interviews focused on the NAC model with its various components that pioneered the implementation of the smart city concept. Specific topics were addressed through a series of open-ended questions, and although the interviews were semi-structured, there was an opportunity for further follow-up questions and discussion.

Q1: What does the program of new, fourth-generation cities, or so-called smart cities mean in Egypt?

As *Interviewee_1* stated, Egypt's approach to the construction of new urban centers, or smart cities, is an ambitious program for the construction of 14 new cities, as part of Egypt Vision 2030. Through the dispersion of these proposed urban centers across the country, the goal is to achieve balanced regional development. The official emphasized that the country's objective is to construct a high-level innovation hub with strong ecosystems to encourage innovation and drive regional development, in addition to addressing urban challenges and large population increase in Egyptian governorates. Furthermore, *Interviewee_1* said that, in accordance with a presidential decree, the Egyptian government has established a national committee to manage the smart city program. Representatives from numerous ministries, including Defence, Interior Affairs, Communication and Information Systems, Housing, Utilities, and Urban Development, as well as the Administrative Capital Corporation for Urban Development (ACUD), participate in this committee (Khalil & Mousa, 2021). This committee's major objective is to create the "Egyptian Smart City Model" and adapt it to the Egyptian context.

Both interviewees confirmed that the government's goal is to implement policy measures that foster innovation ecosystems in these cities. This includes the establishment of fourth-generation universities, R&D centers, business and financial centers, and government agencies that use e-government services. Furthermore, all of these projects will be supported by a high-level smart infrastructure that will facilitate collaboration among various stakeholders, actors of the ecosystem. *Interviewee_2* underlined that the sophisticated, modern, ICT-based urban services provided in these cities would be a helpful element in attracting talented and skilled human resources, which are critical in activating the innovation system within these cities.

Q2: What is the underlying reasoning behind the Egyptian government's aspiration for this program? Moreover, why is there a focus on developing new smart cities instead of transforming existing ones?

The Egyptian government's goal with leveraging new urban centers, according to the two officials, is to create balanced regional development. As noted by *Interviewee_2*, Egypt faces a number of social, demographic and economic challenges (during the interviews, the executive mentioned the same issues and obstacles which were detailed in Chapter 3.1). One of the biggest challenges that Egyptian governorates are facing *massive population growth that inevitably requires the creation of new urban attractions* that will provide new economic activities and opportunities for the residents of existing cities.

Interviewee_2 explained that the practice of building new cities has been a well-known development approach in Egypt since the 1970s. Controlling urban expansion in cities built mostly on productive agricultural areas in the Nile Valley and Delta has long been a challenge for the Egyptian state. Recognizing the challenges posed by uncontrolled urban sprawl in Egypt's limited agricultural areas[21], successive governments have recognized the need to explore new development opportunities by establishing new cities and communities outside the

[21] In Egypt, the total cultivated area is only 3 percent of the total land area, which is limited to the Nile Valley and Delta. (FAO estimate, 2019, https://www.fao.org/countryprofiles/index/en/?iso3=EGY) (available 20th June 2023)

Nile Valley. Egypt's Nile Valley and Delta are densely populated areas, accounting for only 3% of the country's total area however housing 60% of its inhabitants. Uncontrolled and rapid urbanization has put pressure on resources like water, sanitation, and housing, with informal housing accounting for around 40% of built-up regions, posing issues for urban planning and infrastructure development (CAPMAS, 2017).

Furthermore, *Interviewee_1* highlighted that the government is currently carrying out national development projects to improve the quality of existing Egyptian cities and villages, such as the national project for developing centers of existing governorates or the "Haya Karima" national project for a decent[22], sustainable life in Egyptian rural communities. The Egypt Vision 2030 and the Egypt 2052 National Development Plan both also include policy measures for existing Egyptian cities. *Interviewee_1* stressed that the building of the 14 new urban centers will not impede the government's plans to strengthen current urban areas through basic infrastructural improvements, but rather complement them. This primarily includes improving outdated infrastructure networks, i.e., building new roads, and improving accessibility in these densely populated areas. Instead, the government intends to use these new urban centers to explore new development opportunities and address concerns associated with existing urbanization. *Interviewee_1* underlined that one of the advantages of these new urban centers is that they can *easily accommodate a wide range of housing types, thus targeting a wide range of social groups*. The Egyptian government intends to implement various housing projects, including the government's "low-cost" social housing project, "medium cost" housing projects, as well as luxury real estate developer investments. By providing this diversity, the government is addressing concerns about social exclusion that may have hindered the success of smart city initiatives in other countries.

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[22] The "Haya Karima" or Decent Life project, endorsed by President Abdel Fattah Al-Sisi, is a comprehensive endeavor connected with Egypt Vision 2030. Its principal goal is to improve the living circumstances of Egypt's poorest rural areas, which account for about half of the population. This initiative addresses poverty and unemployment in these villages by improving economic, social, and environmental standards. It also provides critical services and job opportunities to inhabitants to foster self-sufficiency. The government has allocated EGP 500 billion (it was recently increased to approximately EGP 750 billion) to the " Haya Karima " initiative, which aims to bridge the gap between urban and rural communities. It chooses target communities based on particular criteria such as a lack of essential amenities, a low rate of education, and a high degree of poverty. The direct interventions of the project include infrastructure development, training, employment, and child development, while the indirect interventions include health services, subsidized food, and environmental improvements. Mid-term reviews have revealed substantial success, including improved quality of life, lower poverty rates, and progress towards key Sustainable Development Goals, demonstrating Egypt's commitment to comprehensive rural development. https://www.hayakarima.com/index.html. (available 25th July 2023)
https://sdgs.un.org/partnerships/decent-life-hayah-kareema-sustainable-rural-communities. (available 25th July 2023)

Upon being asked about adopting smart city concepts in newly created urban centers rather than existing ones, *Interviewee_2* said the state intends to introduce smart city programs in the existing urban centers of Egyptian governorates in the medium to long term. At the same time, the official explained that the state wants to create new smart cities as a first step, as *optimizing the physical infrastructure by introducing modern smart technologies in existing cities can be a challenge*. For example, due to physical constraints to expansion, implementation may face several disruptions, harming of the interests of the residents and businesses, which may affect their daily life. In addition, the *cultural, social and behavioural changes required to implement smart city technologies are more difficult to implement in existing communities*. In sum, greenfield projects provide an opportunity to design and adapt innovative technologies with minimal intervention and without the limitations of existing urban structures. Furthermore, an important argument in favour of greenfield projects is that the physical infrastructure of these new cities is *financed by the proceeds from the sale of land*, which attracts both local and foreign private investors. In existing cities, however, there is a limited amount of land available that can be sold. In the case of existing cities, on the other hand, facing a shortage of free land, forcing the Egyptian government to only launch development initiatives that the limited state budget can afford. As a result, for the Egyptian government, new cities are more attractive investments, as they would be less financially burdensome than existing cities.

The first phase of the New Administrative Capital is a stunning example of this solution. Rather than relying on Egyptian government funding, the Administrative Capital for Urban Development Corporation (ACUD) funded the entire infrastructure of this new city through land sales (Abdeen, 2020). The revenues generated from land sales for the NAC reached over $20 billion during the initial phase. This solution highlights the successful use of new land sales to establish urban centers capable of supporting infrastructure development on their own, easing the pressure on the state's limited budget. In the past, the Egyptian governments supported the infrastructure development of previous generations of new cities exclusively from government funds. Unfortunately, due to a lack of state financial resources, these programs were sometimes delayed, hindering urban development.

Furthermore, some existing Egyptian cities have an economic base that is incompatible with Egypt Vision 2030's goal of building new urban centers as innovation and knowledge hubs. Some of *these existing cities have a well-defined industrial profile, often exerting dominance in conventional sectors*. The Delta governorates are largely focused on the agriculture sector, agricultural production, and agricultural industrialization. Moreover, the governorates in southern Egypt depend on agricultural crop production, as well as certain mining industries inside the Red Sea governorate's territory. Furthermore, the border desert governorates rely on agricultural bases as well as several types of tourism centred on safaris and hunting. While these industries may have been the mainstay of economic development in the past, they may no longer be in line with Egypt's aim of becoming a forward-thinking, knowledge-based economy. As Egypt works to realize its Vision 2030, building new urban centers with a focus on innovation and knowledge-driven sectors would need careful planning and focused investments to guide the economy in the appropriate direction.

Q3: How can the new urban centres’ strategy support *balanced* regional development?

The 14 new cities are (will be) strategically located throughout Egypt, with the goal of dispersing economic development and opportunity more equitably all across the country. The purpose of building these new urban centres is to create job opportunities, attract investment, and boost tourism in their particular regions. This contrasts with the current scenario, in which the Greater Cairo region accounts for the majority of Egypt's economic activity (GCR). This strategy is meant to promote inclusive growth and enable areas outside of Cairo to play a more active role in the nation's economic advancement. In the 1980s, previous generations of new cities were primarily proposed in the Greater Cairo region resulting in increased urban pressures and developmental problems because of massive relocation and migration of people from other governorates looking for job opportunities and further benefits in the capital region. As a result, the government now is seeking to create attractive urban centres offering job opportunities, housing, and modern urban facilities in regions *where this was not possible before*.

Interviewee_1 stressed the importance of the new fourth-generation cities in supporting balanced regional development, emphasizing their role as smart cities. By applying smart technology, these cities will outperform existing cities in terms of sustainability and efficiency. Smart cities strive to reduce energy usage, improve waste management methods, and promote the use of public transit by combining high-level ICT solutions. These multifaceted measures are projected to dramatically reduce the environmental effect of urban expansion, resulting in a more living, environmentally friendly, thus sustainable environment for the city's residents. On the one hand, for geographically disadvantaged, resource-low areas to become liveable, modern technology that enables efficient, eco-friendly, and intelligent resource utilization is essential. On the other hand, individuals in popular but less liveable parts of the country might be attracted to migrate to these new cities because of their ICT-supported high-quality urban services and attractive living environment.

The first example of how the new smart cities is meant to enable balanced regional development is the New Administrative Capital (NAC), which is still under construction in Cairo's eastern desert. This strategic location aims to decongest Cairo and disperse economic activity to another part of the country. The second is the El Alamein smart city, which is located along the magnificent Mediterranean coast. Its construction is aimed to increase tourism and economic development along the North Coast. The third instance is the Galala Hills smart city, which is being built amid the magnificent Red Sea Mountains. This smart city initiative is anticipated to boost tourism and economic growth in the Sinai Peninsula. Egypt is proactively exploiting the potential of its different regions through these well-planned locations, supporting sustainable development, and giving unique opportunities for economic advancement across the country.

Q4: How will these smart cities *foster innovation and development* by providing high-quality urban services?

The government envisions the new cities as hubs of innovation and entrepreneurship. In the second interview, *Interviewee_2* mentioned that the Egyptian government intends to support the development of a high-level innovation ecosystem in these new cities by developing and integrating components necessary for innovation such as fourth-generation universities, knowledge centers, e-government organizations, and financial and central business zones (CBDs). Furthermore, these new cities, as smart cities with cutting-edge information and communication technologies, offer a high quality of life, *attracting a large pool of talented and skilled human capital*. A smart city, with high-tech at its core, can create high-quality urban services that act as a magnet for a talented and skilled workforce. The government hopes that by drawing educated individuals from all around Egypt, it will be able to build a new generation of entrepreneurs and innovation-based sectors that will help sustain the innovation ecosystem of these new cities in the future. Smart cities can be attractive to tech start-ups, entrepreneurs, and innovators who want to exploit advanced infrastructure and technology in different ways. For example, smart cities provide robust digital infrastructure (high-speed internet and connectivity) that enables the growth of online businesses, e-commerce, and digital services, opening avenues for entrepreneurs to reach a global audience. Smart cities collect and analyze huge amounts of data to improve the efficiency of city services. Entrepreneurs can use available open data to develop data-driven businesses. Entrepreneurs can also participate in the development and maintenance of smart infrastructure such as the development of sensors, smart grids, and waste management systems, etc.

At the same time, attracting the right human resources is necessary, but not sufficient, for innovation to take place. It is also necessary to strengthen cooperation between different actors to support knowledge sharing. The government of Egypt supports the creation of these partnerships through various incentives. On the one hand, they create the necessary physical spaces for cooperation and knowledge exchange, such *as innovation districts* (including universities, knowledge centers, and support organizations). It is also worth mentioning the so-called, *smart city testbeds* are designated areas within the city to test emerging technologies and solutions, allowing startups and innovators to pilot and validate their ideas in real urban environments. On the other hand, they plan to provide additional financial incentives to the participants. For example, smart cities encourage more startup-friendly procurement processes by allowing local startups to pilot their solutions for the city. Nevertheless, interviewees argue that smart cities contribute to the strengthening of a collaboration among actors. Smart cities have digital infrastructure and data collection tools that allow data and information to be easily shared and made available to city actors such as businesses, research institutions and government agencies. Easy access to data can help to share information and develop innovative projects. Moreover, *collaboration platform* with stakeholders from academia, public and private sector to identify problems, solutions and opportunities of the city. These platforms allow urban actors to connect, exchange ideas and work on joint projects.

In addition, both interviewees stressed that the creation of a strong innovation ecosystem in these new urban centers also depends on the performance of the innovation systems in the host governorates.

Q5: What are the main pillars of newly formed smart cities?

These new urban centers are anticipated to have further programs designed to help the cities establish a high-level innovation ecosystem. According to *Interviewee_1*, the proposed smart city model is composed of seven components that are closely aligned with the theoretical background presented in Chapter 2.3.2. Among the components of smart cities is *smart infrastructure*, which is established and managed using ICT. As an additional benefit, this infrastructure combines operations management and artificial intelligence to identify and resolve infrastructure problems in a proactive manner. Second, *smart transportation* uses smart apps and artificial intelligence to give the urban community with current and sophisticated transportation services that enhance how they live. Furthermore, *smart governance* is a third component. According to *Interviewee_2*, the government plans to use ICT to administer its institutions, provide online services, and promote transparent involvement in decision-making and city administration. The fourth component is *smart services*, which include a diverse range of services utilizing AI and ICT. The government aims to provide a wide range of services that offer competitive advantages, profitability, and sustainability. Examples of such services include modern building management, smart card services, smart transport management, and automated waste management. The *smart economy* is the fifth component. The government intends to boost the planned cities' competitive advantages by encouraging innovation, entrepreneurship, and a knowledge-based economy. The government seeks to attract entrepreneurs, R&D investments, and private-sector enterprises. Furthermore, the government intends to establish collaboration programs between universities and the private sector to promote applied innovations. The sixth component is *smart people*, often known as human capital. According to *Interviewee_2*, high-quality urban services are important components in attracting skilled and educated citizens to the proposed cities. Finally, the *smart environment* incorporates the use of ICT as well as data analysis to control natural resources and accomplish sustainability. This involves regulating water consumption efficiency, decreasing emissions using advanced sensors, and adopting environmentally friendly architectural projects that are geographically appropriate for the proposed cities.

In the first interview, *Interviewee_1* shared valuable information on the new urban centers' programs. Namely, data on the fundamental measures that would comprise each urban center's proposed smart city initiatives, as well as the distribution of innovation ecosystem measures across these cities. *Table 8* shows the fundamental pillars of smart cities, as well as the components that foster innovation. The components of smart cities can be explored through 1) smart infrastructure, 2) smart transportation, 3) smart governance, 4) smart services, 5) smart economy, 6) smart people, and 7) smart environmental (sustainability). In terms of the innovation components (universities, governmental and central business districts), several features of the proposed smart city programs in Cairo, Alexandria, and Dakahlia governorates demonstrate the majority of the smart city components.

The NAC's innovation components include 8 fourth-generation universities, an innovative government district based on smart e-government, and a thriving financial and Central Business District (CBD). Approximately 3.4 billion dollars of investments have been made in the CBD, which covers an area of 1 million and 700 thousand square meters. The project is being implemented by the Chinese company, CSCC. The development includes administrative and commercial towers, as well as the headquarters of banking, financial, and investment institutions. Located in the district is Africa's tallest building, a 345-meter skyscraper. The Central Bank has a printing press for printing money, as well as an area dedicated to banks, multinational companies, mega entrepreneurs, and administrative, service, and commercial buildings. Additionally, the new city of El Alamein shows some clarity in the proposed components of innovation within the smart city model, such as a new government headquarters where some ministries and government agencies will be consolidated, a financial center (following the model of the CBD in the NAC), and a fourth-generation university. The example of these smart cities illustrates that they are not only smart-city components that enhance urban life quality but also components that foster the innovation ecosystem in these new cities.

In terms of the smartness components, the NAC and El Alamein prefer localizing those components, including smart infrastructure, smart transportation, smart governance, smart services, smart competitive economy, smart environment, and smart people. In both the NAC and El Alamein, **smart infrastructure**, technologies, and technology supporting smart cities have been used to create, manage, and operate the infrastructure, with plans to implement this technology and management in the remaining smart cities. The New Administrative Capital (NAC) is anticipated to benefit from several transport system advancements, including the implementation of a monorail network, the first of its type in the MENA area. Rapid electric trains are also being created to connect smart cities with governorates' capitals, and huge transport terminals are another important element to be included in the NAC. These initiatives demonstrate the government's dedication to enhancing transport infrastructure and promoting sustainable development. The Egyptian government's move to the new government headquarters in the NAC is an example of **smart governance**, a move that is centred on network management, information technology, and data analysis within the framework of the new government network. Government administration in Egypt is aiming to use IT, mechanization, and data analysis for smart governance. A major obstacle to providing government services and their efficiency (bureaucracy) is the reliance on the human element in the current system. Then, by reducing and vanishing this bottleneck and reducing reliance on the human element, and addressing corruption and bureaucracy, the concept of smart governance in smart cities can be activated. Thus, the Egyptian government's move to a new government headquarters and the use of high-tech components and capabilities supports smart governance. The **smart economy** component of the proposed Egyptian smart cities is based on the establishment of new financial and business centers, which will attract multinationals and Over the Top (OTT) companies to establish their headquarters in Egypt (e.g., Apple, Microsoft, and Amazon) (Khalil & Mousa, 2021). Aside from research and innovation centers, there are major financial institutions and banks, which enhance the presence of these companies and promote the concept of smart economies.

According to the Egyptian model of smart cities, **smart services** are delivered through an agent to the recipient through the service provider (see interview report 2 in Appendix 4). Smart services in the smart city model – which is applied to the NAC – require the presence of an intermediary (the ACUD) between service providers (service companies) and service recipients (city residents). Through information systems, smart applications, and smart service cards, the ACUD will follow up on the provision of services as well as work to improve the efficiency of service delivery (Khalil & Mousa, 2021). According to the proposed smart city model, **smart people** are skilled, capable, and knowledgeable, and this has been achieved through the training of 50,000 government employees (who will be transferred to the smart city model) and the use of information technology, data analysis, and the operation of the smart city in cooperation with global technology companies (such as Huawei). In the proposed Egyptian model, the **smart environment** concept is based on sustainability using high technology, alternative and renewable energy sources, and re-exploitation of water (due to a limited supply of water in Egypt) as well as analysing data usage to achieve sustainability in urban environments.

Table 8. Smartness and Innovation components for Egyptian new smart cities

Economic Region	**Governorate**	**New Smart cities****	**Components of innovation**			**Smartness components**	**Population absorption (Million)**	**Area (thous and acres)**	**Distance from nearest Economic Hub (km)**
			4 th -generation universities	**Government**	**Industry/ Business center**				
Greater Cairo Region	Cairo	New Administrative Capital (NAC)	8	Governmental District	Central Business District	Smart Infrastructure – Mobility – Governance – Services– Economy – People – Environment	6.5	170	35
	Giza	New October city				Smart Infrastructure – Mobility – Services	2.6	33.8	40
	Qalyobia	New Alobor City				Smart Infrastructure – Services	2.9	58.91	30
Alexandria Region	Alexandria	Al Alamein New City (ANC)	1	Governmental District	Central Business District	Smart Infrastructure – Mobility– Services – Economy – Environment– People	2	48.13	117
Suze-Canal Region	Port Said	East Port Said city-SALAM				Smart Infrastructure – Services – Economy	0.77	22.24	25
	Ismailia	New Ismailia City (NIC)				Smart Infrastructure –Services	0.3	2.82	10
	Suez	City and resort of Galala	2			Smart Infrastructure – Mobility – Services- Environment	—	17	170
Delta Region	Dakahlya	New Mansoura	1		Business Center	Smart Infrastructure – Mobility – Services	0.68	5.9	54
South-Egypt	Qena	City west of Qena				Smart Infrastructure – Services	0.55	9	5
	New Valley	New Toshka City				Smart Infrastructure	0.08	3	481
Central Upper Egypt	Assuit	Nasser city, west of Assiut				Smart Infrastructure	0.34	6	14

Source: Ali (2021b, p.9)

In conclusion, based on the findings of the interviews presented in this sub-chapter Egypt's strategy to establish 14 new urban centers is an ambitious strategy to foster innovation-driven regional development. The government claims that the spatial distribution of these new cities within the framework of the strategy will help Egypt achieve balanced regional development and address regional development issues. The Egyptian government intends to localize smart city initiatives in these new cities in order to attract and foster innovation, as well as to develop a high-level innovation ecosystem by localizing innovation projects and components. This program's success depends on increasing cooperation and involvement among all agencies, institutions, and stakeholders, **not only inside the new urban centers itself, but also relying on the Egyptian governorates' current Regional Innovation Systems and components**. According to the findings of the interviews, **the Egyptian government recognized that the availability and capacity of present innovation components and aspects in Egyptian governorates are critical to the strategy's success.** Therefore, it is necessary to assess the existing local capacities and the performance of the Regional Innovation Systems (RIS) in Egyptian governorates to ascertain the regional suitability of the proposed urban centers for implementing the new policy.

3.2.4 New Administrative Capital (NAC) as a Pioneer Model for New Urban Centers

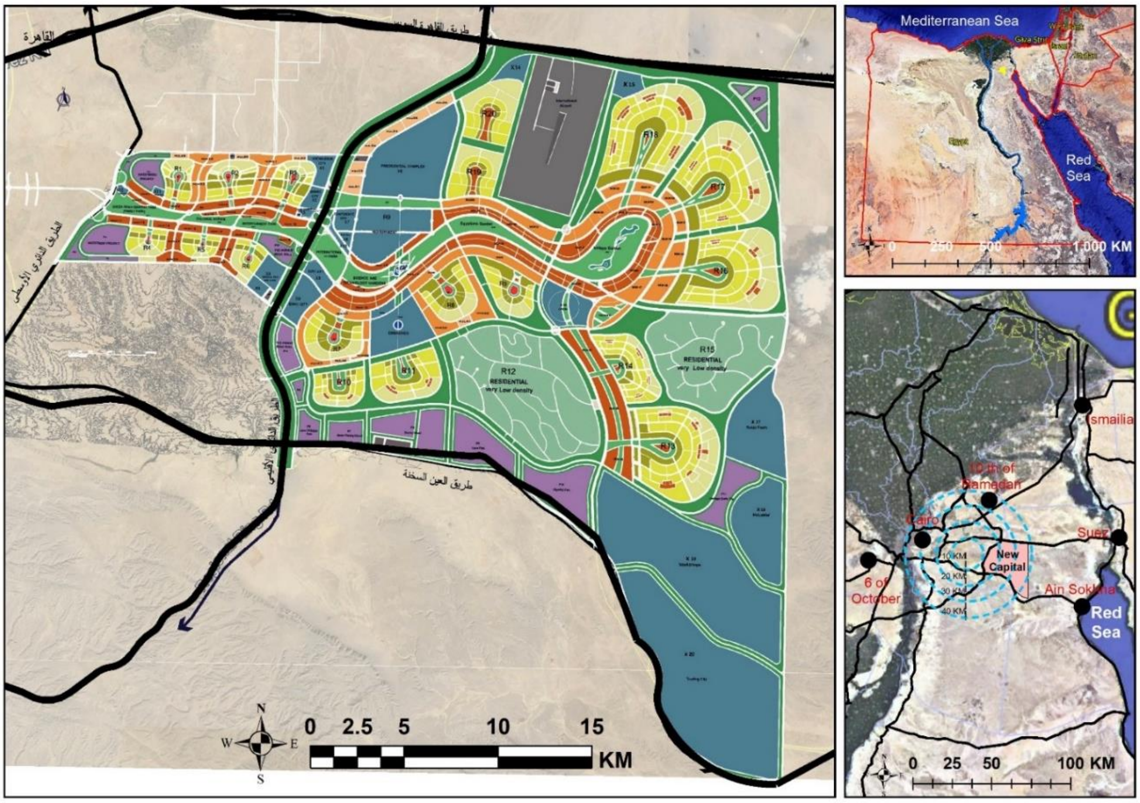
The following subsection builds upon the findings of the interview by delving into the concept of the New Administrative Capital (NAC) as a pioneer model for new urban centers. This chapter's objective is to provide the officials' perspectives on the NAC project. The smart city components of the NAC and its urban services program were thoroughly discussed during the second interview. The first section of the chapter delves into the interview findings, addressing questions regarding the nature of the smart city components within the New Administrative Capital (NAC) and their significance in fostering innovation. The perspectives of the officials on the NAC project shed light on the relevance of smart city components in fostering innovation-driven regional development. The sub-chapter concludes with a summary of the smart city program components and services based on data from the interview and additional sources of data from the Administrative Capital Company for Urban Development (ACUD). Overall, this chapter offers useful insights into officials' perspectives on the NAC model.

