UNIVERSITY OF PÉCS

FACULTY OF BUSINESS AND ECONOMICS

DOCTORAL SCHOOL OF REGIONAL POLICY AND ECONOMICS

Mohamed Abouelhassan Mohamed Ali

Egypt Vision 2030: New Smart Cities for Regional Development

Evaluation of Innovation Capacity in Egyptian Governorates

DOCTORAL DISSERTATION

(Summary)

Supervisors: Prof. Attila Varga

Dr. Éva Somogyiné Komlósi

Pécs, 2022

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

Table of Contents

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.

1. Synopsis of the dissertation

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). If current growth continues, Egypt's population will reach 160.3 million by 2050 (UN, 2022). Fertility rates have started to decline since the 1960s and the population growth rate has slowed since 2014. However, with a growth rate of 1.6% in 2022, the country still expands by nearly 2 million people a year (World Bank, 2023b). More than 8 million additional dwellings will be needed by 2030 to meet the country's housing needs (Waisová, 2022). By 2050, 41.4 million people are expected to live in urban areas, placing additional burdens on the provision of basic services such as water supply and sanitation in these areas (World Bank, 2022). According to Kwasi et al. (2022), Egypt is expected to face critical water shortages by 2025.

Second, there is a shortage of habitable land, which makes urban development and expansion difficult. The so-called informal settlements in Egypt are unplanned and unauthorized urban areas that have developed as a result of rapid urbanization and population growth. Informal settlements are mainly inhabited by low-income people and are characterized by a lack of basic infrastructure, overcrowding, poor sanitation, limited access to clean water and a lack of formal land tenure. It is estimated that around 12-20 million Egyptians live in informal settlements (Kwasi et al., 2022). In 2019, these settlements accounted for around 38% of the built-up area and were home to around 5.2% of the urban population (Ministry of Planning and Economic Development, 2021). 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. For example, Greater Cairo and Alexandria accounted for nearly 60% of the overall population. In contrast, many regions in Upper Egypt and the Western Desert, have much lower population densities. The 12 governorates of Upper Egypt account for only 12% of total GDP, while Lower Egypt and the urban governorates account for nearly 88% (CAPMAS, 2017). The Cairo metropolitan area alone accounts for 47-49% of Egypt's GDP (World Bank, 2022). Regional disparities in educational attainment and literacy are also evident, contributing to the unequal development of human capital. Regional differences are also reflected in poverty rates and unemployment levels. In general, urban areas have lower rates of poverty and more

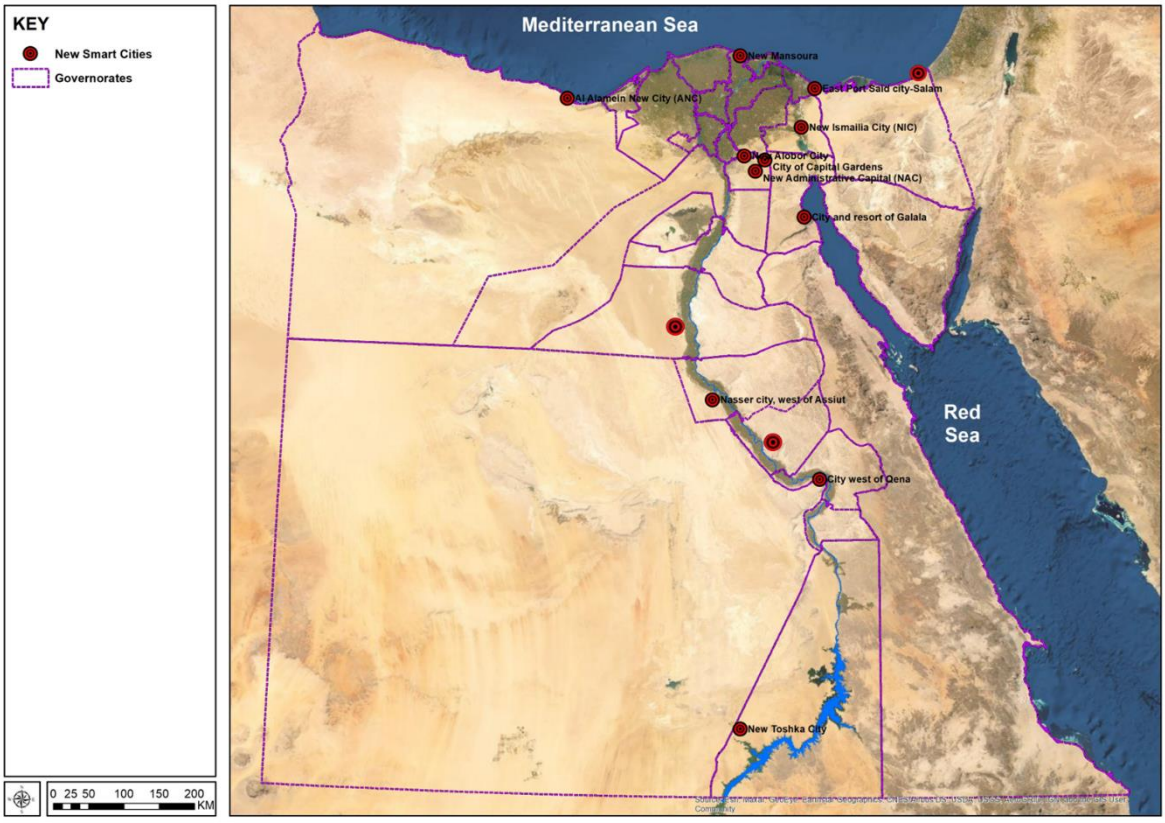
employment opportunities than rural areas. Especially in southern and remote areas, where poverty and unemployment are high. Fourth, previous attempts at economic reform have consistently failed due to a lack of a clear vision and strategy (Ministry of Planning and Administrative Reform, 2014).