Q6: What is the New Administrative Capital? What are the main components of the Egyptian smart city model applied to the NAC? How will the NAC as smart city model foster innovation?

Interviewee_2 mentioned that the construction of the New Administrative Capital (NAC) began in 2015 and is expected to usher in an era of smart cities. The NAC is located 35 kilometres east of Cairo on 170000 acres, which is the equivalent of Singapore (ACUD, 2017). ***Error! Reference source not found.*** depicts the location of the NAC between Cairo and the Suez Canal region. In addition to 21 residential districts and 25 dedicated districts, the city is home to 663 medical centers, 2,000 educational institutions, and a major theme park that is almost four times the size of Disneyland (Khalil & Mousa, 2021). *Interviewee_2* stated that the target population is about 6.5 million people. In December 2021, the first 50 thousand employees to the new governmental district were moved, and after three years the capacity will be increased to 100,000. By creating new innovative urban extensions in eastern Cairo, an environment that encourages business and knowledge, a new administration, and a government center, the NAC will improve innovation environments and diversify economic prospects in Egypt.

Khalil mentioned that the NAC was designed to enhance its innovation ecosystem by providing and executing a set of policy measures, which include establishing eight fourth-generation universities; the City of Knowledge; the central business district and entrepreneurs; Egypt Information City; and startup incubators. The NAC's goal in constructing eight fourth-generation universities is to give over 100,000 students a high-quality education that satisfies worldwide standards, with the goal of preparing them to become future innovators. The City of Knowledge is envisioned as a dynamic hub for knowledge-sharing, innovation, and cooperation, combining academic institutions, research institutes, and industry pioneers. Its main purpose is to boost NAC's competitiveness in higher education and scientific research, with an emphasis on cutting-edge advancements in energy, health, the environment, and communication technology. Through different avenues, the city will form alliances with the industrial and economic sectors. Firstly, it will collaborate with businesses on collaborative research and development initiatives, stimulating innovation and producing new technologies that will benefit the city's businesses. Second, Knowledge City will provide training and educational programs to businesses, allowing them to create a competent talent pool and recruit the best workers in Egypt. In addition, the city will provide incubator and accelerator programs to help entrepreneurs and companies thrive and realize their full potential. Finally, firms will be able to access financial possibilities such as grants and loans to help them expand and flourish. These partnerships seek to establish a thriving and innovative ecosystem within the NAC, benefiting the entire country in the long run. About $1 billion was invested in the creation of the city of knowledge, which covers an area of 396 acres.

Figure 13 The location and the Master Plan of the New Administrative Capital - Egypt



Source: Ali, 2021b, p. 10.

Furthermore, because of its high investment volume of 3.4 billion dollars, the Central Business District (CBD) serves as the NAC's economic and financial center, promoting the growth of firms and entrepreneurs. In the Central Business District (CBD), which is being implemented by the China State Construction Engineering Corporation (CSCEC[23]), there are 18 towers, including administrative companies, entertainment facilities, resorts, and the tallest tower in Africa (Hussein & Pollock, 2019; Report, 2020). This area not only contains the Central Bank, but also a slew of local and foreign banks, as well as the headquarters of a number of multinational corporations. Furthermore, many of the world's greatest commercial locations and projects can be found inside the 195-acre financial and economic sector. The NAC is predicted to become a significant worldwide commercial and finance center in the next years. Google, Microsoft, Samsung, Siemens, and Enel are among the world-renowned enterprises that are home in CBD (Khalil & Mousa, 2021). These firms are anticipated to contribute to Egypt's innovation in a variety of ways. First, these businesses will bring their own talents and

[23] China State Construction Engineering Corporation is the world's largest engineering contractor in the field of housing and mega projects construction. http://www.cscec.com/ (available 18th February 2023).

expertise to the country, assisting in the training and development of local talent. Second, these businesses will be able to work with Egyptian universities and research organizations to develop new ideas and technology. Finally, these companies will generate demand for new products and services, which will aid in the stimulation of the Egyptian economy. Overall, the presence of these world-renowned enterprises in the CBD of the NAC is a significant boost for the city's innovation ecosystem. It is anticipated to attract more firms and create a more robust tech ecosystem in the city. This will aid in the development of new technologies for use in Egypt and the wider region.

Additionally, the Egypt Information City prioritizes informatics learning and training, which are critical in today's digital era to power innovation. This huge project, which spans 200 acres and requires a one-billion-dollar investment, is part of the first phase of the NAC. With this project, advanced technology research and innovation will be supported through an information ecosystem. As part of the first phase of the information city, four main centers are located, including a center for innovation and applied research, another center for technical training, a center for assistive technology research, and finally an Egypt Informatics University that specializes in communication sciences (ACUD, 2017).

Lastly, startup incubators are intended to help early-stage firms develop and prosper by offering resources and mentorship. Further details regarding these components of the innovation-promoting ecosystem within the NAC will be detailed in the next sub-chapter. Overall, the official's focus on these components emphasizes the significance of developing an innovation ecosystem that fosters education, research, and entrepreneurship to drive innovation-driven regional development.

Furthermore, *Interviewee_1* stated that Egyptian universities and regional innovation potential for Cairo governorate are being integrated into the NAC model using the smart city policy for fourth-generation cities (MoHUUC, 2020). According to *Table 8*, 40% of the fourth-generation universities are in the NAC. As a result of these knowledge and innovation potentials, the Egyptian government aspires for the NAC to emerge as a regional innovation hub, encompassing not only the Greater Cairo Region (GCR) but the entire country as well. In order to serve the MENA region as a knowledge hub, the state seeks to integrate international branches of highly reputable universities and institutes across the globe into the NAC. In addition, there are various science and technology parks, which are regarded as innovation environments. According to the official, the government sees the NAC as a *national innovation hub for Egypt*. This is attributable to the presence of different important components, including smart governmental districts, universities, research institutes, high-tech enterprises, and international corporations. These aspects collaborate to develop an ecosystem that fosters innovation and cooperation, offering a chance to boost innovation-driven regional development.

Both two interviewees stressed that the Egyptian government views the NAC's outstanding smart city services as critical determinants in attracting trained and talented human resources. Furthermore, the government intends to boost the NAC's competitiveness by providing high-quality urban services, positioning it as a desirable hub for R&D investment from private enterprises and foreign corporations.

After the completion of the second interview, the official provided a collection of data sourced from the Administrative Capital for Urban Development Company (ACUD), which pertained to the smart city elements and the capabilities of the innovation system in the new administrative capital. Below is the summary of the data for the New Administrative Capital.

Overview of the NAC Components as a smart city model

The ACUD is a government-owned company owned by the Egyptian Sovereign Fund for Investments. It is considered the main owner and developer inside the NAC, in addition to other private developers. According to *Figure 14*, the NAC shows the different districts, including governmental, residential, and commercial areas (ACUD, 2017). In addition to the Parliament and the Council of Ministers, other government offices and ministries are located in **the Governmental District**. The government district also stands out for its large area of 550 acres and its large number of employees and agencies (Ali et al., 2021). In **the Embassies Quarter**, the foreign and Arab embassies will be housed. The size of the district exceeds 1500 acres. The **Residential districts**, a total of 20 residential districts will be established in the new administrative capital by 2050, with a total area of 30% of the NAC. 7 districts are in the initial phase, costing about 1.5 billion US dollars (including infrastructure and facilities for those neighbourhoods).

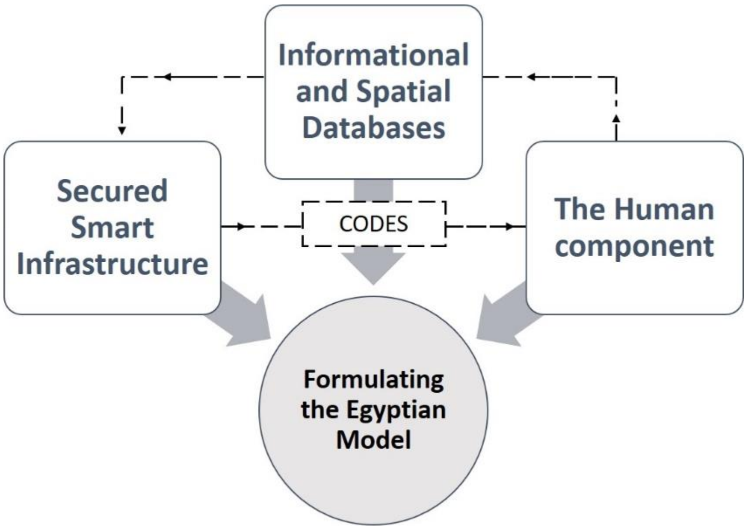
IoT has been adopted by the NAC as part of the fourth-generation of cities. In the first era of cities, steam power drove the development of comprehensive infrastructure, followed by the second wave of cities based on the industrial revolution, followed by the third era of automated services. However, they are not complementary to each other. Lately, the fourth-generation has depended on data and information analysis without human factor intervention; meanwhile, processes management is pivotal for developing decision-making into fourth-generation cities (Khalil & Mousa, 2021). In the NAC, technology plays a fundamental role besides the comprehensive view for the smart city model consisting of technology, education, and community awareness. Therefore, the Egyptian smart city model adopted ISO 37120 and ISO 37122 for sustainable cities and community indicators (ISO, 2018; Khalil & Mousa, 2021).

The NAC's smart city model consists of three main pillars, as shown in *Figure 14*. Its first pillar is its **secured smart infrastructure**, which makes the NAC distinctive, relying on high-tech infrastructure and utilizing artificial intelligence and data analytics to manage it. Furthermore, the **City Operating Center (COC)** and the **Commander Control Center (CCC)** manage and secure this infrastructure. Through the management, operation, and follow-up of the NAC's infrastructure and services, the COC is responsible for managing the technical and service operations controlling the NAC. In addition, the CCC controls and monitors the NAC's security, as well as providing central control and monitoring. In the smart city model, COC and CCC comprise the first pillar (secure smart infrastructure) of the NAC.

In *Figure 15*, the Security Control Center and City Administration Center rely on these databases for their administration. Secondly, the **spatial and informational databases** pillar provides unified rules at the city level that include geographic data. Thirdly, administration and society depend on **the human component** pillar. Through smart applications for city services, the model integrates the human factor in collecting data from citizens. Furthermore, trained, and skilled people are used to manage operations within the NAC. The model uses what is known as a set of codes to achieve integration between these three pillars (Khalil & Mousa, 2021). These codes mean that service providers, developers, mediator (ACUD), and citizens are required to adhere to a group of building and planning requirements in order to ensure the integration of the three pillars (see Appendix 4 – interview report 2). The Egyptian government plans to apply the NAC model to all fourth-generation cities in the second stage, and existing cities in the third stage (Khalil & Mousa, 2021).

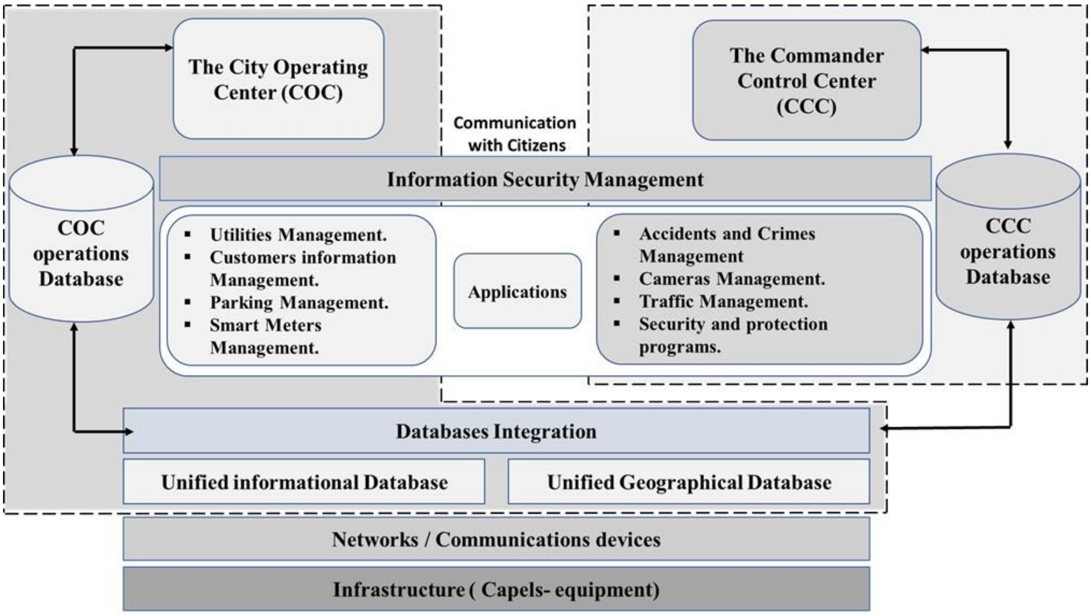
In conclusion, the efforts and initiatives underway in the NAC to establish its high-level innovation ecosystem are being enhanced by the offering of high-quality urban services. These services have the ability to attract people to the NAC. As a result, integrating local and regional innovation components in these new urban centers is essential, not only as a tool for urban planning and services, but also to foster innovation-driven regional development.

Figure 14. Pillars of the Egyptian smart city Model



Source: Own representation, based on the data from the ACUD.

Figure 15. Smart Services application model for the New Administrative Capital



Source: Own representation, based on the data from the technology and systems sector of the Administrative Capital for Urban Development Company (ACUD, 2021).

3.3 Conclusions Based on Policy Documents and Interviews

The reviewed policy documents and discussions with senior officials on Egypt's innovation-driven regional development policy provide useful information and insights which can be summarised as follows:

- Looking at the current social and economic context and the main trends in the country, Egypt **faces many challenges**. For example, the distribution of economic activities and people in the country is not balanced. Secondly, the Egyptian government faces a significant problem of rapid population growth. Due to the scarcity of habitable land, it is important to create new urban centers (in less favoured areas) to alleviate the large spatial disparities. The Egyptian government has launched the Egypt Vision 2030 on *balanced* regional development to address these difficulties and concerns that the Egyptian state is facing. The interviews also revealed that the development of the 14 new cities is a top priority over the development of existing cities. First, **the creation of new cities is absolutely necessary, as the infrastructure and services of existing cities may reach their capacity limits due to massive population growth.** The creation of new cities creates an opportunity to accommodate people while also reducing overpopulation in existing cities. Secondly, it has also been shown that the possibility of upgrading existing cities into smart cities may face various constraints, and that even the creation of new cities can be less financially burdensome for the state.
- Egypt Vision 2030 sets out an ambitious plan to **build new cities with strong innovation ecosystems to promote innovation-driven regional development**. Based on the review of the policy documents, the government plans to promote the development of several elements of the innovation system in new cities to achieve this goal. These include fourth-generation universities, knowledge centers, and CBDs, which are important institutions for fostering knowledge exchange, production, and commercialization. It is important to stress, however, that these new cities are (and will be) *smart cities* with high quality physical infrastructure and other ICT-enabled urban services. It is important to see that these new cities can be found in areas with poor geographical conditions. Thus, **the use of smart technologies in resource/energy-poor environments is essential for the efficient functioning of these new cities**. Meanwhile, the interviews revealed that smart cities can support a collaborative innovation ecosystem in a number of ways. On the one hand, high quality urban services attract people to these cities with the promise of a high quality of life. On the other hand,

making the physical environment, infrastructure, and services work with cutting-edge ICT technologies creates additional business opportunities for innovators and entrepreneurs. *Open data platforms* (digital solutions that continuously collect data on urban life), for example, allow anyone to develop new applications and services to address urban challenges. Smart cities support *community (open) innovation* through these open data platforms, which means that the residents, entrepreneurs, and other stakeholders actively interact and collaborate, and work together to develop and implement of new technologies, services, and projects. Moreover, the city administration can actively involve different local actors in the design and deployment of urban development and technological solutions. Based on the documents and interviews, I conclude that **the viewpoint of the Egyptian policymakers regarding the role of smart cities in fostering innovation aligns with the conclusions of the literature***:* it is in full accordance with the theoretical underpinnings of smart cities literature (outlined in Chapter 2.3.4), notably with the model proposed by Appio (2019).

- Chapter 2.2 highlighted that the availability of local and regional competencies and capacities is critical for the success of innovation-driven regional development. It follows that **the innovation capacity of Egyptian governorates, reflecting the performance of their Regional Innovation Systems (RIS), clearly determines the likelihood of an appropriate innovation ecosystem in the designated new cities**. In other words, investments in new cities will only be effective if a solid foundation of human resources, innovation inputs, and outputs is in place. The findings in Chapter 3.2.2 reveal that regional circumstances vary considerably between Egyptian governorates.
- The interviews found that the NAC model could serve as a model for other smart city projects. However, **the territorial and geographical context of the governorates**, as well as **their innovative capabilities, need to be considered**. Given the significant differences in regional conditions and the availability of skilled human resources, it would probably not be appropriate to replicate the same model used to create the New Administrative Capital (NAC) in other cities. These aspects should be considered in the development and design of new city centers.

In summary, Egypt's strategy to achieve innovation-driven balanced regional development through the creation of 14 new urban centers is an ambitious plan that **requires an assessment of the existing innovation capacities and competencies of Egyptian governorates**, i.e., considering **innovation capabilities at the regional level.**

4. Measuring Innovation Capacity in Egyptian Governorates

The chapter's aim is to assess the regional innovation capacity in Egyptian governorates. The aim is to assess the innovation potential of local and regional factors and competencies. The literature review presented in Chapter 2.2 underlines that local endogenous factors, capabilities, and the local and regional context play a significant role in supporting innovation. Furthermore, the analysis of policy documents and interviews in Chapter 3 highlighted that the successful functioning of new cities as innovation hubs is determined by the innovation capacities of the sub-national territorial units, the governorates, that host them. These governorates' inputs and capacities can serve as a basis for promoting innovation in new urban centers.

Consequently, the fourth chapter of the dissertation addresses the third research question, RQ3: *What is the innovation capacity of the Egyptian governorates? Which Egyptian governorates have the most innovation capacity to foster innovation-driven regional development in new cities?*

In Chapter 4.1, I draw on the relevant literature to examine the definition of innovation capacity. I also review the main components that make up the conceptual framework model of regional innovation capacity. Chapter 4.2 provides a thorough description of the methodology used in the study, which includes three different analyses. Chapter 4.3 presents the main results. First, I assessed the innovation capacity of Egyptian governorates using a composite indicator methodology. Second, I used K-means cluster analysis to categorize governorates according to their innovation capacity. Finally, I examined regional innovation capacity using spatial autocorrelation measures such as the Moran I index and the Local Indicators of Spatial Association (LISA). This allowed me to assess the similarity in the spatial structure of innovation capacity and to identify spatial clusters among Egyptian governorates. Section 4.4 concludes with a summary of the analysis.

4.1 Definition and Conceptual framework of Innovation Capacity

Regional innovation capacity (RIC) is defined as the ability of a region to generate, adapt and support innovation within a given local area, while generating economic benefits. It comprises a region's capacities, resources, and contextual conditions that encourage and promote innovation-driven activities. This notion has acquired popularity in economic geography, especially in the framework of a knowledge-based economy (Powell & Snellman, 2004). RIC has an impact on the outputs of innovation activities (Riddel & Schwer, 2003; Schiuma & Lerro, 2008). It refers to an area's or country's ability to engage in innovation such as the introduction of new goods, services, procedures, processes, and ideas that are unique to that region (Pournasr, 2012). Furthermore, according to Balconi et al. (2004), innovation capacity is an intermediate component that turns stimulating inputs and innovative motivations into outputs such as product and process innovation (Balconi et al., 2004; Pournasr, 2012).

Many research studies have been carried out to study the factors influencing regional innovation capacity. There are main components that are frequently mentioned or used as indicators for measuring regional innovation capacity in the literature. R&D investment, human capital, infrastructure, knowledge creation, knowledge utilization, and innovation support institutions are all essential components (Furman et al., 2002; Cooke, 1992). R&D investment is generally stated as a percentage of GDP spent on R&D as a measurement of the resources allocated to innovation. Human capital refers to the workforce's abilities and knowledge, and it is often measured by counting the number of scientific and engineering graduates. Universities, research institutes, and broadband internet are examples of infrastructure, which includes both physical and technical factors that promote innovation. The sharing of information among diverse players in the region is referred to as knowledge production, and it is frequently evaluated by the number of patents and publications. The number of new businesses and start-ups established is used to quantify knowledge utilization, which entails leveraging knowledge to produce new goods, services, and processes. Universities, research institutes, and business incubators, accelerators are examples of innovation support institutions. Many additional elements, such as the culture (Florida, 2002; Saxenian, 1996), the regulatory environment (Autio & Thomas, 2014; Edquist, 2005), and the availability of funding, also contribute to influencing innovation capacity of regions (Czarnitzki, 2006; Berger & Udell, 2006). The culture of innovation comprises the attitudes and ideas that encourage innovation, such as a willingness to take chances and a tolerance for failure. The regulatory environment includes the laws and regulations that regulate innovation and have a substantial influence on organizations' capacity to innovate. Moreover, the availability of funding refers to the availability of loans, grants, and other sources of financing for innovation, which may be a significant obstacle for small and medium-sized businesses looking to innovate. While analyzing regional innovation capacity, it is critical to consider the major factors and components listed above.

Several scholars and academic institutions have proposed numerous approaches and frameworks for measuring regional innovation capacity. The Furman framework, developed by Furman et al. in 2002, is one such approach. This approach specifies three critical RIC dimensions: 1. innovation inputs, which include innovation-related resources such as R&D expenditure, human capital, and infrastructure. 2. the actors involved in the innovation process, such as corporations, universities, and research institutes, are referred to as innovation subjects. 3. the innovation environment, which includes variables that promote innovation such as the regulatory climate, financial availability, and the culture of innovation. Additionally, multiple models, among them the Saxenian model (Saxenian, 1994) and the Florida model (Florida, 2002), have been used to measure RIC in addition to the Furman framework. Furthermore, the Regional Innovation Systems (RIS) approach, developed by Cooke in 1992, is a widely employed approach for assessing RIC. This approach views a region as an integrated network of actors working together to produce, diffuse, and utilize knowledge. For example, the European Commission's Regional Innovation Scoreboard (RIS) framework[24], offers a quantitative assessment of regional innovation performance based on numerous factors.

As previously indicated, regional innovation capacity refers to a region's entire ability to develop, absorb, and utilize innovation. It includes aspects such as regional research and development institutions, human resources, infrastructure, networks, and supporting policies. A Regional Innovation System (RIS), on the other hand, is the structure or framework within which innovation activities take place in a certain region. This system includes interactions, connections, and institutions that support regional innovation and knowledge exchange. It brings together and coordinates the actions of numerous players such as universities, research institutions, corporations, government agencies, and other stakeholders to stimulate innovation in the region.

In essence, regional innovation capacity reflects a region's total ability and resources to participate in innovation, whereas a Regional Innovation System refers to the specific procedures, networks, and interactions that enable and promote regional innovation activities. Both notions are intertwined and essential for comprehending and supporting innovation within a certain region. As a result, according to the literature, **regional innovation capacity is seen as a measure of the RIS's performance**.

4.1.1 Conceptual framework model

The innovation capacity of the governorates in Egypt was assessed by constructing a composite indicator called as the *Regional Innovation Capacity Index* (RICI). Both the conceptual

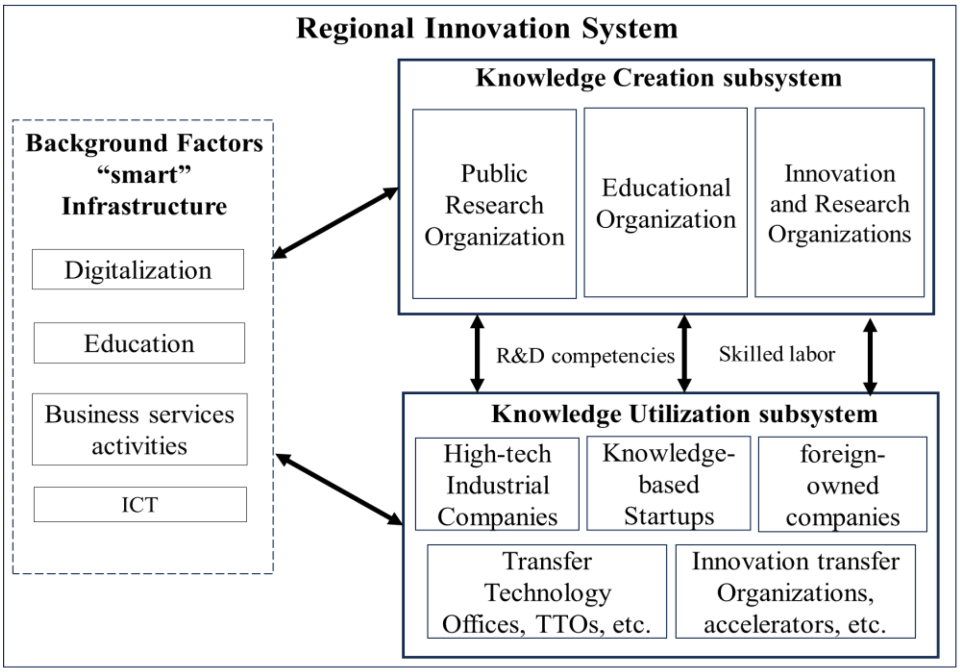
[24] Detailed description of the EC Regional Innovation Scoreboard framework: https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en (available 18th February 2023)

framework and methodology used in Chapter 4 is based on the study of Bajmócy and Kanó (2009), which examined the innovation capacity of Hungarian small regions.

In their study, Bajmócz and Kanó (2009) based their analysis of regional innovation capacity on Trippl's (2006) conceptual framework model, which describes the basic components of a Regional Innovation System (RIS). Trippl (2006) emphasizes that in order to better understand the structure of RIS, it is necessary to focus on three key subsystems and fundamental dimensions: knowledge production, knowledge exploitation and the underlying factors that constitute the 'smart' infrastructure (*Figure 16*). To gain a more complete overview of the innovation capacity of Egyptian governorates, I apply the above conceptual framework, which examines the subsystems of the Regional Innovation System. (It is important to note that the background factors referred to as "smart" infrastructure in the index's construction are distinct from the "smart infrastructure" mentioned in the dissertation's second chapter, which is a key component of the smart city concept.)

- ***Knowledge Creation*** subsystem: The subsystem of *Knowledge Creation* encompasses organizations involved in the production and dissemination of knowledge, expertise, and skills within a Regional Innovation System (RIS) (Asheim et al., 2005; Trippl, 2006). Furthermore, efficient knowledge creation is dependent on the coordination of complementary knowledge elements among different actors and organizations (Boschma, 2005). *Public research organizations, educational organizations* such as universities, research centers, polytechnics, and vocational training institutions, as well as *innovation and research organizations* such as patent offices and innovation centers, are key actors in this subsystem. It denotes the capacity for generating scientific and technological knowledge (Bajmócy & Kanó, 2009). It is worth noting that some methods limit innovation to the knowledge creation subsystem (Porter and Stern, 2002), equating research and development (R&D) with innovation. Knowledge creation and innovation, on the other hand, are frequently accumulating processes that rely on the capacity for learning (Lalrindiki & O'Gorman, 2021).

Figure 16. Key elements of a conceptual framework for measuring RIS



Source: Own modification of Trippl (2006)

However, efficient knowledge utilization or exploitation necessitates absorptive capacity, which entails finding, understanding, and utilizing new knowledge (Boschma, 2005). Since R&D does not necessarily result in innovation (OECD, 2018), given the complexity of RIS, it is essential to examine the Knowledge Utilization subsystem as part of the Regional Innovation System performance.

- ***Knowledge Utilization*** subsystem is an essential part of the Regional Innovation System (RIS). Tödtling and Trippl (2005) describe RIS as an open framework that includes not just the knowledge creation subsystem, but also knowledge application and exploitation, as well as their interconnected systems and influencing policies. The knowledge exploitation subsystem seeks to comprehend the features of the private sector that can utilize innovations (Bajmócy & Kanó, 2009). Knowledge Utilization is the process of discovering opportunities, gaining external knowledge, integrating it with current knowledge, and using it to generate innovation (Pournasr, 2012). It necessitates the ability to receive, understand, and apply knowledge from a variety of sources, such as research organizations and industrial partners. Moreover, the knowledge utilization subsystem inside the RIS focuses on the business dimension (Trippl, 2006).

The knowledge utilization subsystem, as depicted in *Figure 16*, is made up of various organizations located in the region, such as high-tech industrial companies, knowledge-based startups, foreign-owned companies with knowledge-based operations, transfer technology offices (TTOs), and innovation transfer organizations such as accelerators (Bajmócy & Kanó, 2009). These players are critical in exploiting knowledge within the RIS (Tödtling and Trippl,2005). The Knowledge Utilization subsystem is critical to the RIS (Lalrindiki & O'Gorman, 2012). Its major objective is to ensure that knowledge created inside the system is effectively applied, utilized, and transformed into new products, processes, or services (Hamidi et al., 2019). This subsystem goes beyond knowledge creation by emphasizing the concept of practical application and commercialization (Pournasr, 2012).

The RIS can promote the development of new goods, services, and processes, as well as improve current ones, by properly exploiting knowledge. It promotes technological transfer, collaboration among multiple actors, and the diffusion of innovation within the regional ecosystem (Juhász & Lengyel, 2018). Effective knowledge utilization boosts the RIS's competitive advantage, supports economic growth, and improves the region's overall innovation performance.

In conclusion, the Knowledge Utilization subsystem serves as an important connection between knowledge creation and innovation inside the RIS. It implies that the knowledge generated is implemented realistically and transformed into actual outputs, so contributing to the region's innovation capacity and economic development.

Further, *Figure 17* illustrates the impact of research and development competencies and skilled labor on the two sub-systems of knowledge creation and utilization. Theoretically, the presence of these elements within a region directly influences the performance of a Regional Innovation System, making it more effective (Trippl, 2006).

- ***Background factors "smart" infrastructure*** subsystem***:*** The "smart" infrastructure subsystem represents the underlying factors required for the operation of the knowledge creation and knowledge utilization subsystems, as shown in *Figure 16*. Under the framework of globalization, the phrase "smart" infrastructure has emerged, including both physical and intangible aspects necessary to support innovation, the industry sector, and advanced production services (Stimson et al., 2006). The concept of "smart" infrastructure offers a framework for arranging various underlying these background factors (Stimson et al., 2006). It includes both physical infrastructure, such as digitization and ICT, and intangible aspects, such as knowledge-intensive business services that help businesses in the region learn (Bajmócy & Kanó, 2009).

The literature emphasizes the importance of knowledge creation, knowledge utilization, enabling background factors (i.e., "smart" infrastructure), and the complex system of interactions that exist between them. As a result, while analyzing a region's innovation capacity, it is critical to investigate these subsystems in-depth, emphasizing their interconnectedness (Bajmócy & Kanó, 2009). According to *Figure 16*, the background factors of "smart" infrastructure include elements of digitization, education, innovative business services, and ICT. These aspects promote and facilitate the performance of the RIS by providing the infrastructure required for innovation. Theoretically, including these background elements in the RIS improves system performance, leading to increased innovation capacity.

4.2 Methodology

I used the same empirical methods used by Bajmócz and Kanó (2009) in their work to accomplish the aim of Chapter 4, which focuses on evaluating and analyzing the innovation capacity of Egyptian governorates. This method includes three major analyses: 1) the development of a composite indicator, 2) K-means cluster analysis, and 3) spatial autocorrelation analysis.

The development of Regional Innovation Capacity Index (RICI) composite indicator for Egypt's governorates requires a three-stage procedure. The first stage involved **selecting and organizing** a comprehensive set of pertinent indicators that represent the sub-indices of innovation capacity. As shown in *Table 9*, these sub-indices refer to knowledge creation, knowledge utilization, and "smart" infrastructure. Each sub-index was produced by determining a group of indicators. My aim was to include in the analysis the same indicators used in the Bajmócy-Kanó (2009) paper. Unfortunately, some of the indicators were not available for the Egyptian governorates, which led to their exclusion. However, where possible, some of the missing indicators were replaced by available alternatives that captured the essence of the original indicators.

The **knowledge creation sub-index** assesses a region's capacity for contributing to knowledge production through innovation, experimenting, and learning. As a result, because they are the key sources of knowledge creation, this sub-index focuses on variables that *indicate research, development, and higher education*. The indicators chosen include the number of R&D performing units (scientific research and development), total staff of R&D units, number of scientists with PhD, number of teaching staff of higher education, expenditure R&D for higher education and government centers, number of patents, employees' number in scientific & research centers, and the number of scientific & research centers. *Appendix 7* has a detailed table defining the name, description and definition, year, and source of data for all indicators for the three sub-indices. I used eight indicators in the knowledge creation sub-index. Although the number of indicators used is the same as the number of indicators used by Bajmóci and Kanó (2009), nevertheless, the indicator "Investments of R&D units" was replaced in my study with the "Number of Scientific & Research centers" in the governorates due to the unavailability of data for the same indicator used in their study. In addition, my study includes the indicator "R&D expenditure in higher education and government centers" to measure knowledge creation, which can effectively indicate expenditure on R&D units.

Table 9. Indicator set for measuring innovation capacity in Egyptian governorates.

Sub-indices		**Indicator**
Knowledge creation sub-index	1	Number of R&D performing units (scientific research and development) per 100000 inhabitants
	2	Total staff of R&D units per 10000 inhabitants
	3	Number of scientists with PhD per 10000 inhabitants
	4	Number of teaching staff of higher education per 100000 inhabitants
	5	Expenditure R&D for Higher education and government centers Per capita
	6	Number of patents per 10000 inhabitants
	7	Employees Number in Scientific & Research Centers per 10000 inhabitants
	8	Number of Scientific & Research Center per 100000 inhabitants
Knowledge utilization sub-index	1	Number of knowledge-based startups per 100000 inhabitants
	2	Number of foreign-owned companies per 10000 inhabitants
	3	Number of accelerators/incubators per 100000 inhabitants
	4	Number of TTOs/TICO (transfer tech. offices) per 100000 inhabitants
	5	Employment in high-tech industries (Location Quotients (LQs)
“smart” infrastructure sub-index	1	Number of full-time students in higher education institutions per 1000 inhabitants
	2	Employees Number in telecommunications per 10000 inhabitants
	3	Number of innovative service providers units per 100000 inhabitants
	4	Number of employees of innovation-based business services activities (BUS) per 10000 inhabitants
	5	Percent of the population using the Internet

Note*:* The source of data: Central Agency for Public Mobilization and Statistics (CAPMAS, 2017) (indicators 1-5, 7,10,13, 17, and 18; reference year: 2017), The Egyptian Science, Technology and Innovation Observatory (ESTIO) at the Academy of Scientific Research and Technology (ASRT) (indicators 6 and 8; reference year: 2018), EgyptInnovate 2020, cooperated with Ministry of Communications and Information Technology, https://egyptinnovate.com/en/innovation/map (indicators 9, 11,12), Central Agency for Public Mobilization and Statistics (CAPMAS, 2021)(indicators 14-16; reference year: 2018)
Source: own construction based on the data of (CAPMAS, 2017; Capmas, 2021; Ministry of Higher Education and Scientific Research Egypt, 2019; MoHUUC, 2020)

The **knowledge utilization sub-index** measures a region's capacity to successfully use the knowledge created inside its borders to create value. This sub-index includes measures focusing on the private sector's ability to exploit knowledge and innovation within the Regional

Innovation System. Consequently, it includes indicators for the "Number of knowledge-based startups" as well as "Accelerators and business incubators." The latter indicator is included in the knowledge utilization sub-index since it used knowledge provided by the education and research communities, such as patents. Furthermore, the knowledge utilization sub-index includes indicators such as "The number of technology transfer and application offices" in the region, "The number of foreign-owned companies," and "The location quotient of high-tech industries" relative to the total number of industries in the region. The latter indicator reflects the region's capacity to absorb and use knowledge through high-tech industries. Consequently, the sub-index for knowledge utilization was built using a total of five indicators. In contrast to Bajmócy and Kanó (2009), who used nine indicators in their study. This decision was made based on the availability of data. As a result, four variables were excluded: "export sales as a proportion of total sales," "export sales per inhabitant," "income from intellectual properties," and "share capital of foreign-owned companies as a percentage of total share capital". In my study, I chose the remaining five indicators used by Bajmóczy and Kanó (2009), with some modifications, as I combined three of their five indicators. These three variables concerned the total number of companies in various segments of the high and medium technology industries. In my study, I created a single indicator that represents the location quotient of knowledge-based technology industries. This proxy indicator is essentially the same as their three original indicators of the adapted study. At the same time, I included two additional indicators: the number of technology transfer and application offices, as well as the number of accelerators and business incubators. These five indicators, taken together, give useful insights into the knowledge utilization sub-index.

The **"smart" infrastructure sub-index** includes background factors that improve a region's knowledge utilization and learning ecosystem. It systematizes the factors necessary for the operation of the other two sub-indices, notably the presence of "talent." This sub-index includes five indicators: "the number of full-time students enrolled in higher education," "the number of employees in the ICT sector," "the number of innovative service provider units," "the percentage of the population using the Internet," and "the number of employees engaged in innovation-based business service activities."

In my study, the "smart" infrastructure sub-index is made up of five carefully chosen indicators. Unlike the original Bajmócy and Kanó (2009) study, which included nine variables for the "smart" infrastructure sub-index. Two important criteria impacted the selection of these indicators: data availability and the specific aims of my investigation. My research focuses on determining which governorates have the most innovative potential to enable the effective implementation of the planned innovation-driven smart city initiative. As a consequence, the indicators used were customised to completely correspond with this goal. This methodological improvement promotes the relevance and applicability of my study findings and contributes to a more comprehensive knowledge of the subject. Consequently, four variables were eliminated: "registered members of public libraries," "cinema visits," "museum visitors," and "tourist arrivals at public accommodations." Furthermore, in my analysis, I replaced the indicator "broadband internet access" with the indicator "Percent of the population utilizing the Internet." Additionally, instead of the indicator "Percent of white-collar workers among all employees" from their study, I used in my analysis the indicator “employee count in the ICT industry”. The ICT sector is considered to be one that relies on skilled employees with knowledge, talent, and a solid education. As mentioned in the theoretical framework, this is viewed as a critical aspect in strengthening the innovation ecosystem in the designated new cities. By including these five indicators in the "smart" infrastructure sub-index, I aim to reflect elements that facilitate the functioning of the other two sub-indices, knowledge creation and utilization.

To calculate the composite indicator of regional innovation capability in Egyptian governorates, a total of eighteen indicators were gathered and categorized into three sub-indices. Although the composite indicator method used to assess regional innovation capacity in Egypt's governorates gives insight into innovation performance, it has some limitations. Firstly, data accessibility and its quality are the main challenges since governorate-level data on innovation and knowledge is restricted. Secondly, sub-indices indicators are restricted, since there is a need for appropriate indicators on knowledge utilization and R&D in the private sector. Further data on these variables might have a significant influence on the composite index results and its sub-indices. Thus, while the composite indicator approach is useful for evaluating regional innovation capacity, these constraints must be considered when interpreting the results.

In the second stage**, I calculated the three sub-indices and finally the RICI from the created data set**. The operationalization of the RICI includes the following steps:

1) Determination of the overall structure of the RICI (conceptual framework explained in Chapters 4.1.1)
2) Determination of the indicator composition of RICI sub-indexes
3) Calculation of sub-index values
    a. Knowledge creation subindex
    b. Knowledge utilization subindex

c. “Smart” infrastructure subindex

4) Calculation of the overall RICI value

To assess the performance of innovation systems and capacity, composite indicators are widely used. They are useful tools because they give a thorough and concise method of assessing and comparing a country's or region's overall performance. Composite indicators have various features, including comprehensiveness, simplicity of understanding, comparability, and policy-relevant benefits (Nardo et al., 2005). Comprehensiveness pertains to the capability of composite indicators to encompass several dimensions of the examined phenomenon, encompassing aspects such as social, economic, and demographic, etc. They provide a straightforward depiction of a region's or country's capacities, allowing researchers and policymakers to easily comprehend and compare results. Composite indicators enable comparison among various regions or countries, offering valuable insights into the strengths and weaknesses of the examined territorial units. Ultimately, the findings of the index hold policy relevance, enabling policymakers to improve policy decisions and identify bottlenecks that necessitate further attention in capacity building. Notwithstanding their benefits, composite indicators have limitations and challenges. The data utilized to produce the indicators may have limits of its own, and appropriately weighing the different indicators can be challenging (Churchie et al., 2007). Moreover, composite indicators have a number of drawbacks, including the capacity for sending false policy messages if poorly created or misinterpreted. If their creation lacks transparency or statistically invalid conceptual foundations, they may lead to unduly simplified policy findings or be misapplied to promote desired policies. Moreover, the selection of indicators and their weights may become a source of political dispute. Composite indicators may obscure major flaws in specific regions, making it difficult to identify suitable corrective procedures if the building process is ambiguous. They may also result in ineffective policies if they overlook difficult-to-measure performance characteristics (OECD, 2008). Consequently, it is critical to use caution when interpreting composite indicators and to supplement them with further research. The following provides a detailed explanation of the methodological steps[25]:

1. *Reliability Analysis*. Firstly, the indicators are subjected to a Reliability Analysis, which is used to determine the extent of consistency between these sub-indicators and whether they should be used together to form a composite indicator. The Cronbach coefficient

[25] For implementing the steps of the first analysis of the methodology, SPSS 23 statistical software was used to build a composite indicator as well as sub-indicators of the ability of Egyptian governorates to innovate.

alpha (c-alpha)[26] was used in the investigation. Cronbach's alpha of 0.923 shows that the indicators very accurately assess the same underlying component. This indicates that the scale has good reliability. The results of this analysis are shown in *Appendix 8.*

2. *Imputation of missing data*: the dataset did not need missing data imputation because there were no missing values for the indicators utilized.
3. *Standardization*: I processed the data for indicators for each governorate by standardizing them by population, since there are different spatial units.
4. Data Normalization: It is a necessary step before aggregating data as indicators in a dataset often have different measurement units. There are many methods of normalization. In my analysis, I used the min-max re-scaling method for normalization. To determine the normalized value for each sub-indicator, the minimum value must be subtracted from the indicator value, and then the result must be divided by the indicator range (the difference between the indicator maximum and minimum values). In this manner, each rescaled value falls between 0 and 1. The following equation is used to normalize the indicator:

$$I_{qc}^{t} = \frac{x_{qc}^{t} - min_c(x_q^t)}{max_c(x_q^t) - min_c(x_q^t)}$$

, where x_{qc}^{t} is the value of the indicator, $min_c(x_q^t)$ and $max_c(x_q^t)$ are the minimum and maximum values of the indicator. Thus, the indicators that are normalized I_{qc} have values ranging from 0 where $x_{qc}^{t} = min_c(x_q^t)$ to 1 where $x_{qc}^{t} = max_c(x_q^t)$.

5. Aggregation of sub-indexes. The different sub-indices are determined by the arithmetic average method for the values of the indicators associated with the sub-indices. The following equation is used to determine the arithmetic average value for the sub-index:

$$\text{Arithmetic Average} = \sum xi / n$$

, where, xi = i indicators and n = number of indicators.

[26] It is a parameter for measuring the internal consistency of a set of partial indicators, i.e., how well the group describes a structure with a one-way pattern. The higher the value of this coefficient, the greater the degree of internal consistency between the sub-indicators. See (Cortina, 1993)

6. It is possible to provide weights to the various indicators that comprise the composite indicator when using methodologies for creating composite indicators. This weighting enables certain indications to be given more weight than others. However, while developing the RICI to assess the innovation capacity of Egyptian governorates, it is critical to assess the governorate's overall capacity, taking into consideration the importance of all indicators of the RIS. This necessitates giving equal weight to all individual indicators in the composite index. Furthermore, I lacked knowledge about the weights assigned to the indicators, which would have allowed me to prioritize certain indications over others.
7. Calculation of the RICI:

$$RICI = (\text{Knowledge Creation Subindex } i + \text{Knowledge Utilization Subindex } i + \text{“smart” infrastructure subindex } i)/3$$

where i =1, 2…, n represents the number of regions.

In the third stage, based on the RICI composite indicator and its sub-indexes, I offered a **comprehensive analysis and classification** based on the innovation capacity of the Egyptian governorates.

The second analysis employed in this study was the **K-means cluster analysis**, which aimed to classify the Egyptian governorates based on the three subindex values of the Regional Innovation Capacity Index (RICI). This analysis contributed to categorizing the governorates into distinct clusters, providing a better understanding of their innovation capacity. Geoda 1.14 was used to conduct the analysis. For this analysis, I used the same method as Csizmadia and Rechnitzer (2005) and Bajmócy and Kanó (2009). For the RICI, I used the normalized values of the three sub-indices to perform a K-means spatial cluster analysis. Three, four, and five clusters were used in the analysis. The classification, however, did not appear to be especially stable, since increasing the number of clusters resulted in further divides within specific groups, resulting in changes in the content of the different clusters. The three and four-cluster configurations were made up of a collection of governorates with varying features, capabilities, and geographical regions that were all considered as a single cluster. It was discovered that generating five clusters resulted in the establishment of the most homogenous and readily interpretable clusters by assessing the dispersion of distances from the cluster center.

The third analysis of the methodology involved examining the **spatial regularities of innovation capacity** across Egyptian governorates, including whether adjacent territorial units had similar or differing data. The method is called spatial autocorrelation, which is defined as the positive or negative correlation between a variable and itself based on its spatial location (Bouayad & de Bellefon, 2018). There is a systematic pattern in spatial distribution that can be described by spatial autocorrelation. There is usually positive and/or negative spatial autocorrelation among variables in the spatial distribution, or there is no spatial autocorrelation at all. My approach to measuring spatial autocorrelation was to use two types of Moran I analyses: a global spatial autocorrelation analysis on a national scale and a local spatial autocorrelation analysis using local Moran indices on a governorate scale.

(1) *Global Spatial Autocorrelation Analysis* enables us to measure spatial autocorrelation by considering both the location and value of features simultaneously. Given a set of features and an associated attribute, the algorithm determines whether a pattern is clustered, dispersed, or random. There is basically a cross-product of a variable and its spatial lag, expressed as a deviation from the mean. Moran’s I statistic (Anselin, 1995, 2005) is probably the most widely used indicator of global spatial autocorrelation. Additionally, this analysis allows us to determine whether the variables in the data set are spatially autocorrelated. The following equation is used to calculate Moran’s I:

$$I = \frac{M}{\sum_{i=1}^{M}\sum_{j=1}^{M} w_{ij}} \frac{\sum_{i=1}^{M}\sum_{j=1}^{M} x_i w_{ij} x_j}{\sum_{i=1}^{M} x_i^{2}}$$, where

- *I* represent the Moran Index.
- *M* represents the total number of spatial units or observations, in my analysis 27 Governorates.
- *wij* represents the spatial weight between unit *i* and unit *j*.
- *xi* and *xj* represent the attribute values of units *i* and *j* respectively.