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. Firstly, the economic dimension includes four pillars such as (1) balanced regional development, (2) energy, (3) knowledge, innovation, and scientific research, and (4) the transparency and efficiency of institutions. Second, the social dimension includes four pillars that are concerned with (5) social justice, (6) education and training, (7) health, and (8) culture. Finally, the environmental dimension includes (9) environmental and (10) urban development 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. In Egypt, the idea of building new cities dates to the 1970s. In Egypt, new cities are classified into generations based on the duration of their construction, type of planning design, and technology used (Waisová, 2022). Three generations of new cities were planned and built so far: earlier generations were built in the 1970s, 1980s, and 1990s (Attia, 2018; Mohamed, 2021). Since the 1970s, 31 cities have been built across Egypt. The urban expansion relies on two main pillars: first, forming new development axes in uninhabited areas with potential for use; second, establishing a series of new cities and villages throughout the Nile Valley and Delta, serving as centers for development and urbanization to achieve stability, social balance, and reduce population density in existing cities to preserve agricultural lands (Mohamed, 2021; Waisová, 2022).

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 (Figure 1). These include the New Administrative Capital (NAC), New Alamein, New Mansoura, East Port Said, Nasser City in west Assiut, West Qena, New Ismailia, New Rafah, New Galala, New Farafra, New Obour, New Toshka, and Sharq El Owainat. 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).

Figure 1 Egyptian new urban centers “smart cities” locations



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

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). Generally, the *smart city concept* pertains to how technology, particularly ICT and digital solutions, and efficiency gains from digital technology, contribute to improving the well-being and quality of life of urban citizens by improving the services and sustainable economic growth in cities. Based on Caragliu et al. (2011), smart cities are identified as 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 et al., 2011, p. 70). The concept of a smart city is not new. Cities that employ information and communication technology (ICT) to manage urban services have been referred to by a variety of labels in the literature. They have been called "wired cities", "cyber cities", "digital cities", "intelligent cities", or "sentient cities" (Orlando & De La Barrera, 2020). While all of these phrases refer to the influence of ICT on urban structure and lifestyle, they have recently been grouped together under the umbrella term of smart city. The early 1990s have seen a major increase in the general usage of computing technology and the Internet (Eremia et al., 2017). Consequently, numerous city administrations (notably Bangalore in India, San Diego (CA) in the United States, Ottawa in Canada, Southampton in the United Kingdom, and Brisbane in Australia) began using ICT to solve urban difficulties in the late 1990s and early 2000s (Hollands, 2008; Orlando & De La Barrera, 2020).

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. Smart infrastructure, such as enhanced transportation systems, smart grids, and efficient waste management, will be carefully planned using digital technologies to maximize resource usage while minimizing environmental effects. The new cities will have broad high-speed internet connectivity, allowing smart devices, sensors, and data analytics to improve services, security, and convenience for inhabitants. Smart governance will be critical in establishing a citizen-centric government based on data-driven decision-making and smart services for public safety, healthcare, education, and other critical requirements. 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. For the purpose of generating international interest, the Egyptian government showcases promotional videos highlighting these modern cities of the future[1].