Given the multiple interpretations of the neighborhood of territorial units, it is possible to create various neighborhood matrices. In this case, I employed the 'first-order queen' contiguity as the foundation. This contiguity implies that the value of *wij* is assigned 1 if subregions *i* and *j* share a border area, and 0 otherwise. The extent of autocorrelation is determined by the size of the pseudo-significance level produced using the Monte Carlo method, as well as the algebraic sign of the value. Additionally, the real Moran I value, as given in *Table 10*, indicates the direction of autocorrelation.

Additionally, this analysis allows us to determine whether the variables in the data set are spatially autocorrelated. Thus, the local spatial autocorrelations within local clusters can also be run as the second type of analysis.

Table 10. The interpretation of the Moran Index

Significance	**Index value**	**Interpretation**
P< 0,05 and	I < -0.0384	Strong negative autocorrelation
0,05 ≤ p < 0,1 and	I < -0.0384	Weak negative autocorrelation
0,1 ≤ p		Autocorrelation is not significant
0,05 ≤ p < 0,1 and	I > -0.0384	Weak positive autocorrelation
p < 0,05	I > -0.0384	Strong positive autocorrelation

Note: „p" stands for pseudo-significance. Index value must be compared to -1/(M-1) (Anselin & Rey, 2014), which in the governorates database, has a value of -0.0384
Source: own construction on the basis of Bajmócy and Kanó (2009)

(2) *Local Spatial Autocorrelation Analysis* helps us to study the spatial clusters or patterns in a dataset. It examines whether the values of a variable exhibit spatial dependence or spatial autocorrelation. (Huallachain & Leslie, 2007). In addition, significant local spatial association leads to a study of geographical patterns associated with the particular indicators within spatial units (Anselin, 2005; Anselin & Rey, 2014).

The methodology uses Local Indicators of Spatial Association (LISAs), which are a class of local statistics that measure the spatial clusters of subregions within a given geographical area. LISAs examine the relationship between a certain location and its nearby locations at the local level. To find out if there is a spatial relationship, the basic idea is to compare the attribute value at one site with the attribute values of its nearby locations. By producing a statistic for each place that shows the intensity and importance of the link, LISAs can quantify the level of local spatial autocorrelation. In addition to identifying local clusters, it can also identify spatial outliers (Anselin, 1995). Four categories of geographical patterns are recognizable thanks to these statistics. *Table 11* illustrates the differences between High -High (++), Low-High (–+), High-Low (+–), and Low-Low (– –) types of spatial associations (Getis, 2010). Often, variables with geolocated information depend on each other spatially, and this effect gets stronger as the locations get closer together. Due to the growing availability of spatial data, economic decisions can be analyzed in terms of interactions and spatial externalities. An examination of the spatial structures included in the data is crucial if there is a violation of the spatial independence hypothesis. As for interpretation, spatial autocorrelation analysis offers the possibility of quantifying the spatial structure of the phenomena (Bouayad & de Bellefon, 2018). LISA cluster maps using the Local Moran's I statistic are used to determine these spatial clusters, which are associated with positive spatial autocorrelation. The results of negative spatial autocorrelation represent spatial outliers (Anselin, 1995).

By combining the statistical data with the Egyptian map, the analysis focuses on the spatial regularities in innovation capacity across the Regional Innovation Capacity Index for Egyptian governorates. There are 27 cases in the database that refer to the Egyptian governorates. The spatial regularities use statistical data along with an Egyptian map to identify the relationship between the data and their location. Egypt's map was digitized using geographic information system (GIS) software. Statistical data have been merged with polygon IDs for governorates in the digitalized map. The analysis for this part was performed using GeoDa 1.14 software. In addition, the analysis utilizes 'first-order queen' contiguity. The term contiguity means that two spatial units share a common edge of non-zero length (Anselin & Rey, 2014, p. 36). Due to the multidirectional nature of space, the weighted sum of all values belonging to a particular continuity class was used to solve this problem. In order to analyse spatial data, spatial weights need to be applied. According to Anselin and Rey (2014), spatial weights are an essential component in cross-sectional analyses of spatial dependence.

Table 11. The interpretation of the Local Moran I Index

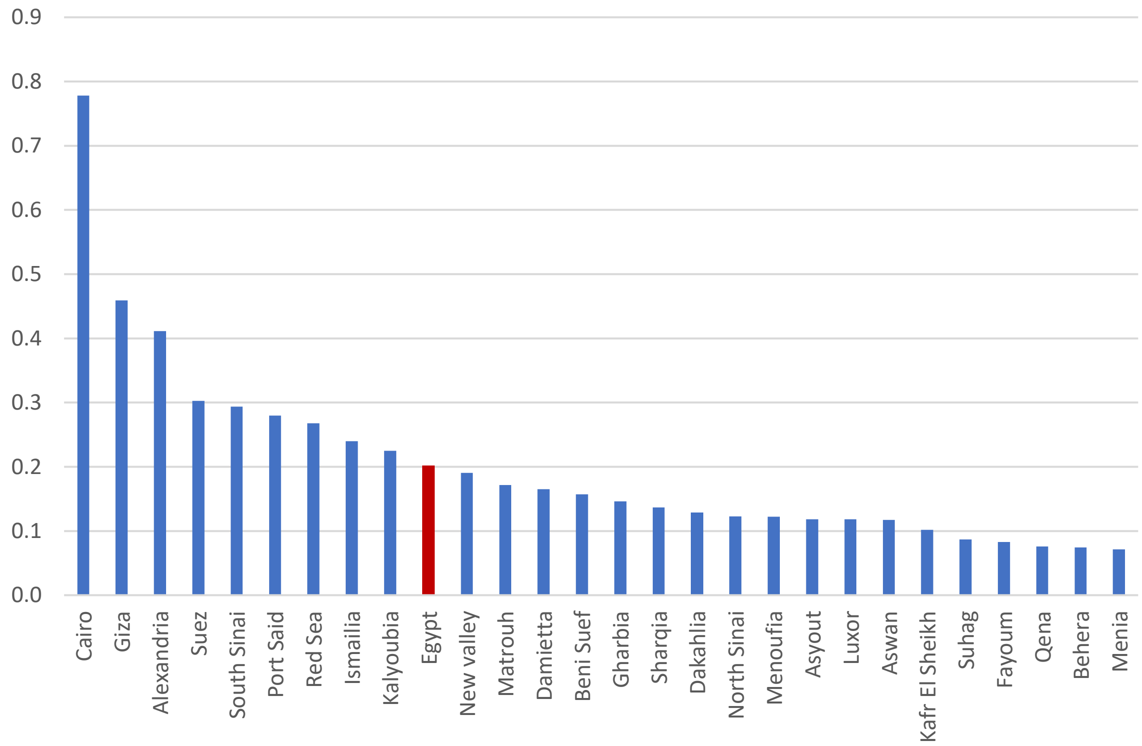
Clusters of autocorrelations	**Interpretation**	**Condition "p" represents pseudo-significance**
High-High	In the given governorate, as well as its neighboring, the index values are significantly high the average.	P-value < 0.05
High-Low	In the given governorate, the index values are significantly above the average, whereas their neighbors are below the average.	P-value < 0.05
Low-High	In the given governorate, the index value is significantly below the average, while the index value of its neighbors is significantly above the average.	P-value < 0.05
Low-Low	In the given governorate, as well as its neighboring, the index values are significantly below the average.	P-value < 0.05
Not significant	Correspondence is not significant	P-value > 0.05

Source: own construction

4.3 Results of Innovation Capacity Evaluation

Table 12 shows the scores and rankings for Egyptian governorates' sub-indices and scores of RICI. These scores are presented on a scale of 0 to 100, along with the appropriate rankings. *Appendix 9* also offers the scores and ranks for all indicators of the subindexes. According to the RICI, the main conclusion that can be drawn is that Egypt has enormous disparities in terms of innovation capacity (see *Figure 17*). In Egypt, there are only nine governorates with performance above the national average (20.17 RICI score). The Cairo Governorate (77.8 RICI score) is clearly superior not only in the RICI composite index but also in all of its sub-indices. Cairo Governorate is the best performer overall, it's performance is almost four times better than the average performance of the whole country, but it still scores 22 points below the hypothetical score of 100. In contrast, the performance of the other 18 governorates is below average. Thus, **innovation capacity is disproportionately concentrated in the northern governorates of Egypt, especially in the greater Cairo region and its surrounding areas.**

Figure 17. Overall innovation capacity of Egyptian governorates based on the RICI scores.



Source: own calculations

Table 12. The scores and rank of Egyptian governorates for the three sub-indices and the RICI

Governorates	**KC**	*Rank*	**KU**	*Rank*	**SI**	*Rank*	**RICI**	*Rank*
Cairo	75.28	1	62.16	1	95.96	1	**77.80**	1
Giza	61.27	2	32.00	2	44.53	5	**45.93**	2
Alexandria	41.55	3	22.00	5	59.90	2	**41.15**	3
Suez	25.54	7	21.48	6	43.76	7	**30.26**	4
South Sinai	23.63	9	20.31	7	44.09	6	**29.34**	5
Port said	27.50	6	4.14	18	52.33	3	**27.99**	6
Red Sea	12.42	19	18.33	8	49.57	4	**26.77**	7
Ismailia	28.22	5	13.16	10	30.61	8	**24.00**	8
Kalyoubia	16.61	12	23.45	4	27.37	11	**22.48**	9
Egypt Average	20.61	10	11.69	11	28.19	9	**20.17**	10
New valley	32.88	4	1.55	25	22.72	14	**19.05**	11
Matrouh	14.58	16	24.84	3	12.06	25	**17.16**	12
Damietta	17.29	11	4.07	19	28.13	10	**16.50**	13
Beni Suef	11.85	20	16.89	9	18.40	18	**15.71**	14
Gharbia	15.93	13	1.59	24	26.31	12	**14.61**	15
Sharqia	14.46	17	9.69	12	16.92	19	**13.69**	16
Dakahlia	11.71	21	2.55	21	24.46	13	**12.91**	17
North Sinai	23.92	8	5.54	16	7.44	28	**12.30**	18
Menoufia	14.97	15	2.62	20	19.04	17	**12.21**	19
Asyout	15.71	14	6.54	13	13.19	24	**11.81**	20
Luxor	12.82	18	6.48	14	16.10	21	**11.80**	21
Aswan	10.28	22	4.89	17	19.92	15	**11.70**	22
Kafr El Sheikh	9.32	23	2.15	22	19.11	16	**10.19**	23
Suhag	8.35	25	6.05	15	11.65	27	**8.68**	24
Fayoum	7.41	27	0.78	26	16.65	20	**8.28**	25
Qena	8.12	26	0.37	28	14.24	23	**7.58**	26
Behera	5.93	28	1.64	23	14.68	22	**7.42**	27
Menia	9.00	24	0.51	27	11.96	26	**7.15**	28
St. Deviation	**15.97**		**13.39**		**19.27**		**15.04**	

Note: KC: Knowledge Creation sub-index, KU: Knowledge Utilization sub-index, SI: "Smart" Infrastructure sub-index

Source: own construction

The RICI ranking did not reveal much surprise when it comes to the readiness and capability of Egyptian governorates to innovate, given the concentration of economic activity and innovation activities within the Greater Cairo Region (GCR, consisting of the governorates of Cairo, Giza, and Kalyoubia). According to Chapter 3, the GCR is home to 25% of the total population, over 50% of universities, 43% of research centers, and 80% of technical jobs in high-tech industries. Therefore, Egypt's regional innovation factors are dominated by this region. Due to its significant contribution to the national economy in terms of population concentration (approximately 6 million people) and knowledge creation, the Alexandria governorate has shown superiority in the ranking as well (3rd in the ranking).

Additionally, the ranking of governorates based on the RICI indicates that most of the governorates in the Suez Canal Region (Suez, South Sinai, Port Said, and Ismailia) are well-positioned, thanks to the establishment of advanced and technology-driven industries in the economic zone of the Suez Canal Region (e.g., DP World, General Electric (GE), and Schneider Electric). Also, this is probably also due to the region's proximity to the GCR, which provides the opportunity for these governorates to benefit from innovation elements and factors of the GCR. As discussed in the theoretical background chapter, innovation and knowledge are sensitive to places, and there is a local and regional impact on the transfer and adaptation of knowledge. Furthermore, the Red Sea Governorate has made tremendous improvements in RICI. This is due to the fact that it is an urban governorate with innovative infrastructure, such as the indicator of the percentage of the population utilizing the internet, where it placed fourth in the sub-index of "smart" infrastructure. Furthermore, the governorate contains several petrochemical and mining industries that rely on R&D for mining, which also featured in an advanced ranking in terms of the sub-indicator of knowledge utilization, where it placed eighth.

Furthermore, despite the presence of over 17 universities and more than 27 research centers, the governorates of Upper Egypt (New Valley, Beni Suef, Asyout, Luxor, Aswan, Suhag, Fayoum, and Qena) and the Delta region (Damietta, Gharbia, Sharqia, Dakahlia, Menoufia, and Kafr El Sheikh) have a completely backward ranking in the RICI. Considering what has been examined in the theoretical background, it is evident that the innovation system is much more complex than simply having the availability of knowledge-creating institutions. It is also essential for governorates to be able to exploit knowledge and provide smart infrastructure for innovation adoption to be able to innovate. Moreover, Matrouh and North Sinai, desert governorates with limited innovative capabilities, possessed values lower than Egypt's average. Furthermore, Menia and Behera have the lowest RICI scores since their economies depend on agricultural activities and reclamation.

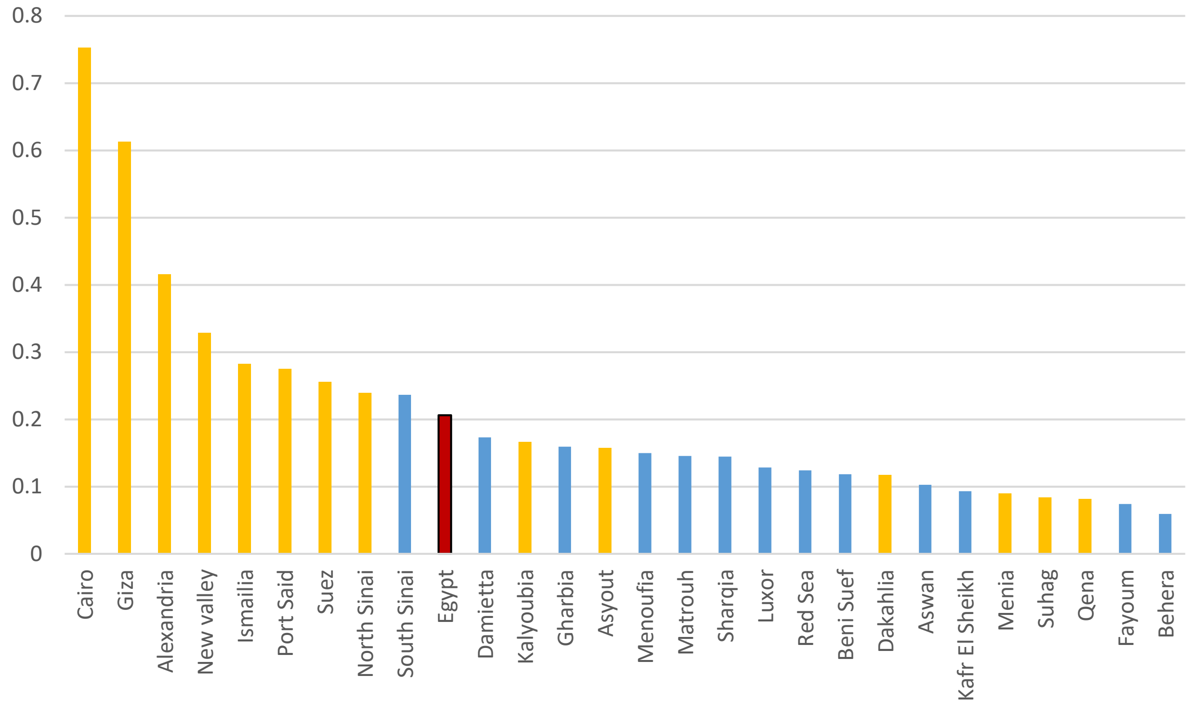
To provide a better understanding of the overall ranking, I highlight Egypt’s regional rankings for the three RICI sub-indices, namely Knowledge Creation sub-index (KC), Knowledge Utilization sub-index (KU), and “Smart” Infrastructure sub-index (SI) (*Table 12*). These three sub-indices make up the overall RICI score and reflect the three aspects of regional innovation capacity. As shown in *Table 12*, regional differences are the highest for “smart” infrastructure (std. deviation = 19.3), and the lowest for knowledge utilization (std. deviation = 13.4). Looking at the 3 top-ranking regions for all three sub-indices, we find that Cairo governorates (including the capital), Giza, and Alexandria are the leaders in the terms of Knowledge Creation (KC). While for Knowledge Utilization (KU) Cairo, Giza, and Matrouh also have the highest position on the ranking. In the case of “Smart” Infrastructure (SP), Cairo governorate takes the first place, while Alexandria ranks second and Port Said is number three.

In the "smart" infrastructure sub-index, Port Said Governorate ranks higher than the other governorates in the Suez Canal Region. This is due to the fact that it is a well-developed metropolitan governorate and the headquarters of the Suez Canal Authority, which administers and operates all of the authority's navigational channel projects. Port Said benefits from the Suez Canal in terms of service, technology, and infrastructural development.

The Knowledge Creation sub-index demonstrates a significant discrepancy among Egyptian governorates, with those above the national average exhibiting noteworthy differences. For instance, Cairo boasts a robust KC score of 75.28, whereas South Sinai lags significantly behind with a score of 23.63. This substantial gap highlights a *threefold difference*, indicating Cairo's superior performance in this specific sub-index (see *Figure 18*). In addition, there are significant differences in the ranking of governorates below the national average. For example, Damietta has a value *three times higher* than the last Behera. In the Knowledge Creation sub-index, there are governorates in the Delta region, which have a large number of universities and research centers, and a number of governorates in the Upper Egypt regions, which appear to be advanced in the ranking such as Damietta, Gharbia, and Assiut governorates.

Egypt's government intends to build new cities in eight governorates with above average KC, these are: Cairo, Giza, Alexandria, New Valley, Ismailia, Port Said, North Sinai, and Suez. These governorates, each of which outperforms the national average in terms of the Knowledge Creation (KC) sub-index, will host nine new cities. Nonetheless, the government also aims to build new urban centers in six governorates with below average KC, these are: Kalyoubia, Asyout, Dakahlia, Menia, Suhag, and Qena. Even though the South Sinai's KC sub-index is above the national average, the government has no plans to build new cities in the region.

Figure 18. The rank of Egyptian governorates based on the Knowledge Creation (KC) sub-index's values.



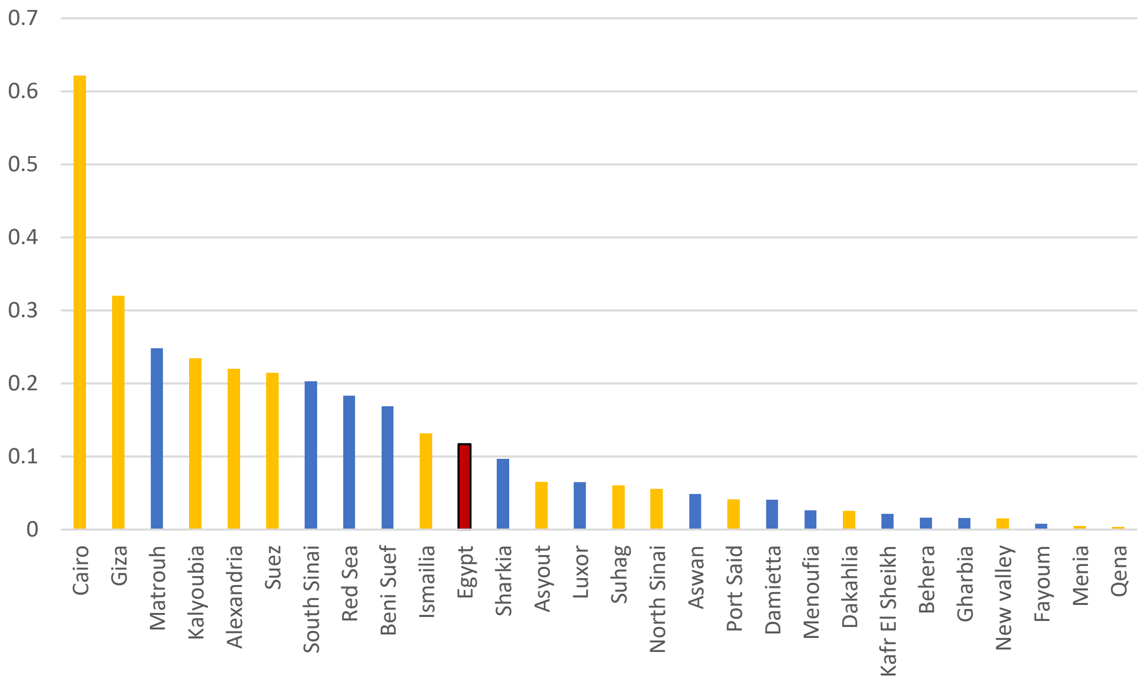
Note: Governorates in orange color show the regions where the government intends to create new cities.

Source: own calculations

Interestingly, some governorates, while scoring below the national RICI average, performed better in the Knowledge Utilization (KU) sub-index. For example, regarding the KU sub-index, Beni Suef governorate in North Upper Egypt achieved the ninth position with a score of 16.9, surpassing the national average. However, there are no plans to establish new cities in this governorate (see *Figure 19*). The indicators used to calculate the KU sub-index are closely related to the ability of the private and industrial sectors to effectively utilize knowledge and advanced technologies. The governorate of Beni Suef is also home to several Samsung International High Technology factories that have been operating in the region since 2013. It is the company's regional headquarters as well as an export center for African and Middle Eastern countries. Matrouh took third place in the KU sub-index, ahead of the region's capital, Alexandria. Even though Alexandria has made considerable progress in the sub-index for knowledge production, Matrouh governorate has made greater gains in the sub-index for knowledge utilization. This is due to the presence of many industrial zones that are home to high-tech industries. For instance, the silicon manufacturing complex at El Alamein, Matrouh governorate, is critical in supplying the microchips industries and electronic sectors. On the contrary, the sub-index for knowledge utilization shows a significant decline in value for Upper

Egypt's governorates (Asyout, Luxor, Suhag, Aswan, New Valley, Fayoum, Menia, and Qena) and the Delta region (Sharkia, Damietta, Menoufia, Dakahlia, Kafr El Sheikh, and Gharbia), reflecting a severe deficiency in the utilization of knowledge in these areas.

Figure 19 The rank of Egyptian governorates based on the Knowledge Utilization (KU) sub-index's values



Note: Governorates in orange color show the regions where the government intends to create new cities.