The creation of Egyptian new (smart) 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: the *New Administrative Capital* in East Cairo, *New Alamein* in the Alexandria region, *New Mansoura* in the northern Delta, *New Ismailia* in the Suez Canal area, and *New Al Galala* on the Red Sea (NUCA, 2023). Furthermore, nine cities are still in the second phase of implementation, working on finishing their residential neighborhoods, projects, and planned land uses. East Port Said, Nasser City in West Assiut, West Qena, New Rafah, New Farafra, New Obour, New Toshka, New Aswan, and East El Owainat are among them. Meanwhile, both the New Administrative Capital and New Alamein have entered the third stage of implementation. The most significant progress has been made in the NAC: since the beginning of 2023, all ministries, the Prime Minister's Office, Parliament and other government offices have moved to the new capital. According to the government press releases, both the NAC and the New Alamein are set to open officially by the end of 2023. Moreover, universities have been constructed in five cities since 2021 (Abbas, 2021). British University in the New Administrative Capital, German International University, American University in the New Administrative Capital, and Coventry University in the NAC are a few examples. In addition, in 2021, the International University of Alamein in New Alamein and the University of Al Galala in New Al Galala City started academic activities.

Recentaly, 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

[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)

also serve as tools for promoting innovation and regional development (Appio et al., 2019; Kraus et al., 2015; Ratten, 2017). Consequently, according to Egypt vision, Egypt's 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. Egyptian policymakers hope that fourth-generation smart cities will transform people's lives by offering diverse activities and services, encouraging innovation, providing reliable transportation alternatives, and adapting to climate change, while adhering to the ideals of sustainability (Mostafa & Beshir, 2023).

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. This serves as an additional catalyst for private sector investments and entrepreneurial innovation. According to the additional 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.

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 governorates of Giza and Cairo stand out as outliers, with high performance in innovation-related indicators (Ali, 2021). Official statistics reveal a high concentration of knowledge-based startups, around 80%, in Cairo and Giza governorates, while other regions are relatively underrepresented. In

CAPMAS addition, around 65% of research and innovation institutions are concentrated in Greater Cairo. Moreover, there's a significant disparity in the distribution of innovative industry workers, with over 80% located in the Greater Cairo region, while all other governorates combined make up less than 20% (CAPMAS, 2017; Capmas, 2021; Ministry of Higher Education and Scientific Research Egypt, 2019; MoHUUC, 2020). The above points to the fact that the Egyptian governorates are facing many challenges that could impede the implementation and later operation of smart cities within them, such as the behavior of inhabitants and their education level, the low entrepreneurial and innovation base, and the lack of basic infrastructure (Galal & Elariane, 2022).

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.

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.

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 2, 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).

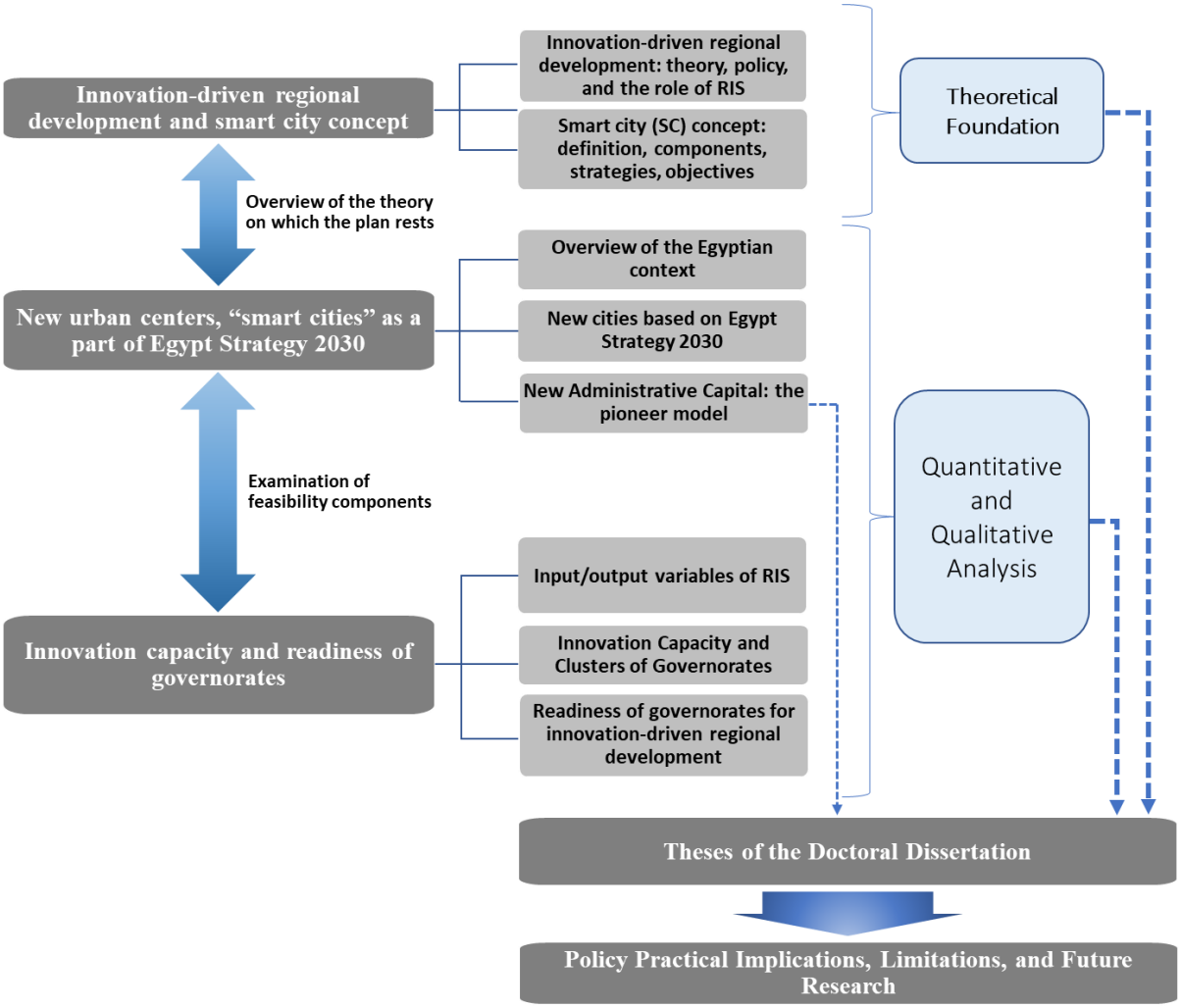
Chapter 5. Theses of the doctoral dissertation

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 (T1, T2, and T3), (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 2. The structure of the dissertation



Source: own edition.

4. Theses of the doctoral dissertaion

Here I summarize the main conclusions of my research. I present my theses, which address the research questions and hypotheses of the dissertation. 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. Governorates with a higher innovation capacity can host more advanced innovation hubs. In contrast, governorates with lower innovation capacity can only make a limited contribution. 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) 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 other 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. This chapter is founded on a comprehensive **systematic literature review (SLR)** that includes **a detailed analysis of 60 highly relevant journal papers**. In this chapter, I conducted a comprehensive literature assessment on the concept of smart cities, encompassing definitions (chapter 2.3.1), components (chapter 2.3.2), strategies (chapter 2.3.3), and their role in fostering innovation (chapter 2.3.4). In this review, I also examine the implementation of smart city programs in various developing countries, addressing the research question of why and how these programs are being implemented in different contexts (chapter 2.3.5). In sum, in this chapter, I comprehensively explore the concept of smart cities and its evolution over the past three decades.

- According to the findings presented in chapter 2.3.1, the concept of smart cities **lacks a universially 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.**
  - One early definition by Hall et al. (2000) emphasized the monitoring and integration of critical infrastructures to optimize resources, maintenance, and security while maximizing urban services for citizens. Other definitions, such as those by Hollands (2008a) and Washburn and Sindhu (2010), stressed the importance of information and communication technology (ICT) and knowledge-based methods in making cities intelligent, interconnected, and efficient.
  - However, more recent definitions, for example, by Caragliu and Del Bo (2012) and Lombardi et al. (2012) emphasized the role of human and social capital, sustainable economic growth, environmental management, quality of life, and competitiveness. A comprehensive literature review by Echebarria et al. (2020) classified smart city definitions into three perspectives: technological, humanistic, and collaborative. The technological perspective focuses on the importance of technology in facilitating productivity and decision-making. The humanistic perspective highlights the need to invest in human capital alongside technology. Investing in human capital is a must-have need for smart city development. It ensures the presence of talented and skilled people, which is required for the operation and upkeep of the city's technical

infrastructure. Simultaneously, it encourages an environment of innovation and entrepreneurship, which serves as the foundation for smart cities' success. This human resource investment may be made through education and training. The collaborative perspective emphasizes the interrelatedness of various urban actors and the importance of collaboration for social change. As I indicated in chapter 2.3.1, open data initatives can contribute to smart city interconnection by allowing various urban actors to exchange and collaborate on massive amount of data to solve urban challenges.

- Based on the content of the various smart city definitions, however, we can observe that they tend to emphasize the following main characteristics:
  - Despite the lack of a universally agreed-upon definition, **most definitions emphasize the significance of ICT**.
  - In recent years, the understanding of smart cities has evolved to encompass a multidimensional nature, considering **not only ICT but also the human component and social dimension**. Stakeholders and researchers agree that a holistic approach that considers technology, human capital, and collaboration is crucial for sustainable and inclusive smart city development. It is important to engage stakeholders from different perspectives to develop a comprehensive vision and ensure the needs of all community members are met, leading to sustainable and beneficial urban development.
  - However, there are challenges and critiques that need to be addressed, such as social polarization, and the need for inclusive decision-making processes. Evaluating smart city performance is essential to understand their effectiveness and identify areas for improvement. Ultimately, a holistic and people-centred approach is crucial for the successful development and implementation of smart city initiatives.
  - Free access to data for people (citizens, entrepreneurs, innovators, etc.) allowing them the opportunity to propose changes and improvements.
- 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**.