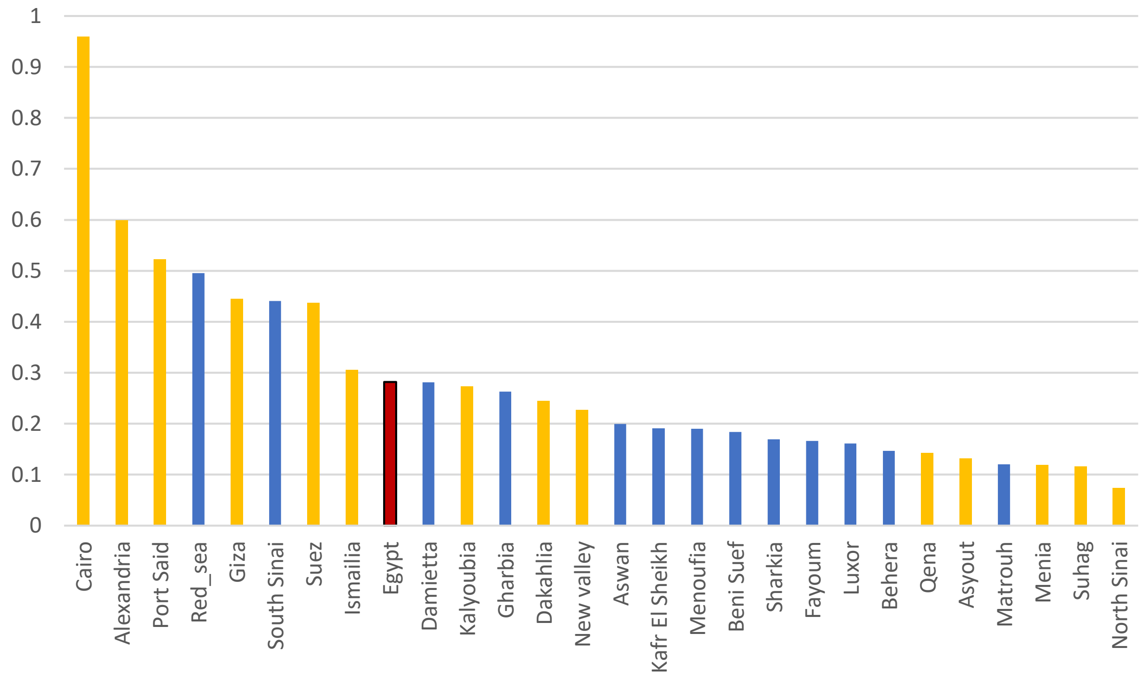
Source: own calculations

The Egyptian government intends to build new cities in six governorates, including Cairo, Giza, Kalyoubia, Alexandria, Suez, and Ismailia, all of which outperform the national average in terms of the Knowledge Utilization (KU) sub-index. Nonetheless, the government also aims to build new urban centers in eight additional governorates: Asyout, Suhag, North Sinai, Port Said, Dakahlia, New Valley, Menia, and Qena. However, the KU sub-index considerably falls below the national average in these governorates. Furthermore, even though Matrouh, South Sinai, Red Sea, and Beni Suef were not designated for the development of new cities, their KC sub-index scores exceed the national average.

According to the "Smart" Infrastructure (SI) subindex, no governorates in the Delta (Sharkia, Damietta, Menoufia, Dakahlia, Kafr El Sheikh, and Gharbia) or Upper Egypt (Asyout, Luxor, Suhag, Aswan, New Valley, Fayoum, Menia, and Qena) outperformed the national average (score 28.19). In contrast, governorates located above the national average include those in the Greater Cairo region, the majority of governorates in the Suez Canal region (Ismailia, Port Said, South Sinai, and Suez), and the Alexandria governorate (see *Figure 20*).

Egypt's government intends to build new cities in six governorates, including Cairo, Alexandria, Port Said, Giza, Suez, and Ismailia, all of which outperform the national average in terms of the "Smart" infrastructure (SI) sub-index. Nonetheless, the government also aims to build new urban centers in eight additional governorates: Kalyoubia, Dakahlia, New Valley, Qena, Asyout, Menia, Suhag, and North Sinai. However, the SI sub-index falls below the national average in these governorates. Furthermore, even though the Red Sea and South Sinai have not been earmarked for the development of new cities, their "Smart" infrastructure (SI) sub-index scores exceed the national average.

Figure 20 The rank of Egyptian governorates based on the "Smart" infrastructure (SI) sub-index's values



Note: Governorates in orange color show the regions where the government intends to create new cities.

Source: own calculations

The analysis of the composite indicator RICI and its associated sub-indicators reveals the importance of addressing the innovation capacity of Egyptian governorates from a broader perspective. Developing innovative capability involves identifying the ability to create knowledge, not only through higher education institutions, universities, and research centers, but also by exploiting knowledge and innovations within the private sector. Furthermore, "smart" infrastructure plays an important role in supporting the adoption of innovation within these governorates by providing the necessary background factors. According to the results of the analysis, the composite RICI differed significantly from the knowledge exploitation sub-index and the “smart” infrastructure sub-index in Egyptian governorates above the national level.

The Geoda 1.14 software was used for the K-means cluster analysis. The normalized values of three sub-indices were examined in order to categorize the Egyptian governorates based on their capacity for innovation. The results of the cluster analysis are as shown in *Table 13* and *Figure 21*. According to the investigated factors, five clusters can be identified as follows:

- The first cluster contains only one governorate, the Cairo governorate with a **superior innovation capacity**. Despite Cairo governorate delivers excellent performance in all three categories, it excels most in knowledge utilization (3.7677). Additionally, Cairo governorate within this cluster is distinguished in terms of the indicators of knowledge-based startups, foreign-owned companies, and incubators and business accelerators under the knowledge utilization sub-index. Furthermore, all indicators in the "smart" infrastructure sub-index performed exceptionally well in terms of the availability of background factors that promote innovation, such as the number of high-education students, workers in the ICT sector, as well as those working in innovation-based business services activities. As a result, the Cairo governorate distinguishes itself from the other governorates by outperforming not just the national average but also the rest of the governorates in terms of innovative capacity. This one-of-a-kind cluster is exclusive to Cairo governorate, demonstrating its outstanding innovation capability.

- The second cluster contains two governorates, Giza and Alexandria governorates with a **substantial innovation capacity**. The cluster’s governorates rank significantly above the average in each of the three sub-indices, as well as significantly above the rest of the governorates, except for Cairo governorate. In the case of the second cluster, the Knowledge Creation sub-index showed the highest value (1.9253). The following indicators contributed the most to the high KC subindex: expenditure on R&D, patents number, and percentage of workers in research and scientific centers. This might be attributed to the density of research institutes, universities, and high patent activity numbers in Giza and Alexandria governorates. The RICI investigation additionally showed that the two governorates ranked second and third in terms of regional potential for innovation, respectively.

Table 13. Cluster centers in case of five clusters analysis

	Superior innovation capacity	**Strong innovation capacity**	**Medium innovation capacity**	**One-sided innovation capacity "knowledge utilization"**	**Weak innovation capacity**
Number governorates in cluster	1	2	5	3	16
Knowledge creation (Zscore)	3.4176	1.9253	0.1781	-0.3919	-0.4364
Knowledge exploitation (Zscore)	3.7677	1.1425	0.2829	0.7488	-0.6071
Smart infrastructure (Zscore)	3.5178	1.2470	0.8245	-0.4626	-0.5467
Governorates	**Cairo**	**Giza** **Alexandria**	**Suez** South Sinai **Port Said** Red Sea **Ismailia**	**Kalyoubia** Beni Suef Matrouh	Damietta Gharbia Sharkia **Dakahlia** **North Sinai** Menoufia **Asyout** Luxor Aswan Kafr El Sheikh **New Valley** **Suhag** Fayoum **Qena** Behera **Menia**

Note: Governorates highlighted in **bold** indicate the government's intention to establish new cities, whereas the governorates displayed in black have no proposed plans for new cities.
Source: own calculations-based K-means cluster analysis results running by the Geoda software package 1.14

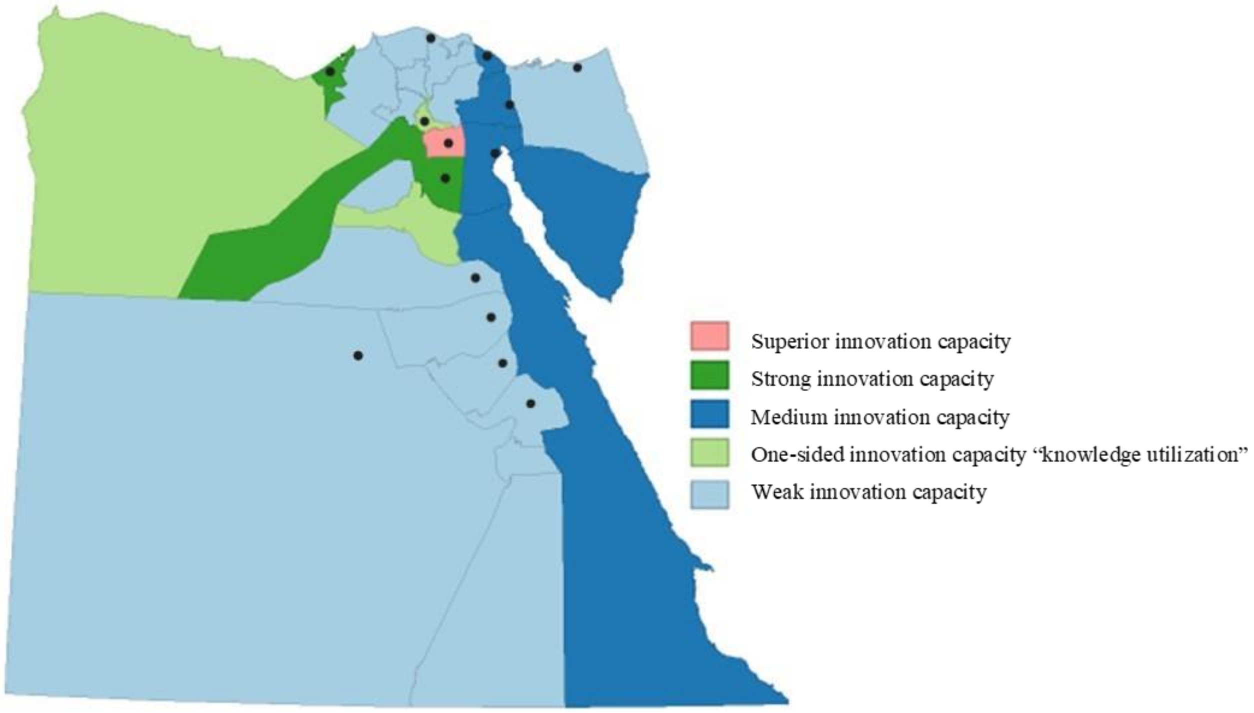
- The third cluster's five governorates can be characterized with a **medium innovation capacity**. Although governorates in the third cluster perform better than Egypt's average in the RICI and its sub-indices, but their innovation capacity is at a medium level compared to governorates in the first and second clusters. Most governorates of the Suez Canal region belong to this third cluster, with substantial urban advantages and competencies, such as Suez and Port Said. Considering the cluster governorates' medium innovation capacity performance in the three sub-indices, they stand out relatively in respect of the "Smart" Infrastructure (SI) sub-index (0.8245). Significant differences can be observed among the governorates in the third cluster in terms of the indicators of the SI sub-index, such as the percentage of people covered by internet services and the number of workers in the telecommunications industry.

- In the fourth cluster, the three governorates can be characterized with a **one-sided innovation capacity** (high knowledge utilization). The findings of the cluster analysis showed that the governorates in the fourth cluster perform lower than Egypt's average in all sub-indices. However, governorates in this cluster show a significant difference in the Knowledge Utilization (KU) sub-index (0.7488). The governorates of the fourth cluster have a notable difference in the indicators of location quotient of the concentration of high-technology industries and technology transfer centers (TTO). This is due to the governorates in the fourth cluster, such as Kalyoubia and Beni Suef, are home to electronics and technological industries, for example the Samsung Industrial Complex in the MENA in Beni Suef governorate, and the Toshiba Al Arabi Industrial Complex in Kalyoubia governorate.

- The fifth cluster is composed of 16 governorates characterized with **weak innovation capacity**. The fifth cluster consists of the governorates of Egypt, which showed low values in all three sub-indices used to evaluate the regional innovation capacity. This cluster includes the governorates of the Delta and Upper Egypt, which lack the necessary elements for knowledge production and utilization, along with the underlying contextual factors needed to foster a regional innovation ecosystem. These governorates rank lower than the national average in the composite indicator of Regional Innovation Capacity and its sub-indices. This means that nearly 60% of Egyptian governorates show a very limited capacity for innovation. The fifth cluster includes seven governorates with weak innovation capacity: Dakahlia, North Sinai, Asyut, New Valley, Suhag, Qena, and Menia. Despite this, these governorates have been selected for new city projects, as shown in *Table 13* and *Figure 21*. However, Cluster 3 encompassing governorates with medium innovation capacity, comprises only three governorates (Suez, Port Said, and Ismailia) that are proposed for the new smart city project.

To conclude the assessment of innovation capacity, I conducted a **spatial autocorrelation analysis** to investigate the spatial patterns of regional innovation capacity, with the goal of identifying governorates with either significant concentrations or deficits in innovation capacity. I also looked to see if innovation capacity for neighboring governorate units exhibited characteristics that would allow for meaningful comparisons. Real economic territorial relationships can cross governorate boundaries, the innovation capacity of one governorate can also be influenced by the "spillover" effects of neighboring governorates. Therefore, it is important to examine both the Greater Cairo region due to its strong innovation capacity and the Upper Egypt region due to its lower innovation capacity. The cluster analysis allowed us to identify clusters of governorates with “superior”, “strong” and “weak” innovation capacities. Therefore, it is interesting to study whether these governorates have a significant (positive / negative) impact on their surroundings. Thus, the spatial autocorrelation analysis is interesting, especially for this reason.

Figure 21. Classification of Egyptian governorates by their innovation capacity



Note: Black dots refer to the location of the new urban centers (smart cities).

Source: own edition.

The Moran I test results show that only the Knowledge Utilization (KU) sub-index demonstrates significant (positive) autocorrelation between its territorial values at 0.2049 with a significant p-value of 0.01. While there is no spatial autocorrelation between spatial values in the composite index of innovation capacity (RICI) and other sub-indices (*Table 14*). This shows that the factors influencing the level of knowledge utilization extend beyond the boundaries of governorates, while the presence of such factors beyond the governorate boundaries is not significant in the case of the other sub-indices and the RISI.

Table 14 The results of the global Moran I test

Index	Moran, I value	P-value	Significance interpretation*
RICI	0.0479	0.176	No significant autocorrelation
Knowledge creation	0.0225	0.238	No significant autocorrelation
Knowledge utilization	0.2049	0.013	significant autocorrelation
"Smart" infrastructure	-0.0840	0.336	No significant autocorrelation

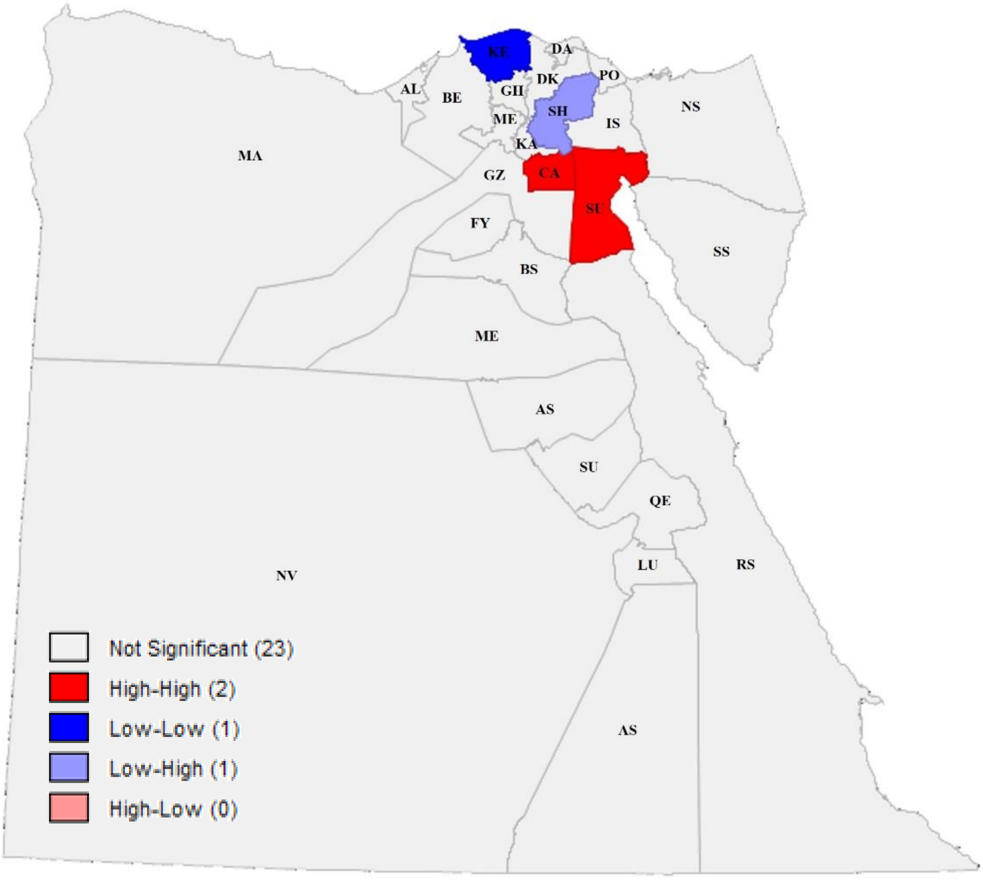
Note: * The significance level of 5% of pseudo-significance. Calculations were carried out by GeoDa 1.14.
Source: own calculations

According to *Figure 22*, only four governorates are significant and are distributed among the high-high, low-low, and low-high categories, as assessed by the spatial dispersion of the Local Moran Index. A coherent pattern is observed between the governorates of Cairo and Suez, with both regions exhibiting high values in the knowledge utilization sub-index, placing them in the high-high categorization. Cairo governorate, in particular, has a high degree of knowledge utilization, as does its neighbor governorate (Suez). Suez, on the other hand, has the situation reversed, showing a reciprocal interaction. This indicates that, in terms of knowledge utilization, these governorates form an integrated entity with territorial connections that extend well beyond their own boundaries. Hence, apart from this particular area, no other notable innovation hub in Egypt demonstrates a similar innovation "radiation" that reaches beyond the boundaries of the governorates.

In addition, the Sharkia governorate is a "low-high" case, where Sharkia is low, and its surroundings (Cairo and Suze) have a high knowledge utilization sub-index value. Despite the presence of two surrounding governorates with high knowledge utilization capacity, Cairo and Suez, the Sharkia governorate has been unable to effectively exploit their closeness. This means that Sharkia is unable to capitalize on the potential benefits of these two governorates' proximity, both of which display a high-level of knowledge utilization.

Additionally, according to the spatial autocorrelation analysis, the Kafr ElSheikh governorate is in the low-low group for the knowledge utilization sub-index. This indicates that Kafr ElSheikh has low capabilities for knowledge utilization, and it is worth noting that its neighboring governorates likewise have a low capacity in this regard. This is not surprising since Kafr ElSheikh governorate is part of the Delta region, where knowledge utilization lags significantly behind the national average in other governorates as well.

Figure 22. The spatial cluster of the Local Moran Index in the context of the Knowledge Utilization subindex



Note: By using the first-order queen's contiguity method, the map represents the Local Moran I-Test values at a 5% level of pseudo-significance. In the case of high-high relations, both governorate and its neighbors have a high "knowledge-utilization" sub-index value, whereas in low-high relations, the governorate is low, and its neighbors have a high. In the case of low-low relations, both governorate and its neighbors have a low "knowledge-utilization" sub-index value. GeoDa 1.14 was used to calculate the results.

Note: **CA**: Cairo, **KA**: Kalyoubia, **GZ**: Giza, **AL**: Alexandria, **BE**: Behera, **MA**: Matrouh, **PO**: Port-said, **SU**: Suez, **SH**: Sharkia, **IS**: Ismailia, **NS**: North Sinai, **SS**: South Sinai, **DA**: Damietta, **DK**: Dakahlia, **KE**: Kafr El Sheikh, **GH**: Gharbia, **ME**: Menoufia, **BS**: Beni Suef, **FY**: Fayoum, **ME**: Menia, **AS**: Asyout, **NV**: New Valley, **SU**: Suhag, **QE**: Qena, **LU**: Luxor, **AS**: Aswan, **RS**: Red sea.

Source: own calculations

4.4 Discussion: Governorates readiness for the innovation-driven regional development

In this chapter, I summarize the key findings from the previous analyses conducted to evaluate the innovation capacity of Egyptian governorates. *Table 15* reveals a considerable variation in the innovation capacity among Egyptian governorates, with the Northern governorates having relatively higher levels of innovation capacity. The RICI score for Cairo Governorate is 77.8, while Menia Governorate, ranking last in terms of innovation capacity, has a RICI score of 7.15. The difference between the two governorates is tenfold. The literature review results in Chapter 2.2 demonstrated that regional characteristics and local competencies for innovation are essential. Therefore, governorates with a strong innovation capacity have a greater chance of accomplishing the goals of Egypt Vision 2030. Governorates with low innovation capacity, on the other hand, are less likely to meet this ambitious strategy's goals. The analysis of the sub-dimensions of innovation capacity reveals that the Egyptian government plans to establish new cities in governorates that do not perform well in any dimension. On the other hand, some governorates were completely ignored, no plans were made to create new cities in their territory. Although these governorates do not excel overall, they perform exceptionally well in certain dimensions.

According to the cluster analysis based on the three sub-indices of RICI, the Egyptian governorates can be categorized into five homogenous categories based on their capacity to innovate. Governorates in Cluster 1 or 2 groups have outstanding and strong innovation capabilities, respectively. Meanwhile, Cluster 3 contains governorates with medium innovation capacity that differ in terms of the components of their innovation capacity. While governorates in Cluster 4 have capacities in only one sub-index, which is knowledge utilization, and lack capacities in the other two sub-indices. Finally, governorates with low RICI scores and its three sub-indices comprise the classification's final category (Cluster 5).

The first classifying category (*"superior innovation capacity"*), which includes only one governorate, Cairo, is notable for its extraordinary innovation capacity. It scored a composite indicator value of 77.8 for innovation capacity and ranked first in knowledge creation (75.28), knowledge utilization (75.28), and "smart" infrastructure (95.96). Spatial autocorrelation analyses revealed a positive relationship (High-High) between Cairo governorate and its surrounding governorate (Suez) indicating a strong capacity for innovation (for knowledge utilization) in these locations. Considering that Cairo is Egypt's capital and a megapolis region, this spatial clustering of innovation capacity is not surprising. According to the literature review, the efficacy of an innovation-driven regional development strategy is strongly reliant on local skills and regional innovation capacities. The strategic location of NAC within Cairo Governorate gives a unique potential to build a high-level innovation ecosystem by using Cairo Governorate's well-established innovation capacity. In sum, by relying on Cairo Governorate's known innovation capability, NAC's location affords an excellent setting to enhance and support robust regional innovation activities.

The second cluster contains governorates with *"strong innovation capacity"* in comparison to the rest of Egypt. This is apparent in their composite indicators of innovation capacity and its sub-indices. Giza governorate came in second in the composite indicator with a score of 45.93, while Alexandria governorate came in third with a score of 41.93. The Knowledge Utilization sub-index's spatial autocorrelation investigation revealed that these governorates are not significant. This indicates that, based on the analysis of Local Indicators of Spatial Association, these governorates exhibit neither a positive nor a negative spatial autocorrelation concerning the sub-indicator of knowledge utilization.

According to the RICI indicators analysis, universities, research institutes, high-tech employment, the concentration of knowledge-based startups, and "smart" infrastructure are all important components of the innovation capacity in the governorates in the second category. They also encompass a new urban center, New Alamein City (Alexandria Governorate) and New October City (Giza Governorate), with the goal of establishing high-level innovation hubs. These new cities can gain from their governorates in the second group's innovation competencies and regional innovation capacities to strengthen their own innovation ecosystems. As a result, the governorates of Giza and Alexandria have high innovation capacities, giving them more opportunities of supporting their planned new cities.

In sum, based on the results of the comprehensive analyses, **the governorates in the first and second clusters (Cairo, Giza, and Alexandria) demonstrate suitable attributes of innovation capacity, making them viable candidates for implementing innovation-driven regional development policies**. (*Table 15*, Column 8).