- *Smart economy* stands out for its innovative and entrepreneurial spirit, delivering high productivity in both quantity and quality. This is achieved through the reduction of trade barriers and the opening up of local and global markets, resulting in enhanced labour market flexibility.
- *Smart people* are nurtured by increasing investments in education, supporting lifelong learning with ICT-enabled e-skills, fostering community organization and connectivity, facilitating swift information exchange between city governments and residents, and promoting creativity through knowledge sharing.
- To attain *smart mobility*, it is crucial to establish a comprehensive transportation system integrated with ICT infrastructure and transition to eco-friendly vehicles (such as electric vehicles) that consume minimal resources. Expanding the capacity of this system can be achieved by encouraging greater usage of automated metro subways, as well as promoting alternative modes of transportation such as cycling, walking, and carsharing.
- To ensure effective *smart governance*, cities should persist in providing online services for the management of their administrative functions. They should utilize technology as an open data resource accessible to the public, encouraging greater user responsibility and fostering transparent practices.
- Providing high-quality urban services by using technologies that enable people to live properly is referred to as *smart living*.
- *Smart environment* refers to the utilization of resources in the city, encompassing various aspects such as energy conservation, water efficiency, and reduction of CO2 emissions. It also involves identifying green energy sources that are well-suited to the local natural conditions, all of which are supported by green urban planning (Virtudes et al., 2017).

- Chapter 2.3.3. discusses various strategies for developing smart cities. It highlights the need to evaluate different strategies and identify potential challenges, particularly in the case of newly constructed smart cities. Based on the literature, four spatial strategic alternatives for smart cities are identified: national vs. local strategies, building new smart

cities vs. adapting existing ones, soft infrastructure vs. hard infrastructure strategies, and geographic vs. sector-based approaches. In conclusion, 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.**

- In chapter 2.3.4, the literature review highlights the role of smart cities in fostering innovation. Based on the findings of the literature review, we can state that **smart cities aim to act as catalysts for innovation**. Both the practical examples and the theoretical framework model presented in the literature show that smart cities can contribute to the development of strong, collaborative ecosystems of different actors. According to the literature, smart cities are seen as "experimental" or "test" centers (platforms) of innovation and learning, providing opportunities for testing innovative solutions. It is important to acknowledge that innovation is not solely dependent on the existence of smart infrastructure. According to the literature, 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**. The model of Appio et al. (2019) combines physical infrastructure and technological aspects with social, economic, and environmental considerations to offer a comprehensive understanding of smart cities and their role in promoting a collaborative ecosystem for innovation. Barcelona and London are good examples of how the innovation-enabling function of smart cities can be successfully implemented.

  Finally, the analysis of smart city experiences in other countries in Chapter 2.3.5 found that the majority 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 centers 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 findings:

- 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 centers is essential to improve the social and economic conditions of the country**. For example, the distribution of economic activity and people across the country is unbalanced. Second, the Egyptian government has a significant challenge because of the country's high population growth, which is now 1.6% per year (compared to the global average of 0.8% in 2022, according to World Bank data[2]). Furthermore, the increasing population pressure on existing cities, along with the scarce availability of land for further expansion, has resulted in a major

[2] https://data.worldbank.org/indicator/SP.POP.GROW?locations=EG (available 20th June 2023).

increase in population density inside these existing cities. In 2020, the average population density of existing cities was 108 persons per km^2, which is above the world average of 60 persons per km^2, according to the World Bank. This situation has led to a number of overpopulation-related consequences in existing Egyptian cities, such as insufficient living space, congestion, pollution, and pressure on infrastructure. Rapid population increase has exceeded urban service capacity, leading to a decline in the quality of services offered to citizens. Finally, due to the scarcity of habitable land in some urbanized regions, **it is necessary to create new urban centers – in less popular and less populated regions – to alleviate these pressing problems, which ultimately lead to huge regional disparities**.

According to the investigation in chapter 3.2.1, Egypt's ambitious plan indicates its endeavors to address the country's significant challenges. Consequently, the Egyptian government adopted the Egypt Vision 2030, which addresses the challenges and concerns facing the Egyptian state. 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. Policymakers are striving to achieve innovation-driven balanced regional development. Establishing these new urban centers across the country as **innovation hubs** characterized **by advanced innovation ecosystems** is an important part of their endeavors. The first step is to build the physical infrastructure (roads, sewage systems, water and energy networks, buildings, public spaces, etc.) of these cities.

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 RIS) 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

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

  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. 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. 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 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.

To summarise, smart cities foster innovation by fostering a milieu conducive to experimentation and collaboration among stakeholders.

- Innovation can contribute to regional development. Consequently, Egypt's commitment to implementing an innovation-driven regional development policy, with a priority on boosting the innovation ecosystem in its new smart cities, is both rational and reasonable. Nonetheless, it is essential to recognize that **regional development driven by innovation has essential preconditions**. The theoretical framework of innovation-driven regional development, as discussed in chapter 2.2, emphasizes the significance of taking these conditions into consideration. It emphasizes the importance of endogenous factors, local competencies, and regional innovation skills in enabling innovation-based regional development. The Egyptian planning documents emphasize **the importance of current competencies and capacities within the Egyptian governorates.** Also, the interviews highlighted that **Egyptian policymakers and planners are fully aware that these factors are indeed preconditions for the success of innovation-led regional development**.

- 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. The findings showed that the concentration of the population is accompanied by the concentration of employers in the industrial sector in the northern governorates of Egypt (Cairo, Giza, Kalyoubia, and Alexandria), which also represents 25% of the country's total population. Further, it is explored that in the northern governorates, high-tech industries (such as electronics, software, communication, programming, computer activities, data processing, and analysis) comprise 80% of the total innovative industries at the national level. In addition, 44 % of universities, 43 % of research centers, and 24 % of workers are engaged in scientific research and development can be found in the northern part of the country. The northern

governorates also encompass 50% of the total number of business incubators (background factors).

- Additionally, the findings of interviews in chapter 3.2.3 revealed deeper insights into the essence of Egypt's ambitious plan and 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 for developing new urban centers rather than existing cities. The interviews indicated that the Egyptian government has long struggled to manage urban expansion in cities that have mostly grown on agricultural lands in the Nile Delta and Nile Valley. Recognizing the consequences of uncontrolled urban expansion on the Nile Valley's limited agricultural resources, successive governments have recognized that it is necessary to explore new development opportunities by developing new cities and communities beyond the Nile Valley. Furthermore, the findings of the interviews revealed that the government is actively conducting national development initiatives to improve the quality of existing Egyptian cities and villages. Egypt Vision 2030 and Egypt 2052 National Development Plan both include initiatives for enhancing existing cities. The respondents stressed that the government's continued efforts to improve existing urban areas are not hampered by the creation of new urban centers.

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. Many current cities confront substantial obstacles, such as a lack of infrastructure preparedness for smart cities, which is critical for fostering a high-level innovation ecosystem. Additionally, the expense of changing existing cities with undeveloped infrastructure is excessive, far beyond Egypt's capabilities. This is due to the fact that the creation of these new urban centers is funded by land sales and attractive investment possibilities that appeal to both domestic and foreign investors. In contrast, the new urban centres' locations and attributes serve as sources of finance for their construction. Furthermore, new city projects give the potential for partnership among the government, real estate developers, and private sector companies. These collaborations are critical in the establishment of new cities, whether through joint investments or initiatives completely sponsored by the private sector. I received considerable insights into the New Administrative Capital (NAC) through the interviews, which served as a

prominent example of the previously described solution. Significantly, the early phase of the NAC's infrastructure was funded without the use of direct government money. Instead, the Administrative Capital for Urban Development Corporation raised funds by selling land, totalling nearly $20 billion.

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 serve as the base for fostering innovation in emerging urban centers.

- Additionally, 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 centers 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 the 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.

Evidence from **Chapter 4** supports thesis 3. In this chapter, the innovation capacity of the governorates in Egypt was assessed by constructing a composite index called as the **Regional Innovation Capacity Index (RICI)**. Both the conceptual model and methodology applied are based on a study of Bajmócy and Kanó (2009). In Chapter 4.1, I provide an in-depth definition of innovation capacity based on the relevant literature. In addition, I summarise the key components of Bajmóczi and Kanó's (2009) conceptual framework model, which provides a comprehensive approach to measuring the performance of the main components of the Regional Innovation System (RIS). To develop a Regional Innovation Capacity index, I examine knowledge creation, knowledge utilization, and enabling factors such as "smart" infrastructure. This approach enables a thorough evaluation of the governorates' innovation capacities. Chapter 4.2 thoroughly explained the applied methodology used in the study, which includes three distinct analyses. Initially, I assessed the innovation capacity of Egyptian governorates using a composite indicator methodology that considers several characteristics and recognizes the complex nature of innovation.