The third cluster comprises governorates with *"medium innovation capacity"* when compared to other categories. Apart from the Red Sea governorate, cluster analysis found that this group was made up of five governorates in the Suez Canal region: Suez, Ismailia, Port Said, the Red Sea, and South Sinai. With a value of (30.26), the Suez governorate placed fourth in the composite indicator of RICI while Ismailia governorate had the lowest score in the group with a value of (24.0), placing eighth in the composite indicator of RICI. Regarding the three sub-indices defining innovation capabilities, the governorates differed, but they were rated as medium in comparison to the first and second groups. Notably, the "smart" infrastructure sub-index values stand out from the other sub-indices.

According to the findings of the spatial autocorrelation analysis, the Suez governorate had a high positive spatial autocorrelation for the knowledge utilization sub-index, with neighboring governorates also having high values for this sub-index (High-High). Suez is neighboring Cairo, the governorate with the most innovation capacity, and is part of the cluster with positive spatial autocorrelation for knowledge utilization. The remaining governorates in the third cluster, however, did not demonstrate the spatial significance for the spatial autocorrelation of knowledge utilization, since a number of them include large desert hinterlands, for example, the Red Sea and South Sinai governorates.

This third cluster additionally includes three new urban centers (the city and resort of Galala in Suez governorate, East Port Said city-SALAM in Port Said governorate, and New Ismailia City in Ismailia governorate) as part of the innovation-driven regional development strategy. Based on the characteristics of the innovation capacity exhibited by these governorates in the third group, they can be classified at the second readiness level for implementing the innovation-driven regional development strategy. According to the findings of the research, the governorates of Suez, Port Said, and Ismailia should prioritize increasing their capacity for innovation, particularly in the areas of knowledge creation and utilization. Its enhancement is critical because it will give new urban centers critical inputs for their development. Interestingly, the spatial autocorrelation analysis within this cluster 3 suggests that Suez retains a slightly better position and can facilitate the efficient execution of the strategy. This is due to the Cairo governorate's favorable effect on knowledge utilization.

The fourth cluster contains governorates with *"one-sided innovation capacity"*, which is "knowledge utilization". This group is composed of the following governorates: Kalyoubia, New Valley, and Matrouh. In terms of innovation capacity, governorates in this category perform worse in the sub-indices than in the previous three categories. They do, however, perform rather well in the sub-index of knowledge utilization. Matrouh Governorate, which is in the Alexandria region, ranks fourth in Egypt in terms of the sub-index for knowledge utilization, with a score of 24.84. Following closely afterward is Kalyoubia Governorate within the Greater Cairo Region, which ranks fifth with a score of 23.45 for the same sub-index. Consequently, this group of governorates has a relative advantage in regard to their innovation capacity in terms of knowledge utilization. This strength may be utilized and developed to improve their knowledge production capacities and to support the "smart" infrastructure required to build an innovation ecosystem in these governorates.

It is worth mentioning that this cluster of governorates includes two new urban centers: Obour (in Kalyoubia Governorate) and Toshka (in New Valley Governorate). Unfortunately, **these governorates' Regional Innovation Systems are not yet completely prepared to support a high-level innovation ecosystem in these new urban centers**. More precisely, knowledge creation indicators (R&D performing units, staff of R&D units, number of scientists with PhD, expenditure R&D for Higher education and government centers, and number of patents) and "smart" infrastructure indicators (students in higher education institutions, employees in ICT, and a number of innovative service providers units) must be improved. Due to the unilateral innovation capacity identified in the governorates of the fourth cluster, they may find themselves at a third degree of preparation to execute innovation-driven regional development policy. However, it is essential for these governorates to strengthen their indicators of innovation capacity in order to progress further in this regard.

In terms of defining Egyptian governorates' innovation capacity, the final category consists of governorates with *“low innovation capacity”* across all sub-indices. This category comprises the majority of Egyptian governorates, including 16 governorates from Upper Egypt and the Delta regions. *Table 15* shows that the values of all sub-indices for this category's governorates show a significant decline in innovation indicators such as knowledge creation and utilization, as well as "smart infrastructure". Nevertheless, due to the existence of industrial complexes for international firms, such as the Samsung industrial complex for MENA region, some governorates, such as Beni Suef, have a competitive advantage in the sub-index for knowledge utilization due to high employment rates in technology industries. Except for Beni Suef, all governorates in the fifth group exhibit a significant decline in indices of innovation capacity.

Furthermore, the findings of the spatial autocorrelation analysis of the knowledge utilization sub-index reveal that, aside from the Sharkia governorate, all governorates in this category were not significant. Sharkia's neighbors exhibited significant positive spatial autocorrelation (low - high) since the governorate of Sharkia borders the Cairo governorate. Furthermore, the spatial autocorrelation results indicate a low negative correlation (low-low) between Kafr El-Sheikh governorate and its neighbors, which can be attributed to the governorate's geographic region in the agricultural Delta region, which has weak innovation capacity characteristics. Moreover, as compared to the other four categories, this fifth cluster of governorates contains six new urban centers (New Mansoura in Dakahlia governorate, West Asyout in Asyout governorate, New Suhag in Suhag governorate, West Qena in Qena governorate, New Rafah in North Sinai governorate, and New Menia in Menia governorate).

However, **these governorates' inadequate low innovation capacity in all three sub-indices values for measuring innovation capacity make it doubtful whether the governorates of this category contribute to the innovation-driven regional development policy through the new cities.** Based on these results, **these governorates in terms of innovation capacity are not prepared enough to support the creation of new smart cities within their territory.**

To conclude, the analysis of the Egyptian governorates' innovation capacity demonstrates a considerable variance in their regional innovation capacity. The measures of knowledge creation and utilization, as well as the underlying factors ("smart" infrastucture) that support the innovation ecosystem, differ greatly throughout the Egyptian context. The outcomes of the interviews and policy documents highlight the significance of regional innovation components as essential inputs to enhance the innovation ecosystem in new urban centers adopting the smart city concept. Furthermore, the findings of the literature review emphasize the importance of local competencies and endogenous factors for innovation capacity in fostering innovation-driven regional development. It can be assumed that governorates with high innovation capacity are better placed to make a contribution to the accomplishment of Egypt Vision 2030, whereas governorates with weak innovation capacity are doubtful to meet the goals of this ambitious strategy.

In conclusion, **based on the comprehensive analyses conducted in Chapter 4, Cairo, Giza, and Alexandria governorates are fully prepared for the task. On the other hand, Suez, South Sinai, Port Said, Red Sea, Ismailia, Kalyoubia, New Valley, and Matrouh governorates are only partially prepared and require further improvements**, particularly concerning their capacity for knowledge creation and "smart" infrastructure indicators. The majority of Egyptian governorates, including Damietta, Beni Suef, Gharbia, Sharkia, Dakahlia, North Sinai, Menoufia, Asyout, Luxor, Aswan, Kafr El Sheikh, Suhag, Fayoum, Qena, Behera, and Menia, have low innovation capacity. Additionally, they are not in close proximity to other governorates to benefit from the positive "radiation" of knowledge. Consequently, significant improvements are needed in their Regional Innovation system (RIS) to enhance their innovation capacity.

Table 15. Egyptian governorates categorized according to their readiness to implement innovation-driven regional development

Governorates	Regional Innovation Capacity INDEX	Knowledge creation	Knowledge utilization	"Smart" infrastructure	Spatial autocorrelation results	Classification of the innovation capacity clusters	Priorities for implementation of innovation-driven regional development	Proposed new urban centers
Cairo	77.80	75.28	62.16	95.96	High-High	**Superior innovation capacity**	**1**	New Administrative Capital
Giza	45.93	61.27	32	44.53	Not-significant	**Strong innovation capacity**		New October City
Alexandria	41.15	41.55	22	59.9	Not-significant			Al Alamein New City
Suez	30.26	25.54	21.48	43.76	High-High	**Medium innovation capacity**	**2**	City and resort of Galala
South Sinia	29.34	23.63	20.31	44.09	Not-significant			
Port said	27.99	27.5	4.14	52.33	Not-significant			East Port Said city-SALAM
Red sea	26.77	12.42	18.33	49.57	Not-significant			
Ismailia	24.00	28.22	13.16	30.61	Not-significant			New Ismailia City
Kalyoubi	22.48	16.61	23.45	27.37	Not-significant	**One-sided innovation capacity "knowledge utilization"**	**3**	New Alobor City
New valley	19.05	32.88	1.55	22.72	Not-significant			New Toshka City
Matrouh	17.16	14.58	24.84	12.06	Not-significant			
Damietta	16.50	17.29	4.07	28.13	Not-significant	**Weak innovation capacity**	**Not prepared enough**	
Beni Suef	15.71	11.85	16.89	18.40	Not-significant			
Gharbia	14.61	15.93	1.59	26.31	Not-significant			
Sharkia	13.69	14.46	9.69	16.92	Low-High			
Dakahlia	12.91	11.71	2.55	24.46	Not-significant			New Mansoura
North sinia	12.30	23.92	5.54	7.44	Not-significant			New Rafah
Menoufia	12.21	14.97	2.62	19.04	Not-significant			
Asyout	11.81	15.71	6.54	13.19	Not-significant			Nasser city, west of Assiut
Luxor	11.80	12.82	6.48	16.10	Not-significant			
Aswan	11.70	10.28	4.89	19.92	Not-significant			
Kafr El Sheikh	10.19	9.32	2.15	19.11	Low-Low			
Suhag	8.68	8.35	6.05	11.65	Not-significant			New Souhag
Fayoum	8.28	7.41	0.78	16.65	Not-significant			
Qena	7.58	8.12	0.37	14.24	Not-significant			West Qena city
Behera	7.42	5.93	1.64	14.68	Not-significant			
Menia	7.15	9.00	0.51	11.96	Not-significant			New Menia

Source: own construction

5. Summary and Conclusion

5.1 Theses of the doctoral dissertation

In this chapter, I present my theses. A comprehensive analysis was conducted to answer the research questions and test the hypotheses. This process included conducting a systematic literature review, assessing case studies, policy documents, and interviews, as well as performing an empirical analysis tailored to the Egyptian context. My general aim was to examine how ready Egypt's governorates are to facilitate the development of a strong innovation ecosystem in the designated new smart cities they (will) host. To this end, I assessed the current innovation capacity of the Egyptian governorates. Specifically, I wanted to determine which governorates have the most potential to contribute to the implementation of Egypt’s innovation-driven regional development strategy.

All theses of my dissertation are structured in the following way to be as precise, accurate, and detailed as possible: (1) restate the research questions or hypotheses (RQ1, RQ2, RQ3, H1, H2, H3) (2) the thesis statement (THESIS 1, THESIS 2, etc), (3) chapters of the dissertation providing evidence(s) for the statement, and (4) argumentation for the statement and conclusions.

The first thesis provides an answer to **RQ1**: *What is a smart city (SC)? What are its main components? What role can it play in regional development and how can it foster innovation? For what purpose and in what way is SC concept used in other countries?*

THESIS 1

Based on the comprehensive literature review, I conclude that smart cities, despite the lack of a generally accepted definition, are characterized by their **multidimensional** nature: a **holistic approach involving technology, human capital, and collaboration** is key to the sustainable and inclusive implementation of smart city initiatives. Smart cities can play a key role in driving innovation **by promoting collaborative ecosystems**. Smart city strategies should take **a balanced approach**, incorporating different perspectives of local communities and addressing both hard and soft infrastructure. In addition, smart city experiences in developing countries highlight the importance of **tailoring strategies to specific development requirements and goals**, making them valuable tools for addressing urban challenges and even for regional development in developing countries.

The evidence presented in **Chapter 2.3** strongly supports thesis 1. According to the conclusions presented in Chapter 2.3.1, the concept of smart cities lacks a universally accepted and unified definition, which is reflected in the diverse definitions found in the existing literature. Different perspectives have emerged, highlighting different aspects of smart cities, which also points to the evolving understanding of this concept. Even though there is no unified concept of smart cities, there are several factors and components that are regarded as the fundamental pillars of smart cities based on the findings of the systematic literature review. In Chapter 2.3.2, I discuss these key dimensions of smart cities. The review highlighted various elements that are considered fundamental pillars of smart cities. The papers typically identified the following components of smart cities based on Cohen (2012) "Smart City Wheel" model: smart economy, smart people, smart mobility, smart governance, smart living, and smart environment. Chapter 2.3.3 concluded that the selection of a smart city development strategy should consider a balanced approach, incorporating different perspectives and addressing the unique needs of cities and regions. Policymakers must weigh the advantages and disadvantages of each strategy, involve local communities in decision-making, and consider both hard and soft infrastructure investments. Furthermore, Chapter 2.3.4 concluded that innovation is not solely dependent on the existence of smart infrastructure. Smart cities are viewed as intelligent communities that foster innovation by encouraging collaboration and effective interactions among citizens, firms, government agencies, universities, and research institutes. Finally, the analysis of smart city experiences in other countries in Chapter 2.3.5 concluded that most of these countries rely substantially on technology and information, but they employ different tools depending on their development goals, financial resources, and local challenges. Smart cities have the capability to address a diverse array of urban challenges, including those pertaining to regional development. Overall, my findings imply that the investigated three developing countries stand to greatly benefit from smart city strategies that are tailored to their specific development requirements and goals.

The second thesis provides an answer to **RQ2**: *What are the main aims of the Egypt Vision 2030 regarding the balanced regional development of the country? Based on the strategy, how does Egypt intend to adapt the smart city concept to accomplish the balanced, innovation-driven development of the country? How Egyptian officials evaluate the new urban centres program?*

THESIS 2

In Egypt, the new generation of smart cities is envisioned as **innovation hubs**. Based on the reviewed planning documents and interviews, this is largely expected to be achieved through (1) **creating necessary framework conditions in related areas** (urbanization policy, innovation policy, and digitalization), and (2) through **the complex, multi-layered operation of smart cities**. An analysis of innovation inputs and outputs in Egyptian governorates **revealed regional disparities**. Both the strategy documents and the interviewees stressed the need to leverage existing regional-level innovation capacities in the development of new innovation hubs. The interviews also underscored the significance of **adapting smart city strategies to each region's unique characteristics** for effective urban development.

Chapter 3 provides supporting evidence for thesis 2. The chapter provides a comprehensive overview of the content of development policy documents that are shaping and defining Egypt's future, and presents the views of senior officials on these plans. THESIS 2 is supported by the following research conclusions:

- The examination of the present social and economic circumstances of the country in Chapter 3.1 showed that Egypt confronts a variety of challenges. Based on this investigation, it is obvious that developing new urban centres is essential to improve the social and economic conditions of the country.
- Chapter 3.2.1 revealed that Egypt Vision 2030 encourages the creation of 14 new cities. These new cities are proposed in different regions of the country to support balanced regional development. Egypt Vision 2030 also clearly recognizes the crucial role of innovation. Furthermore, according to the investigation of policy documents and interviews, the establishment of innovation hubs largely expected to be achieved through (1) creating necessary framework conditions (developing elements of the innovation system) in related areas (urbanization policy, innovation policy, and digitalization), and (2) through the complex, multi-layered operation of smart cities, which may be classified into three layers, according to Egypt Vision 2030. This multi-layered operation consists of:
  - Layer 1: Smart living – The attractiveness of high quality of life.
  - Layer 2: Smart environment / Smart infrastructure – Unlocking business opportunities.
  - Layer 3: Collaborative ecosystem – Openness.

- The findings in chapter 3.2.2 revealed that there is a large disparity in local and regional innovation components within Egyptian governorates. The analysis of regional innovation inputs and output factors in Egyptian governorates clearly shows that the northern governorates perform more effectively in terms of regional innovation than the southern governorates of Upper Egypt.
- Additionally, the findings of interviews in chapter 3.2.3 revealed deeper insights into the essence of Egypt's ambitious plan. They shed light on how the government intends to implement it to achieve innovation-driven balanced regional development. Furthermore, the interview findings addressed an important question of the desire to develop new urban centres rather than existing cities. Due to the interview findings, I gained deeper insights into the motivation for adopting the smart city concept in newly designed cities, as envisioned in Egypt's Vision 2030. Many considerations support using this approach in new urban centres rather than existing ones. Finally, the findings of the interviews showed that the Egyptian government recognized that the availability of present innovation components and aspects in Egyptian governorates is critical to the strategy's success. These governorates' inputs and capacities are the base for fostering innovation in emerging urban centres.
- The findings of chapter 3.2.4 revealed that the NAC can serve as a pioneering model for future smart city project implementation. However, planning for new cities, it is critical to carefully evaluate the unique spatial characteristics and geographical conditions of each region. Adapting approaches to each region's unique setting is critical for effective urban development efforts.

Hence, it is critical to examine Egyptian governorates' current innovation capacity since those with strong innovation capacity have the most potential to develop new urban centres into flourishing innovation hubs. In contrast, we can recognize the shortcomings and substantial hurdles to advancement in these locations by conducting a thorough examination of Regional Innovation Capacity. We can address the gaps and hurdles that hinder the development of Regional Innovation Systems in different regions by acquiring a thorough understanding of these bottlenecks.

The third thesis provides an answer to **RQ3**: *What is the innovation capacity of the Egyptian governorates? Which Egyptian governorates have the most innovation capacity to foster innovation-driven regional development in new cities?*

RQ3 is derived from empirical research. The conducted empirical investigation allowed for testing the following three hypotheses:

- **H1**: There are significant differences in the innovation capacity of Egyptian governorates.
- **H2**: Egyptian governorates can be grouped into homogeneous clusters based on their innovation capacity, differing from each other along dimensions describing innovation capacity.
- **H3**: There is no spatial clustering or pattern of similarity in innovation capacity among neighboring governorates in Egypt.

Bases on the empirical investigation in Chapter 4, I can accept H1 and H2, but reject H3:

H1 → THESIS 3

As measured by the Regional Innovation Capacity Index (RICI), there are significant differences in the innovation capacity of Egyptian governorates. Measures of knowledge creation and use, as well as the underlying background factors, vary widely across governorates in Egypt.

H2 → THESIS 4

Cluster analysis based on the sub-indices of RICI revealed that the Egyptian governorates can be categorized into five distinct clusters depending on their capacity to innovate. There are huge differences among governorates with “superior” or “strong” innovation capacity (Cairo, Giza, and Alexandria) and governorates with relatively weak innovation capacity (upper Egypt and the Delta regions).

H3 → THESIS 5

The results of the spatial autocorrelation analysis showed that the Knowledge Utilization sub-index demonstrates significant (positive) autocorrelation.

The results in **Chapter 4.3** showed that there is a considerable gap in Egypt's governorates' capacity for innovation. Thesis 3 is supported by the following research findings:

- According to the RICI, the main conclusion is that Egypt has enormous disparities in terms of innovation capacity. In Egypt, there is only nine governorates with performance above the national average (20.2 RICI score). The Cairo Governorate (77.8 RICI score) is clearly superior not only in the RICI composite index but also in all of its sub-indices. In contrast, the performance of the other 18 governorates is generally below average. Thus, innovation capacity is proportionately concentrated in the northern governorates of Egypt, especially in the greater Cairo region and its surrounding areas.
- According to the cluster analysis of the sub-indices used to assess regional innovation capacity, the Egyptian governorates were categorized into five distinct categories depending on their capacity to innovate. Governorates in the first and second groups (Cairo, Giza, and Alexandria) have outstanding and strong innovation capabilities, respectively. Meanwhile, the third category contains governorates with medium innovation capacity that differ in terms of the components of their innovation capacity (5 governorates). Governorates in the fourth category have capacities in only one sub-index, which is knowledge utilization, and lack capacities in the other sub-indices (3 governorates). Lastly, the results showed that governorates with low innovation capacity scores in the composite indicator of Regional Innovation Capacity and its three sub-indices comprise the classification's fifth category (16 governorates).
- The results of the spatial autocorrelation analysis showed that Moran I test results shows that only the knowledge utilization sub-index demonstrates significant (positive) autocorrelation. On the other hand, there is no spatial autocorrelation between spatial values in the composite index of innovation capacity (RICI) and other sub-indices.

The main research question of the dissertation is the following: *Do the Egyptian governorates have enough innovation capacity to foster a high-level innovation ecosystem in the new (smart) cities, thereby achieving a balanced regional development of the country?*

Innovation-driven regional development policies can contribute to balanced regional development, provided that local and regional capabilities for innovation and knowledge are taken into consideration. My results from evaluating the Egyptian context indicate that the **Egyptian governorates differ in their applicability of the intended innovation-driven smart city strategy.** Consequently, considering innovation-driven regional development plans, it is critical to consider the disparities in innovation capability rankings among Egyptian governorates. To guarantee successful implementation, the priorities for executing this policy in the chosen new cities must be reconsidered, where first the necessary components or the basic requirements for fostering innovation capacity should be found for the policy to be implemented successfully. Thus, governorates with high innovation capacity are better placed to contribute to the accomplishment of Egypt Vision 2030, whereas governorates with weak innovation capacity are doubtful to meet the goals of this ambitious strategy. Therefore, policymakers should strive to boost the latter group's innovation capacities to support balanced regional development.

5.2 Practical Implications, Limitations, and Future Research

According to interviews, case studies from developing countries, theoretical foundations, and a review of the Egyptian situation, the new fourth-generation (smart) city initiatives have a range of objectives, circumstances, and criteria. Based on the findings of my dissertation, I provide the following practical implications:

1. ***Increase efforts and initiatives to enhance regional innovation performance especially in "lagging" group of governorates with low innovation capacity.*** In Chapter 4, the evaluation of the Egyptian context shows that the Egyptian governorates are approaching the implementation of the new innovation-driven Egyptian regional development strategy with different opportunities. Consequently, considering innovation-driven regional development plans, it is critical to take into account the disparities in innovation capacity among Egyptian governorates. According to my analyses, Cairo, Giza, and Alexandria governorates are *fully prepared* for the task. On the other hand, Suez, South Sinai, Port Said, Red Sea, Ismailia, Kalyoubia, New Valley, and Matrouh governorates are only *partially prepared* and require further improvements, particularly concerning their capacity for knowledge creation and "smart" infrastructure. However, the majority of Egyptian governorate's are *not prepared* as they are lagging regions regarding their innovation capacity (including Damietta, Beni Suef, Gharbia, Sharkia, Dakahlia, North Sinai, Menoufia, Asyout, Luxor, Aswan, Kafr El Sheikh, Suhag, Fayoum, Qena, Behera, and Menia). To guarantee successful implementation, the necessary components or basic requirements for strengthening the innovation capacity must first be created. Therefore, decision-makers should strive to improve governorates with insufficient innovation capacity.

2. ***Diversifying the targeted socioeconomic categories.*** This means not only focusing on attracting people from high-income economic backgrounds, but also accepting socioeconomic diversity. A significant lesson may be derived from the China model, which was examined in Chapter 2.3, where many shortcomings were linked to a failure to involve a varied population of classes. Smart city initiatives experienced low demand among various social sectors due to a lack of socioeconomic variety, contrary to the desired Egyptian approach. The Egyptian approach's overall purpose is to create inclusive communities that can accommodate inhabitants from all social strata. Therefore, smart cities should attract various social classes of the society due to different policy measures and projects. Egypt Vision 2030 and the National Urban Development Plan 2052 seek to increase the inhabited urban area of the designated cities, but the difficulty of attracting different social classes may hinder the implementation of these plans. A smart city that is excessively costly for individuals in the lower socioeconomic class (working class) could potentially lead to social tensions, which will make it more difficult to achieve regional development equality and convergence. *Interviewee_1* addressed this concern by highlighting strategies targeted at encouraging social and economic diversity within newly designed cities.

3. ***Avoiding copying successful smart city solutions.*** Considering the analysis in Chapter 3, in order to successfully create the 14 smart cities, the characteristics and level of development of the governorates surrounding the cities must be taken into account. Consequently, it is very important to avoid the NAC model being copied by other planned smart cities. Adopting a model without taking into account the specificities or internal regional components of the territory where it is intended to be implemented usually leads to failure, as discussed in Chapter 2.2. chapter. In order to ensure the sustainability of the economy, the economic base and local competencies of the proposed smart cities' governorates must be considered. The model of El Alamein, Egypt's new city on the Mediterranean Sea, exemplifies the Egyptian government's ambition to create an economic framework based on a cultural and tourism hub that competes worldwide and is regarded as Egypt's northern gateway. To meet the sustainable development goals established in Egypt's Strategy 2030, it is critical to determine each smart city's economic base and specific economic development path(s).