Second, I used K-means cluster analysis to categorize the governorates based on their capacity for innovation. Finally, I examined regional innovation capability using spatial autocorrelation measures, especially the Moran I index and the Local Indicators of Spatial Association (LISA) study. My analyses provide a thorough view of the performance of Regional Innovation System across governorates, revealing their relative positions and allowing me to assess the similarity in the spatial structure of innovation capacity and identify spatial clusters among the governorates of Egypt.

The results in Chapter 4.3 showed that **there is a considerable gap in Egypt's governorates' capacity for innovation**. The literature review results in Chapter 2.2 demonstrated that regional characteristics and local competencies for innovation are essential in fostering innovation-driven regional development. Consequently, we can assume that governorates with a strong innovation capacity have a greater chance of executing Egypt's Vision 2030 innovation-driven regional development plan. Governorates with low innovation capacity, on the other hand, are less likely to meet this ambitious strategy's goal. Chapter 4.4 concluded with a summary of the analyses.

T3 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.**
- Further, given that the RICI composite index is composed of sub-indicators of knowledge creation, knowledge utilization, innovation, and “smart” infrastructure that supports innovation, I found further interesting findings. Although the knowledge creation sub-index does not indicate a significant difference between Egyptian governorates located above the national average, rather they are the same as in the RICI composite index. In the framework of the sub-national knowledge index, there are discrepancies in the ranking of governorates that are below the national average. In the knowledge creation sub-index, there are governorates in the Delta region, which have a large number of higher education

institutions, and a number of governorates in the Upper Egypt regions, which appears to be advanced in the ranking such as Damietta, Gharbia, and Assiut.

- Further, the analysis findings found that the composite indicator RICI and its associated sub-indicators reveal 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 essential role in supporting the adoption of innovation within these governorates by providing the necessary background factors.
- 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). Furthermore, based on the comprehensive analyses conducted in Chapter 4, Cairo, Giza, and Alexandria governorates as leading are fully prepared for the task. On the other hand, Suez, South Sinai, Port Said, Red Sea, Ismailia, Kalyoubia, New Valley, and Matrouh governorates (third and fourth clusters) are only partially prepared and require further improvements, particularly concerning their capacity for knowledge creation and "smart" infrastructure indicators. The majority of Egyptian governorate's lagging cluster, 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 for the three sub-indices (Knowledge Creation, Knowledge Utilization, and "Smart" Infrastucture).
- 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. According to the LISA, findings showed that 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. The governorates of Cairo and Suez, with both regions exhibiting high values in the knowledge utilization sub-index. In contrast, 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 its neighbouring governorates likewise have a low capacity in this regard. This pattern becomes apparent because of Kafr ElSheikh's geographical location in the Delta region, where a reduction in the knowledge utilization sub-index has been observed throughout all governorates in this region. In addition, 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, Sharkia governorate has been unable to effectively exploit their closeness.

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 take into account 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 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. Therefore, policymakers should strive to boost the latter group's innovation capacities in order to support balanced regional development.

References

Abbas, W. (2021, May 11). Fourth generation city plans (in arabic). *The Seventh Day*. https://www.youm7.com/story/2021/5/11

Ali, M. A. (2021). Modeling regional innovation in Egyptian governorates: Regional knowledge production function approach. *Regional Science Policy and Practice*. https://doi.org/10.1111/rsp3.12450

Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting and Social Change*, *142*, 1–14. https://doi.org/https://doi.org/10.1016/j.techfore.2018.12.018

Attia, S. (2018). Al Alamein New City, a Sustainability Battle to Win. In S. Attia, Z. Shafik, & A. Ibrahim (Eds.), *New Cities and Community Extensions in Egypt and the Middle East: Visions and Challenges* (1st ed., pp. 1–18). https://doi.org/10.1007/978-3-319-77875-4

Barca, F., Mccann, P., & Rodríguez-Pose, A. (2012). The case for regional development intervention: Place-based versus place-neutral approaches. *Journal of Regional Science*, *52*(1), 134–152. https://doi.org/10.1111/j.1467-9787.2011.00756.x

CAPMAS. (2017). *census*.

Capmas. (2021). *Population statistics*. https://www.capmas.gov.eg/

Caragliu, A., del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82. https://doi.org/10.1080/10630732.2011.601117

Eremia, M., Toma, L., & Sanduleac, M. (2017). The Smart City Concept in the 21st Century. *Procedia Engineering*, *181*, 12–19. https://doi.org/10.1016/j.proeng.2017.02.357

Galal, A., & Elariane, S. (2022). A Tool for Measuring the Smart Readiness of Existing Buildings and Cities in Egypt–Focusing on Energy Sector: Towards Smart Ready Checklist. *HBRC Journal*, *18*(1), 141–155. https://doi.org/10.1080/16874048.2022.2129141

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), 303–320. https://doi.org/10.1080/13604810802479126

Kraus, S., Richter, C., Papagiannidis, S., & Durst, S. (2015). Innovating and Exploiting Entrepreneurial Opportunities in Smart Cities: Evidence from Germany. *Creativity and Innovation Management*, *24*(4), 601–616. https://doi.org/10.1111/caim.12154

Kwasi, S., Cilliers, J., & Yeboua, K. (2022). Race to sustainability? In *NORTH AFRICA REPORT* (Vol. 7). https://ssrn.com/abstract=4049992

Ministry of Higher Education and Scientific Research Egypt. (2019). *National Strategy for Science, Technology and Innovation 2030*.