4. ***Preparing people open to the high-tech era with their training.*** According to the analysis offered in Chapter 2.3, while developing smart city initiatives, it is critical to address the social circumstances of the community. Successful smart city administration and operations need a workforce that is both innovative and qualified. To be effective, the suggested

administrative and governance systems rely on the participation of such skilled and talented people. Collaboration between the government, the business sector, real estate developers, local communities, and stakeholders is required under the notion of multi-actor management. As a result, it is critical to incorporate educated, creative, open-minded individuals into smart city management. Furthermore, in Chapter 2.3, the importance of human capital in driving innovation and growth in smart cities is emphasized. To ensure the success of these cities and the creation of living and successful communities for inhabitants, aspects such as people and their talents must be considered throughout the planning, development, and implementation phases. Additionally, people must be educated about the significance of urban intelligence. In Egypt, smart cities are a relatively new approach to urban development. Therefore, it is critical to educate Egyptian people about their potential influence on public services and utilities to stimulate economic growth.

Several limitations must be acknowledged concerning this dissertation. First, due to data availability limits, the narrative analysis relied on interviews with authorities, which may have introduced a one-sided viewpoint. Furthermore, it is worth noting that this study did not involve interviews with Citizens, business owners, or urban planners, a choice influenced by a number of restrictions that may not be immune to criticism. As a result, interpretation should be addressed with caution. Second, the study is limited by a lack of government data on planned new urban centers and smart city programs, many of which are still in the early phases. Lastly, the lack of regional data at the governorate level poses challenges when calculating the composite indicator of innovation capacity. While the composite indicator method provides insights into the innovation performance in Egypt's governorates, it has significant limitations. Data accessibility and quality are key difficulties, and certain indicators were used as proxies for variables, such as patents as a proxy for innovation, even though innovation is not solely encapsulated by patents. Regrettably, no further variables are available at the governorate level in Egypt to quantify innovation production. Moreover, the selection and weighting of indicators is difficult since no indication is given more weight than others, which provides a complete perspective of innovation performance but makes it difficult to determine which indicators contribute the most to the composite index. Furthermore, the study used 18 indicators to quantify innovation capacity in the empirical section, however, it is recommended that more complex indicators be included in the background factors of the "smart" infrastructure sub-index. Finally, the number of sub-indices indicators is restricted, notably in terms of indicators for knowledge utilization and R&D in the private sector. Additional data on these variables might have a substantial influence on the composite index and its sub-indices. As a result, while the composite indicator method is a useful instrument to evaluate regional innovation capabilities, these limits must be taken into account when interpreting the results.

According to the literature review on smart cities as a policy concept, smart cities can serve a variety of purposes and follow a variety of policy patterns, such as addressing population growth, urban issues, environmental concerns, regional development disparities, and fostering innovation ecosystems. While this study acknowledged the importance of these several factors for balanced regional development, it focused on an innovation-driven regional development policy via the perspective of smart cities. Consequently, future research is needed to investigate the notion of suggested new urban centers, "smart cities," from alternative perspectives that may be better adapted to the conditions of most Egyptian governorates.

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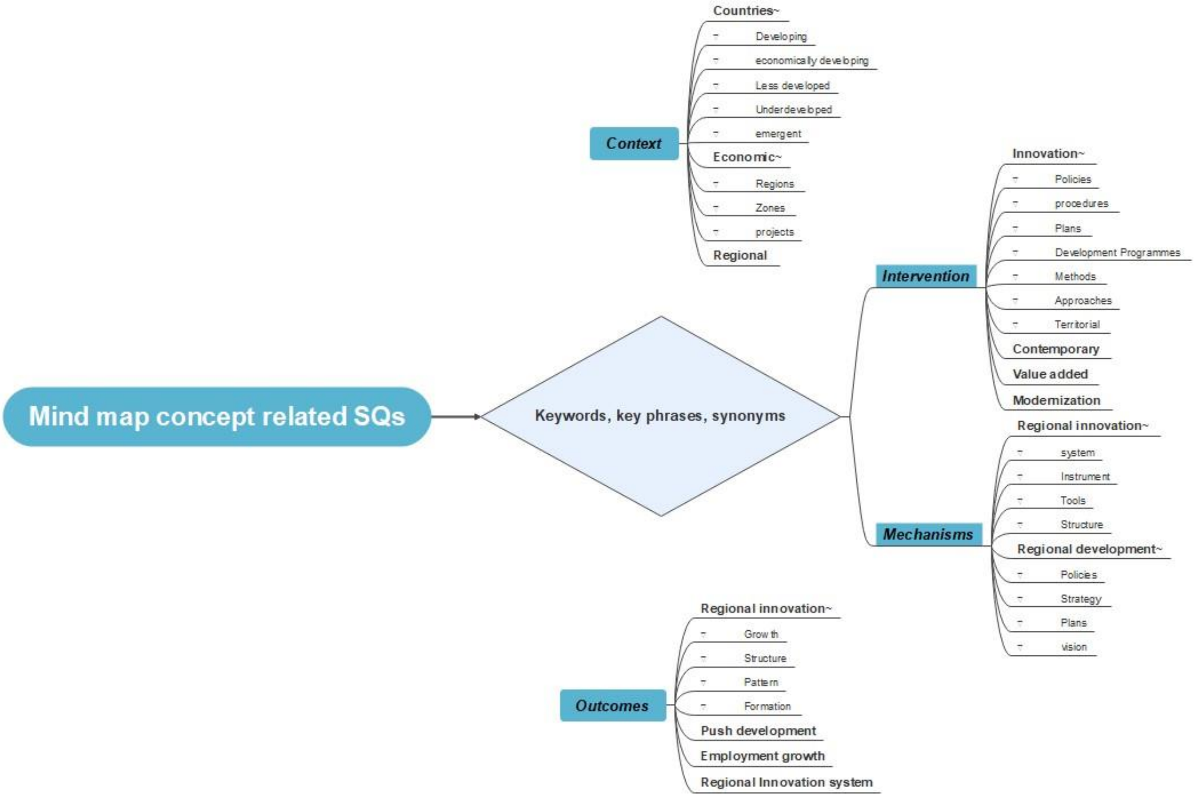
Appendices

Appendix 1. The Search queries for Regional Innovation policy literature

[1]:	TOPIC: ("regional innovation polic*") OR TOPIC: ("innovation polic*") OR TOPIC: ("innovation system*") AND TOPIC: ("developing countr*") AND TOPIC: ("regional economic growth") OR TOPIC: ("economic growth") OR TOPIC: ("economic performance") Refined by: DOCUMENT TYPES: (ARTICLE) AND WEB OF SCIENCE CATEGORIES: (ECONOMICS OR REGIONAL URBAN PLANNING OR DEVELOPMENT STUDIES) AND LANGUAGES: (ENGLISH) AND RESEARCH AREAS: (DEVELOPMENT STUDIES OR URBAN STUDIES OR SOCIAL SCIENCES OTHER TOPICS) AND Open Access: (All Open Access) AND DOCUMENT TYPES: (ARTICLE) Timespan: 1995-2019. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC.
[2]:	("regional innovation polic*") *OR* TOPIC: ("innovation polic*") *OR* TOPIC: ("regional innovation strateg*") *OR* TOPIC: ("regional innovation plan*") *OR* TOPIC: ("regional innovation procedure*") *OR* TOPIC: ("regional innovation programm*") *AND* TOPIC: ("developing countr*") *OR* TOPIC: ("less developed") *OR* TOPIC: ("underdeveloped countr*") *OR* TOPIC: ("emergent countr*") *OR* TOPIC: ("regional innovation system") *OR* TOPIC: ("regional innovation tool*") *OR* TOPIC: ("regional innovation system*") *AND* TOPIC: ("regional economic growth") *OR* TOPIC: ("economic performance") *OR* TOPIC: ("regional growth") *OR* TOPIC: ("regional employment growth") *OR* TOPIC: ("regional modernization polic*") Refined by: Databases: (WOS) AND RESEARCH AREAS: (BUSINESS ECONOMICS) AND LANGUAGES: (ENGLISH) AND SOURCE TITLES: (REGIONAL STUDIES OR RESEARCH POLICY OR SUSTAINABILITY OR APPLIED ECONOMICS) AND SOURCE TITLES: (REGIONAL STUDIES OR SUSTAINABILITY OR APPLIED ECONOMICS OR RESEARCH POLICY) Timespan: 1995-2019. Databases: WOS, BCI, CCC, DRCI, DIIDW, KJD, MEDLINE, RSCI, SCIELO, ZOOREC. Search language=English
[3] :	TOPIC: ("innovation*system") *OR* TOPIC: ("developing* country*") *OR* TOPIC: ("regional development") *AND* TOPIC: (regional) Refined by: WEB OF SCIENCE CATEGORIES: (ECONOMICS OR GEOGRAPHY OR REGIONAL URBAN PLANNING) AND LANGUAGES: (ENGLISH) AND WEB OF SCIENCE INDEX: (WOS.SSCI) AND RESEARCH AREAS: (BUSINESS ECONOMICS OR GEOGRAPHY OR URBAN STUDIES) AND DOCUMENT TYPES: (ARTICLE) AND Open Access: (All Open Access) Timespan: 2000-2019. Indexes: SCI-EXPANDED, SSCI, A&HCI, BKCI-SSH, ESCI.
[4]:	("innovation regional policy*") OR TOPIC:(" innovation regional polic*") OR TOPIC: ("economically developing country*") OR TOPIC:("Less

	developed countr*")AND TOPIC: ("regional development policy*") OR TOPIC:("regional development Strategy *") Refined by: LANGUAGES: (ENGLISH) AND RESEARCH AREAS: (BUSINESS ECONOMICS OR GEOGRAPHY OR URBAN STUDIES OR SOCIAL SCIENCES OTHER TOPICS OR DEVELOPMENT STUDIES) AND Open Access: (All Open Access) Timespan: 2000-2019. Indexes: SCI-EXPANDED, SSCI, A&HCI, BKCI-SSH, ESCI.
[5]:	("innovation regional polic*") OR TOPIC: ("innovation system") AND TOPIC: ("developing countries") AND TOPIC: ("regional development") OR TOPIC: ("innovation system") Refined by: LANGUAGES: (ENGLISH) AND RESEARCH AREAS: (BUSINESS ECONOMICS OR URBAN STUDIES OR DEVELOPMENT STUDIES OR SOCIAL SCIENCES OTHER TOPICS) AND WEB OF SCIENCE INDEX: (WOS.SSCI) AND LANGUAGES: (ENGLISH) AND SOURCE TITLES: (RESEARCH POLICY OR PAPERS IN REGIONAL SCIENCE OR EUROPEAN PLANNING STUDIES OR AFRICAN DEVELOPMENT REVIEW REVUE AFRICAINE DE DEVELOPPEMENT OR CHINA ECONOMIC REVIEW OR REGIONAL STUDIES OR WORLD DEVELOPMENT OR INNOVATION MANAGEMENT POLICY PRACTICE OR INDUSTRY AND INNOVATION OR JOURNAL OF ECONOMIC GEOGRAPHY OR HABITAT INTERNATIONAL OR SPACE POLICY OR EUROPEAN URBAN AND REGIONAL STUDIES OR THIRD WORLD QUARTERLY OR ANNALS OF REGIONAL SCIENCE OR APPLIED ECONOMICS OR GROWTH AND CHANGE OR URBAN STUDIES OR DEVELOPMENT SOUTHERN AFRICA OR DEVELOPMENT POLICY REVIEW) Timespan: 2000-2019. Indexes: SCI-EXPANDED, SSCI, A&HCI, BKCI-SSH, ESCI
[6]:	TOPIC: ("economic region*") *OR* TOPIC: ("under developed countries") *OR* TOPIC: ("innovation system") *AND* TOPIC: ("regional development*" or " regional growth" or "territorial development") Refined by: LANGUAGES: (ENGLISH) AND RESEARCH DOMAINS: (SOCIAL SCIENCES) AND RESEARCH AREAS: (BUSINESS ECONOMICS) Timespan: 1995-2019. Databases: WOS, BCI.

Appendix 2. Mind map technique Keywords, key phrases, synonyms related to the Search Queries



Source: Own construction, based on [edrawsoft](https://www.edrawsoft.com/mindmaster/?gclid=EAIaIQobChMIrprKzI_43QIVyp3tCh0SfgkEAAYASAAEgJ3ZfDBwE) mind-mapping software, available online:

https://www.edrawsoft.com/mindmaster/?gclid=EAIaIQobChMIrprKzI_43QIVyp3tCh0SfgkEAAYASAAEgJ3ZfDBwE

Appendix 3. The Search queries for Smart city policy

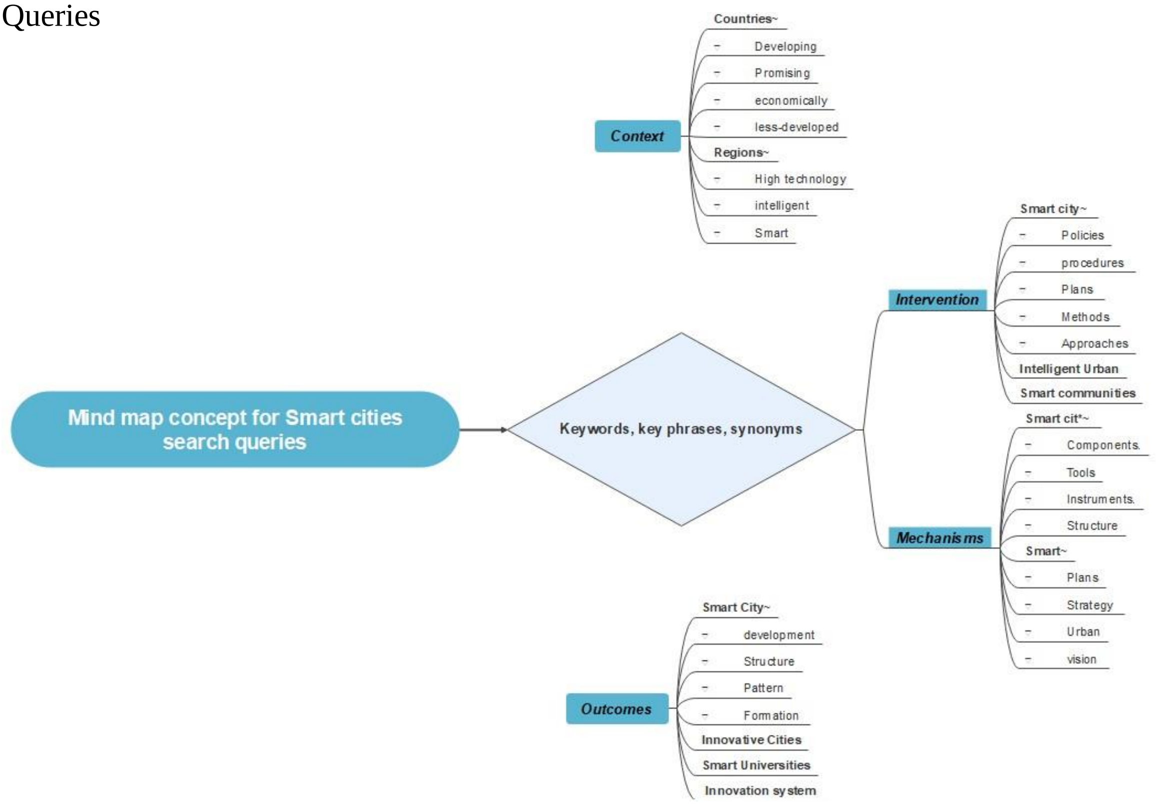
Database	Web of science WoS
[1] Search query:	**TOPIC:** (Developing countries) *AND* **TITLE:** ("smart city") *AND* **TOPIC:** (development) **Refined by: DOCUMENT TYPES:** (PROCEEDINGS PAPER OR ARTICLE OR BOOK CHAPTER OR REVIEW) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 46
[2] Search query:	**TOPIC:** (less developed countries) *AND* **TOPIC:** ("smart city") *AND* **TOPIC:** (development) *AND* **TOPIC:** (approaches) *AND* **TOPIC:** (innovative* city*) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 2
[3] Search query:	**TITLE:** ("smart urban") *OR* **TOPIC:** (smart city) *AND* **TOPIC:** (approaches) *AND* **TOPIC:** ("innovative city") **Refined by: LANGUAGES:** (ENGLISH) AND **WEB OF SCIENCE CATEGORIES:** (URBAN STUDIES OR DEVELOPMENT STUDIES OR GREEN SUSTAINABLE SCIENCE TECHNOLOGY OR GEOGRAPHY OR SOCIAL SCIENCES INTERDISCIPLINARY OR AREA STUDIES OR GEOGRAPHY PHYSICAL OR REGIONAL URBAN PLANNING OR ECONOMICS) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 50
[4] Search query:	**TITLE:** ("smart cities") *AND* **TITLE:** ("Egypt") *AND* **TOPIC:** (Smart city Policies) *AND* **TOPIC:** (plans) *OR* **TITLE:** ("innovative city") *OR* **TOPIC:** (Smart city structure) **Refined by: Open Access:** (OPEN ACCESS) AND **WEB OF SCIENCE CATEGORIES:** (ECONOMICS OR GEOGRAPHY OR SOCIAL SCIENCES INTERDISCIPLINARY OR URBAN STUDIES OR GEOGRAPHY PHYSICAL OR REGIONAL URBAN PLANNING OR AREA STUDIES) AND **Open Access:** (OPEN ACCESS) AND **LANGUAGES:** (ENGLISH) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Results: 72
[5] Search query:	**TITLE:** ("smart regions") *OR* **TITLE:** ("smart communities") *OR* **TOPIC:** (tool*) *AND* **TOPIC:** ("Smart urban") *AND* **TOPIC:** ("Smart university*") **Refined by: WEB OF SCIENCE CATEGORIES:** (AREA STUDIES OR REGIONAL URBAN PLANNING OR GEOGRAPHY OR DEVELOPMENT STUDIES OR ECONOMICS OR SOCIAL SCIENCES INTERDISCIPLINARY OR URBAN STUDIES OR TRANSPORTATION SCIENCE TECHNOLOGY) AND **LANGUAGES:** (ENGLISH) AND **WEB OF SCIENCE CATEGORIES:** (REGIONAL URBAN PLANNING OR ECONOMICS OR URBAN STUDIES OR GEOGRAPHY OR DEVELOPMENT STUDIES OR SOCIAL SCIENCES INTERDISCIPLINARY) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 26
[6] Search query:	**TITLE:** ("Underdeveloped countries") *AND* **TITLE:** ("smart city plans") *OR* **TOPIC:** ("Innovative cities") *OR* **TOPIC:** ("Smart urban") *OR* **TOPIC:** ("Smart university") **Refined by: WEB OF SCIENCE CATEGORIES:** (URBAN STUDIES OR REGIONAL URBAN PLANNING OR GEOGRAPHY OR ECONOMICS OR DEVELOPMENT STUDIES OR SOCIAL SCIENCES INTERDISCIPLINARY) AND **LANGUAGES:** (ENGLISH)

	Timespan: 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Results: 106
[7] Search query:	("smart city") *AND* **TITLE:** (Egypt) *OR* **TOPIC:** ("Innovative cities") *OR* **TOPIC:** ("Smart urban") *AND* **TOPIC:** ("Smart university") **Refined by: WEB OF SCIENCE CATEGORIES:** (ECONOMICS OR REGIONAL URBAN PLANNING OR URBAN STUDIES OR GEOGRAPHY) AND **LANGUAGES:** (ENGLISH) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 18
[8] Search query:	**TOPIC:** ("smart city") *AND* **TOPIC:** (Egypt) *NOT* **TOPIC:** (programs) *NOT* **TOPIC:** ("Smart urban") **Refined by: WEB OF SCIENCE CATEGORIES:** (DEVELOPMENT STUDIES OR GREEN SUSTAINABLE SCIENCE TECHNOLOGY OR ENGINEERING ELECTRICAL ELECTRONIC OR ENVIRONMENTAL SCIENCES OR ENVIRONMENTAL STUDIES) AND **WEB OF SCIENCE CATEGORIES:** (GREEN SUSTAINABLE SCIENCE TECHNOLOGY OR ENVIRONMENTAL SCIENCES OR ENVIRONMENTAL STUDIES OR DEVELOPMENT STUDIES) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 2
[9] search query:	**TITLE:** ("smart city") *AND* **TOPIC:** ("innovation system") **Refined by: WEB OF SCIENCE CATEGORIES:** (REGIONAL URBAN PLANNING) **Timespan:** 1995-2020. **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI. Results: 1
SCOPUS	
[1] Search query:	developing AND countries AND title: "smart city" AND topic: AND development AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (LANGUAGE , "Englsh")) AND (EXCLUDE (SUBJAREA , "BUSI") OR EXCLUDE (SUBJAREA , "ENER") OR EXCLUDE (SUBJAREA , "COMP") OR EXCLUDE (SUBJAREA , "ENGI") OR EXCLUDE (SUBJAREA , "EART") OR EXCLUDE (SUBJAREA , "DECI") OR EXCLUDE (SUBJAREA , "ARTS")) AND (EXCLUDE (SUBJAREA , "ENVI") OR EXCLUDE (SUBJAREA , "AGRI") OR EXCLUDE (SUBJAREA , "BIOC") OR EXCLUDE (SUBJAREA , "MATH") OR EXCLUDE (SUBJAREA , "PSYC")) Results: 44
[2] Search query:	**TOPIC:** (less developed countries) *AND* **TOPIC:** ("smart city") *AND* **TOPIC:** (development) *AND* **TOPIC:** (approaches) *AND* **TOPIC:** (innovative* city*) Results: 5

[3] Search query:	ALL (*less* AND *developed* AND *countries* AND *"smart city"* AND *development* AND *approaches* AND *innovative** AND *city**) AND (LIMIT-TO (SUBJAREA , *"SOCI"*) OR LIMIT-TO (SUBJAREA , *"ECON"*) OR LIMIT-TO (SUBJAREA , *"ARTS"*)) AND (LIMIT-TO (LANGUAGE , *"English"*)) Results: 51
[4] Search query:	*title: "smarturban"* OR *topic:* AND *smart* AND *city* AND *topic:* AND *approaches* AND *topic: "innovative city"* AND (LIMIT-TO (LANGUAGE , *"English"*)) AND (LIMIT-TO (SUBJAREA , *"SOCI"*) OR LIMIT-TO (SUBJAREA , *"ECON"*)) Results: 16
[5] Search query:	**TITLE:** ("smart regions") *OR* **TITLE:** ("smart communities") *OR* **TOPIC:** (tool*) *AND* **TOPIC:** ("Smart urban") *AND* **TOPIC:** ("Smart university*") Results: **0**
[6] Search query:	*topic: "developing countries"* AND *title: "smart city"* OR *topic: "Innovative cities"* OR *topic: "Smart urban"* AND (LIMIT-TO (SUBJAREA , *"SOCI"*) OR LIMIT-TO (SUBJAREA , *"ECON"*) OR LIMIT-TO (SUBJAREA , *"ARTS"*)) AND (LIMIT-TO (LANGUAGE , *"English"*)) Results: **16**
[7] Search query:	*"smart city"* AND *topic:* AND *egypt* AND *topic: "Smart urban"* AND (LIMIT-TO (SUBJAREA , *"SOCI"*)) Results: **1**
[8] Search query:	*topic: "smart city"* AND *topic:* AND *egypt* AND (LIMIT-TO (AFFILCOUNTRY , *"Egypt"*) OR LIMIT-TO (AFFILCOUNTRY , *"Saudi Arabia"*) OR LIMIT-TO (AFFILCOUNTRY , *"India"*)) AND (LIMIT-TO (SUBJAREA , *"SOCI"*)) AND (LIMIT-TO (LANGUAGE , *"English"*)) Results: **5**
[9] Search query:	*topic: "smart city"* AND *topic:* AND *egypt* AND (LIMIT-TO (SUBJAREA , *"SOCI"*)) Results: **30**
EBSCO **Academic Search Complete, OpenDissertations, Business Source Premier, Regional Business News**	
RQ1	**TOPIC:** (Developing countries) *AND* **TITLE:** ("smart city") *AND* **TOPIC:** (development) Results: **4**
RQ2	**TOPIC:** (less developed countries) *AND* **TOPIC:** ("smart city") *AND* **TOPIC:** (development) *AND* **TOPIC:** (approaches) *AND* **TOPIC:** (innovative* city*) Results: **0**
RQ3	**TITLE:** ("smart urban") *OR* **TOPIC:** (smart city) *AND* **TOPIC:** (approaches or strategies) *AND* **TOPIC:** ("innovative city") Results: **18**
RQ4	**TITLE:** ("smart cities") *AND* **TITLE:** ("Egypt or Egyptian") *OR* **TOPIC:** (Smart city Policies) *NOT* **TOPIC:** (plans) *OR* **TITLE:** ("innovative city") *OR* **TOPIC:** (Smart city structure) Results: **25**