Ministry of Planning and Administrative Reform. (2014). *Sustainable Development Strategy: Egypt's Vision 2030*.

Mohamed, R. (2021). Exploring the urban spatial structuring of new fourth-generation city sites for Delta region development: New Mansoura city, the Delta tourism capital. *International Design Journal*, *12*(4).

MoHUUC. (2020). *Ministry of Housing, Utilities & Urban Communities*. http://www.mhuc.gov.eg/Programs/Index/132

Mostafa, L., & Beshir, S. (2023). User Sentiment Analysis Towards Adapting Smart Cities in Egypt. In *Lecture Notes on Data Engineering and Communications Technologies* (Vol. 164, pp. 337–347). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-27762-7_32

NUCA. (2023). *New Urban Communities Authority: New Cities in Egypt*. http://www.newcities.gov.eg/know_cities/default.aspx

Orlando, J., & De La Barrera, M. (2020). *A Historical View of Smart Cities: Definitions, Features and Tipping Points Working Paper*. https://ssrn.com/abstract=3637617

Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities* (Vol. 1). https://doi.org/10.4324/9781315407463

UN. (2022). *Department of Economic and Social Affairs, Population Division. Probabilistic Population Projections based on the World Population Prospects 2022*. https://population.un.org/wpp/

Waisová, Š. (2022). The Tragedy of Smart Cities in Egypt. How the Smart City is Used towards Political and Social Ordering and Exclusion. *Applied Cybersecurity & Internet Governance*, *1*(1), 144–153. https://doi.org/10.5604/01.3001.0016.0985

World Bank. (2022). *Country Climate and Development Report: Egypt*. https://documents1.worldbank.org/curated/en/099510011012235419/pdf/P17729200725ff0170ba05031a8d4ac26d7.pdf

World Bank. (2023a). *Population growth (annual %) - Egypt, Arab Rep.* data.worldbank.org/indicator/SP.POP.GROW?locations=EG

World Bank. (2023b). *Population, total - Egypt, Arab Rep.* data.worldbank.org/indicator/SP.POP.TOTL?locations=EG

List of Publications

Journal articles

Ali, M. A. (2021a). Modeling regional innovation in Egyptian governorates: Regional knowledge production function approach. *Regional Science Policy and Practice*. https://doi.org/10.1111/rsp3.12450

Ali, M. A. (2021b). Smart city policy in developing countries: case study of the New Administrative Capital (NAC) in Egypt. *Journal of Public Affairs*. https://doi.org/10.1002/pa.2774

Ali, M. A., Kabil, M., Alayan, R., & Magda, R. (2021). Entrepreneurship Ecosystem Performance in Egypt : An Empirical Study Based on the Global Entrepreneurship Index (GEI). *Sustainability*, *13*(13), 1–22. https://doi.org/10.3390/su13137171

Kabil, M., **Ali**, M. A., Marzouk, A., & Dávid, L. D. (2022). Gender Perspectives in Tourism Studies: A Comparative Bibliometric Analysis in the MENA Region. *Tourism Planning & Development*, 1–23. https://doi.org/10.1080/21568316.2022.2050419

Mohamed Abousafi, E. M., **Ali**, M. A., & Iparraguirre, J. L. (2023). Industrial Clusters and the Five Drivers of Regional Productivity in Egypt. In R. El Ebrashi, H. Hattab, R. S. Hassan, & N. H. Bouchra (Eds.), *Industry Clusters and Innovation in the Arab World* (pp. 157–203). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80262-871-520231008

Conference papers

Ali, M. A. (2020). Entrepreneurship development performance in Egypt: An empirical study based on the Global Entrepreneurship Index (GEI) data 2006-2017. *In The 9th Jubilee Interdisciplinary Doctoral Conference 2020 Conference Book*, Pécs, Hungary, 12-13 November 2021, pp.88-89.

Ali, M. A. (2021). Smart city approach for sustainable urban development in developing countries: Egypt case *In 7th Annual 'Life in Kyrgyzstan' Conference (abstract)*, online, 26-28 October, 2021.