RQ5	**TITLE:** ("smart regions") *OR* **TITLE:** ("smart communities") *OR* **TOPIC:** (tool*) *AND* **TOPIC:** ("Smart urban") *AND* **TOPIC:** ("Smart university*") Results: **2**
RQ6	**TITLE:** ("Underdeveloped countries") *AND* **TITLE:** ("smart city plans") *OR* **TOPIC:** ("Innovative cities") *OR* **TOPIC:** ("Smart urban") *OR* **TOPIC:** ("Smart university") Results: **17**
RQ7	("smart city") *AND* **TITLE:** (egypt or egyptian) *OR* **TOPIC:** ("Innovative cities") *OR* **TOPIC:** ("Smart urban") *AND* **TOPIC:** ("Smart university") Results: **20**
RQ8	**TOPIC:** ("smart city") *AND* **TOPIC:** (Egypt) *NOT* **TOPIC:** (programs) *NOT* **TOPIC:** ("Smart urban") Results: **0**
RQ9	**TITLE:** ("smart city") *AND* **TOPIC:** ("innovation system") Results:**2**

Appendix 4. Mind map technique for Keywords, key phrases, synonyms related to the Search Queries



Source: Own construction, based on [edrawsoft](https://www.edrawsoft.com) mind-mapping software, available online:

https://www.edrawsoft.com/mindmaster/?gclid=EAIaIQobChMIrprKzI_43QIVyp3tCh0SfgkEAAYASAAEgJ3ZfD_BE

Appendix 5. Smart city definitions

A city that monitors and integrates conditions of all of its critical infrastructuresincluding roads, bridges, tunnels, rails, subways, airports, sea-ports, communications,water, power, even major buildings, can better optimize its resources, plan itspreventive maintenance activities, and monitor security aspects while maximizing services to its citizens	(P. Hall, 2000)
There are as many definitions of SCs as there are cities that labels themselves as smart:(1) An SC is one that makes high use of ICTs; (2) an SC is one that has a strong entrepreneurial spirit; (3) an SC is one that cares about social and environmental sustainability; (4) an SC is characterized by the three'T's': tolerance, technology andcreative talent. In short, SCs involve a very diverse range of elements (ICT, business innovation, government, communities and sustainability). An SC uses ICTs toimprove economic and political efficiency and enable social and environmentaldevelopment.	(Hollands, 2008a)
A Smart City is defined as a city that takes advantage of the opportunities offered by ICTs to increase local prosperity and competitiveness, an approach which impliesintegrated urban development involving multi-actor, multi-sector and multi-levelperspectives	(Paskaleva, 2011)
An SC is one that uses ICTs to make the critical infrastructure components and servicesof a city (which include city administration, education, healthcare, public safety, realestate, transportation and utilities) more intelligent, interconnected and efficient.	(Washburn & Sindhu, 2010)
A city is smart when investments in human and social capital and traditional (transport)and modern (ICT) communication infrastructure fuel sustainable economic growthand a high quality of life, with a wise management of natural resources through participatory governance.	(Caragliu & Del Bo, 2012)
The SC concept is multi-dimensional. It is a future scenario; even more it is an urbandevelopment strategy. It focuses on how (Internet-related) technologies enhance thelives of citizens	(Schaffers et al., 2012)
A city in which ICT is merged with traditional infrastructures, coordinated andintegrated using new digital technologies, and where intelligence functions and is ableto integrate and synthesize urban data to improve the efficiency, equity, sustainabilityand quality of life in cities.	(Batty, 2013)
Smart Cities are the result of knowledge-intensive and creative strategies aiming atenhancing the socio-economic, ecological, logistic and competitive performance ofcities. Such smart cities are based on a promising mix of human capital (e.g. skilledlabour force), infrastructural capital (e.g. high-tech communication facilities), socialcapital (e.g.	(Kourtit et al., 2012)

intense and open network linkages) and entrepreneurial capital (e.g.creative and risk-taking business activities).	
Smart Cities incorporate the following groups: smart governance (related to participation); smart human capital (related to people); smart environment (related to national resources); smart living (related to the quality of life); and smart economy(related to competitiveness)	(Lombardi et al., 2012)
Smart Cities are all urban settlements that make a conscious effort to capitalize on thenew Information and Communications Technology (ICT) landscape in a strategicway, seeking to achieve prosperity, effectiveness and competitiveness on multiplesocio-economic levels	(Angelidou, 2014)
A Smart City can be characterized by three elements: (1) e-governance, (2) engagementby stakeholders, citizens and communities, and (3) network-based relationships	(Gil-Garcia et al., 2015)
The Smart City concept embraces more than just the use of ICT, where ICT often is seenas a means to achieve better city services and/or more efficient city administration	(Anthopoulos, 2017)
A city that is supported by the pervasive presence and massive use of advanced ICT,which, in connection with various urban systems and domains and how theseintricately interrelate and are coordinated respectively, enables the city to controlavailable resources safely, sustainably, and efficiently to improve economic andsocietal outcome	(Bibri, 2018)
There are'three types of drivers of Smart Cities (community, technology, policy) whichare linked tofive desired outcomes (productivity, sustainability, accessibility, well-being, liveability, governance). These drivers and outcomes altogether assemble asmart city framework	(Yigitcanlar et al., 2019)
A Smart City is made up of 6 elements: human capital; social capital; transport; technological infrastructure; natural resources and e-government.	(Caragliu & Del Bo, 2019)
Smart Cities are considered as socio-technical systems in which technologicaldevelopment is aligned with human, social, cultural, economic, and environmentalfactor.	(Mora et al., 2019)

Appendix 6. Interviews reports

INTERVIEW REPORT #1

Eng. Wael Moussa

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Technical advisor to the Minister of Housing, Utilities and Urban Development, Egypt.

Online meeting. 12/24/2020

Mohamed Ali, PhD candidate (The author).

In our online interview - conducted through the Duo application, one of the Google applications - Eng. Wael and I talked for about an hour. The purpose of this interview was to determine what is the proposed smart city policy. How is the model created? In the Egyptian state, what is the vision of decision-makers and stakeholders regarding smart cities? During the interview, the focus was on the new administrative capital model, which is considered a pioneering case model for applying smart city approaches in Egypt.

Wael explained that the Egyptian government has been developing a plan for developing 14 new smart cities since 2016, with the goal of using information technology and urban intelligence in the management and operation of the fourth-generation of new cities. Moreover, he explained that the aim of these cities is not only luxury, but also to distribute the large population increase, doubling the Egyptian population instead of concentrating it in the delta and valley, in addition to placing Egypt on the map of global investments. The future population of these cities is expected to reach 30 million. These strategic locations were chosen to achieve multiple criteria, including their unique location that makes them competitive global and regionally, and their location on the population doubling development axes in addition to their link to major projects that the state is working on implementing. According to Wael, these smart cities are supposed to be managed and operated through the use of information technology and urban intelligence.

According to Wael, in order to implement the urban intelligence plan in a meaningful way, a supreme committee was formed by republican resolution, headed by the Prime Minister, which consists of several relevant ministries from the Egyptian government, including those of (communication and information technology, transport, interior, housing, and urban development, and defense). In Wael's view, these government agencies were established specifically to serve the proposed model for smart cities, which depends on communications and information technology, transportation strategies, safe city security, intelligent facilities and infrastructure, and data centers and control, just like in the New Administrative Capital (NAC) model. The NAC model consists of a variety of components such as an Intelligent Transportation Systems (ITS), smart lighting, a City Operating Center (COC), smart applications, a central data center, a Commander Control Center (CCC), smart facilities, and finally universities and research centers within the city.

Wael stated at the end of our interview that the Egyptian government intends to apply the NAC model to other fourth-generation cities, such as Alamein in the Alexandria Governorate. According to him, Egypt's government is preparing to move with all its organs to the NAC by the end of 2021. In response to my inquiry about documenting information on the Egyptian smart city policy and making data available, Wael replied that the model is still in its infancy and that the concerned committee is determined to formulate the national plan for smart cities based on its components and policy tools, and its future goals, as soon as the government moves into its new administrative capital. Upon request, Wael provided a set of work papers and documents - sent via e-mail - that could be read and used for the academic purpose of using them as references and sources.

As a result of the interview, I gained a deeper understanding of the Egyptian model in general as well as the government's vision, especially since this information was not publicly available in the press or on the websites of these authorities and ministries.

Mohamed Ali 01/02/2021

INTERVIEW REPORT #2

Dr. Mohamed Khalil

linkedin.com/in/mohammed-khalil-02a4482b

Chief Technology Officer (CTO) at Administrative Capital for Urban Development - ACUD

Online meeting. 12/26/2020

Mohamed Ali, PhD candidate (The author).

An interview was conducted with Dr. Muhammad Khalil over Zoom, and the interview lasted approximately one hour. The primary objective of the interview was to identify the components of the Egyptian smart city model, including information technology, data analysis, and its organizational structure.

Khalil described the NAC model, which he described as one of the fourth-generation cities that rely on information technology, data analysis, and making decisions based on the Internet of Things, which he described as "operations management". A key question Khalil brought up during the interview is what should be the policy or plan to make the NAC a sustainable smart city based on international standards for smart cities. Khalil points out that establishing a governmental committee to conceptualize smart cities in the Egyptian context has greatly helped to implement the first phase of the NAC. This committee was formed from representatives from the Ministry of Interior, Ministry of Defense, Ministry of Housing and Urban Development, and the Ministry of Communications and Information Systems, which worked in partnership with the Administrative Capital for Urban Development company ACUD in order to form the proposed model.

Khalil indicated that the proposed model avoids the errors that similar smart city models in similar countries have encountered when it comes to development. Additionally, he mentioned how ACUD (an investment company owned by the state and other parties) developed and managed the city by investing in its assets. According to Khalil, what differentiates the NAC from other cities is its use of technology, which makes it more of a smart and sustainable city rather than merely a technological city. In his commentary, Khalil discussed how the NAC relies on three elements for achieving sustainable intelligence: the smart structure, the information database (which encompasses all management and operation components), and the human element in management and society, which grows with experimental operation.

The NAC has adopted the concept of "smart city codes," one of the most important things Khalil stressed when discussing the information system in operating the city and providing facilities and services. Smart infrastructure and smart services (managed by the City Control Center), special services (such as digital advertisements), and the human element (through smart applications) rely upon these codes. Khalil emphasized that codes are the first step to integrating the human element and community awareness within the NAC. Khalil indicated at the conclusion of the interview that the NAC relies on a "smart" model of services and is based on three pillars: the service provider, the service receiver, and the ACUD (which acts as a mediator between the service provider and its recipient). I received working papers and data from Dr. Mohamed Khalil on the smart services used in Egypt's smart city model.

Throughout the interview, I gained a deeper understanding of the NAC model, the proposed service model, and how the IOT-based model works, as well as a deeper understanding of the administrative model on which the NAC is premised as a smart city.

Mohamed Ali 01/03/2021

Appendix 7. The Description and Source of Innovation Capacity Indicators Used in the RICI for Egyptian Governorates

	The Description and Source of Innovation Capcity Indicators Used in the RICI for Egyptian Governorates				
Code	***Sub-index***	***Indicator***	***Description and definition***	***Source of Data***	***Data Availability***
KC1	***Knowledge creation***	R&D performing units	It is the total number of R&D units in the governorate, whether associated with a research institution or housed within universities.	Central Agency for Public Mobilization and Statistics (CAPMS) - Ministry of Planning	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621
KC2		Staff of R&D units	It is the entire number of R&D personnel, whether they be researchers, technicians, or supporting staff.	CAPMS	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
KC3		Number of scientists with PhD	It is the total number of Ph.D. degree holders in the governorate, whether they are university staff in universities or outside the academic sector.	General Census for Population, Housing and Establishments 2017	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
KC4		Number of teaching staff of higher education	The total number of faculty members in public, private, and Al-Azhar university education.	General Census for Population, Housing and Establishments 2017	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
KC5		Expenditure R&D for Higher education and government centers *	It is the total government spending on research and development in the university sector and government research centers associated with the governorate's government entities.R&D activities in the academic sector. It includes spendings such as labor costs, which can be further broken down (annual wages and salaries and all associated costs of researchers, technicians, and	The Egyptian Science, Technology and Innovation Observatory (ESTIO) at the Academy of Scientific Research and	

			supporting staff). Other current costs are also included, such as purchases of materials, supplies, and R&D.	Technology (ASRT)	
KC6		Number of patents *	It is the total number of patent applications submitted to the Egyptian Patent Office(EPO) in 2018, which includes patent applications from individuals, companies, and research centers.	Egyptian Patent Office(EPO)	http://www.asrt.sci.eg
KC7		Employees Number in Scientific & Research Centers	It is the total number of employees in the ministries' connected research and scientific centers, which are national governmental research centers.	General Census for Population, Housing and Establishments 2017	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
KC8		Number of Scientific & Research Center	The total number of research and scientific centers within the governorate	General Census for Population, Housing and Establishments 2017	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
KUT1	***Knowledge Utilization***	Number of knowledge-based startups	The governorate's total number of startups focused on knowledge and innovation.	EgyptInnovate	https://egyptinnovate.com/en/innovation/map
KUT2		Number of foreign-owned companies	The total number of firms owned by non-Egyptians, which demonstrates the possibility of using the governorate's knowledge and the possibilities offered to non-Egyptians.	General Census for Population, Housing and Establishments 2017	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
KUT3		Number of accelerators/incubators	The number of accelerators and incubators in the governorates reflects the providing knowledge utilization in the governorates.	EgyptInnovate	https://egyptinnovate.com/en/innovation/map

KUT4		Number of TTOs/TICO(transfer tech. offices)	It is the number of The Technology Transfer Office (TTO) or the Technology and Innovation Coordination Offices (TICO). It is responsible for managing the transfer of technology to industry . The transfer of technology and knowledge from academia to industry plays a crucial role in promoting innovation and economic growth. This can result in the utilization of knowledge and the creation of new businesses, jobs, and products.	EgyptInnovate	https://egyptinnovate.com/en/innovation/map
KUT5		Employment in high-tech industries	The information includes employment in the high technology industry from industries such as electronic and optical products, electronic components and boards, communication equipment, irradiation, testing, and electromedical and electrotherapeutic equipment. The Location Quotient (LQ) for high technology industries employment is used in this concentration, which relates to the contribution of high technology industries to overall industrial activity within the governorate. A location quotient relates to regional and national importance of an industry, based on its related share in the regional and the national economy. Equation: LQ = (EMPLHTGOV/EMPLTOTGOV)/ (EMPLHTEGYPT/EMPLTOTEGYPT), where EMPLHT and EMPLTOT stand for employment in high technology industries and total employment, respectively.	Egyptian Economic Census 2018, CAPMS	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/405/download/840

SMART1	**“smart” infrastructure**	Number of full-time students in higher education institutions	The total number of students enrolled in the university sector in terms of public and private universities.	CAPMS	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
SMART2		Employees Number in telecommunications	The total number of workers in the communications and information technology sector in the governorate	General Census for Population, Housing and Establishments 2017	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621/related_materials
SMART3		Number of innovative service providers units	Throughout the governorates, there are technology and innovation support centers. These are facilities that offer assistance to talented and entrepreneurs.	TIEC (Technology Innovation and Entrepreneurship Center)	https://egyptinnovate.com/en/innovation/map
SMART4		Number of employees of innovation-based business services activities (BUS)	It is measured by the number of innovation support services employed. It has focused on local bases for financial, legal, and marketing or technical knowledge for innovation services activities. Legal knowledge (M691, M70) refers to the legal activities and head offices, and management consultancy activities (CAPMAS, 2017)	Egyptian Economic Census 2018, CAPMS	https://censusinfo.capmas.gov.eg/Metadata-env4.2/index.php/catalog/405/download/840
SMART5		Percent of the population using the Internet	It is the proportion of the governorate's population serviced by Internet services as a percentage of the total population.	Central Agency for Public Mobilization and Statistics (CAPMS) - Ministry of Planning	https://censusinfo.capmas.gov.eg/Metadata-en-v4.2/index.php/catalog/621

* Dr. Mohamed Ramadan and his team deserve special gratitude for supplying statistics on patent data and R&D expenditure.

Appendix 8. Cronbach alpha statistics results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.923	.925	18

Case Processing Summary

		N	%
Cases	Valid	27	100.0
	Excluded[a]	0	0.0
	Total	27	100.0

a. Listwise deletion based on all variables in the procedure.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
KCR_1	3.5322201	7.230	.328	.924
KCR_2	3.4892635	6.587	.722	.916
KCR_3	3.4410090	6.683	.866	.913
KCR_4	3.3987073	6.772	.677	.917
KCR_5	3.5107009	6.768	.724	.916
KCR_6	3.3797792	6.797	.643	.918
KCR_7	3.3963130	6.413	.753	.915
KCR_8	3.3485365	7.243	.245	.927
KEX_1	3.5697064	6.725	.830	.914
KEX_2	3.4606880	6.723	.570	.920
KEX_3	3.5462917	6.824	.592	.919
KEX_4	3.5434624	7.487	.063	.931
KEX_5	3.5110819	7.209	.308	.925
SMART_1	3.4480964	6.685	.882	.913
SMART_2	3.2909164	6.620	.670	.917
SMART_3	3.5659517	6.728	.785	.915
SMART_4	3.2616250	6.670	.823	.914
SMART_5	3.2398953	6.631	.627	.918

Appendix 9*. The scores of indicators for the three sub-indices*

Govs	***knowledge creation***								***Knowledge utilization***					***"smart" infrastructure***				
	KCR_1	***KCR_2***	***KCR_3***	***KCR_4***	***KCR_5***	***KCR_6***	***KCR_7***	***KCR_8***	***KUT_1***	***KUT_2***	***KUT_3***	***KUT_4***	***KUT_5***	***SMART_1***	***SMART_2***	***SMART_3***	***SMART_4***	***SMART_5***
Cairo	28.14	100.00	100.00	100.00	52.07	64.72	100.00	57.33	100.00	73.85	68.93	28.31	39.70	100.00	85.32	100.00	100.00	94.49
Alexandria	10.00	33.69	45.36	40.58	25.31	62.45	96.22	18.82	26.13	35.63	28.29	8.71	11.23	41.95	86.63	18.47	72.20	80.27
Port Said	0.00	0.00	39.49	48.89	9.90	33.57	22.91	65.25	0.00	14.95	0.00	0.00	5.75	28.60	35.98	42.68	54.39	100.00
Suez	28.27	19.16	12.57	21.16	3.66	64.87	15.84	38.81	0.00	7.23	100.00	0.00	0.17	15.45	75.74	0.00	43.63	83.98
Damietta	13.77	11.33	19.26	19.46	4.18	16.68	23.96	29.71	0.00	20.11	0.00	0.00	0.21	8.29	10.99	0.00	55.27	66.12
Dakahlia	7.14	4.92	19.93	21.23	3.71	2.43	20.04	14.31	5.00	4.81	0.00	0.00	2.91	22.27	17.39	4.89	33.37	44.41
Sharkia	6.44	5.68	22.28	25.46	4.60	17.34	21.54	12.35	1.94	16.96	0.00	6.24	23.30	12.83	11.05	4.41	22.59	33.71
Kalyoubia	4.57	19.31	19.70	20.40	6.20	18.89	22.24	21.53	0.82	16.41	0.00	0.00	100.00	12.12	38.17	0.00	35.51	51.06
Kafr El Sheikh	6.09	2.95	16.52	10.76	1.37	17.86	1.11	17.93	1.37	3.04	0.00	0.00	6.32	11.94	27.73	0.00	26.00	29.86
Gharbia	2.06	1.00	21.39	24.70	4.50	26.25	33.85	13.73	3.71	2.97	0.00	0.00	1.27	20.48	28.33	0.00	34.23	48.51
Menoufia	2.39	0.92	18.79	26.64	4.91	18.55	24.17	23.40	6.45	3.57	0.00	0.00	3.07	14.13	16.71	0.00	27.64	36.70
Behera	2.48	0.80	7.11	4.57	0.00	20.46	3.55	8.44	2.98	3.20	0.00	0.00	2.04	0.00	36.50	0.00	25.12	11.75
Ismailia	3.92	18.21	37.88	59.84	12.30	4.99	48.64	39.95	7.06	26.03	0.00	0.00	32.71	23.57	38.84	0.00	38.27	52.39
Giza	20.20	40.05	41.23	53.15	100.00	100.00	98.20	37.30	25.17	35.62	33.64	20.72	44.83	29.28	58.27	18.30	64.85	51.93
Beni Suef	4.83	3.12	6.44	22.37	4.75	18.90	9.09	25.28	1.45	1.27	0.00	56.18	25.54	20.26	30.40	9.92	20.12	11.32
Fayoum	1.41	0.55	5.09	16.93	2.75	6.13	9.75	16.64	0.00	0.87	0.00	0.00	3.02	1.45	33.11	0.00	37.39	11.29
Menia	2.77	3.75	11.78	16.82	2.84	9.64	10.61	13.75	2.49	0.03	0.00	0.00	0.01	4.07	30.43	0.00	19.69	5.62
Asyout	1.15	3.13	19.69	27.76	5.16	15.02	30.21	23.56	2.08	1.28	16.34	10.07	2.93	17.08	13.59	0.00	22.06	13.22
Suhag	4.08	2.96	8.94	10.55	1.34	20.29	8.23	10.41	0.00	0.00	14.44	8.89	6.92	4.78	11.41	0.00	26.33	15.74
Qena	0.00	0.00	7.17	15.56	2.47	14.72	7.37	17.62	1.45	0.42	0.00	0.00	0.00	5.30	9.19	9.88	24.65	22.20
Aswan	4.09	3.96	0.00	28.39	5.35	33.34	0.72	6.41	0.00	4.69	0.00	0.00	19.78	14.15	11.78	0.00	34.06	39.63
Luxor	10.37	5.36	4.38	0.00	6.51	23.80	6.00	46.11	0.00	1.32	0.00	30.14	0.96	5.10	19.87	0.00	26.08	29.45
Red sea	14.21	5.50	22.21	0.00	16.47	25.36	4.43	11.15	0.00	90.76	0.00	0.00	0.88	36.21	68.72	0.00	70.32	72.61
New valley	21.24	90.51	13.89	0.00	17.32	10.83	9.25	100.00	0.00	4.15	0.00	0.00	3.60	14.73	21.38	0.00	34.70	42.78
Matrouh	0.00	0.00	7.66	0.00	7.48	20.47	0.00	81.00	0.00	23.06	0.00	100.00	1.12	4.36	33.62	0.00	22.30	0.00
North Sinai	0.00	0.00	10.15	44.89	9.20	43.67	38.63	44.79	10.29	0.51	0.00	0.00	16.88	23.76	0.00	0.00	0.00	13.44
South Sinai	100.00	38.74	6.97	0.00	43.36	0.00	0.00	0.00	0.00	100.00	0.00	0.00	1.53	34.58	100.00	0.00	59.47	26.41