Doctoral Dissertation

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2022

PÉCSI TUDOMÁNYEGYETEM
UNIVERSITY OF PÉCS
FACULTY OF BUSINESS AND ECONOMICS

DOCTORAL SCHOOL OF REGIONAL POLICY AND ECONOMICS
International Program of Regional Development

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REGIONAL DEVELOPMENT BASED ON SMART CITY AND INNOVATION POLICY IN EGYPT

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Submitted according to the requirements for the degree of
Doctor of Philosophy of the University of Pécs

Pécs, Hungary
September - 2022

Dedication

I dedicate this dissertation to my beloved parents and my wonderful, faithful wife

والديّ الأحباء وزوجتي الرائعة المخلصة أهدى اليكم هذه الرسالة

Acknowledgment

In September 2018, I began my PhD journey. Since then, I have realized that it is not just me who is a hero of the journey, but there are many people who have a great deal of gratitude and thanks.

First, I want to express my gratitude to my Wonderful supervisor Prof. Attila Varga, professor at the Faculty of Business and Economics at the University of Pecs, for his counsel, advice, and guidance during the stages of research and scientific publishing, who was supportive, advising and assisting me in various ways. I am honored to have been his student. I also wish to thank my co-supervisor, Éva Somogyine Komlósi, associate professor, for her helping with the thesis structure and the scientific writing improvement, as well as being a loyal and wonderful teacher for scientific research methods. Without her guidance, it would have been challenging to advance this research work and transform it into its final shape. I thank Prof. László Szerb, Professor and Regional Development Program Director for his invaluable advice and comments on research activities that I provided during my PhD research seminars. I sincerely thank Dr. Monika Tiszberger Galambosne, assistant professor, program coordinator of the International PhD Program in Regional Development, who always addressed any difficulty I had during my doctoral studies. In addition, I wish to thank my best friends and fellow PhD classmates, especially Aida Musaeva, Evelyn Calispa, and Zhanna Ishuova, who have all been supportive and helpful to me over the years.

In appreciation of the data, I would like to thank Eng Wael Mousa, the minister's technical advisor at the Ministry of Housing, Utilities, and Urban Development, and Dr. Mohammed Khalil, the Chief Technology Officer (CTO) at the ACUD company. I thank Prof. Mervat Elshabrawy for her valuable assistance.

I want to thank the Egyptian Ministry of Higher Education and scientific research (MHESR), which provided a scientific study mission for me and financial support. My sincere thanks also go out to the Egyptian Cultural Office in Vienna for its ongoing support and assistance with all administrative, financial, and scientific problems. Thanks to the Hungarian government for providing the Stipendium Hungaricum Scholarship program's financial support, which allowed me to pursue my doctoral education in Hungary.

Lastly, my unreserved thanks to my family for unfailing support, especially my wife and my two little boys who helped me through my tough and tumultuous study period. In particular, my beloved wife's support encouraged me to continue our journey.

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8 **Ali, Mohamed Abouelhassan**

Entrepreneurship development performance in Egypt: An empirical study based on the Global Entrepreneurship Index (GEI) data 2006-2017

In: Csiszár, B; Hankó, Cs; Kajos, L F; Kovács, O B; Mező, E; Szabó, R; Szabó-Guth, K (eds.) IX. INTERDISZCIPLINÁRIS DOKTORANDUSZ KONFERENCIA 2020 ABSZTRAKTKÖTET : 9th INTERDISCIPLINARY DOCTORAL CONFERENCE 2020 BOOK OF ABSTRACTS

Pécs, Hungary : Doctoral Student Association of the University of Pécs (2020) 384 p. pp. 88-88. , 1 p.

Abstract (Chapter in Book) | Scientific

List of Abbreviations

NAC: New Administrative Capital

NCA: New City of El Alamein

RIS: Regional Innovation System

RIPs: Regional Innovation Policies

SLR: Systematic Literature Review

SQs: Search Queries

RQ: Research Question

SC: Smart city

ICT: Information and communication technology

EPO: Egyptian Patent Office

CAPMS: the Central Agency for Public Mobilization and Statistics

ASRT: Academy of Scientific Research and Technology

OECD: Organisation for Economic Co-operation and Development

IPP: Innovation Policy Platform

MENA: The Middle East and North Africa

GERD: Gross Expenditure of Research and Development

GCR: Greater Cairo Region

IT: Information technology

OTT: Over the Top

CCC: Commander Control Center

COC: City Operating Center

IoT: Internet of Things

LISA: Local Indicators of Spatial Association

RKPF: Regional Knowledge Production Function

ESDA: Exploratory Spatial Data Analysis

Abstract

Title: Regional development based on smart city and innovation policy in Egypt

Submitted by: Mohamed Abouelhassan Mohamed Ali

Supervisors: Prof. Attila varga, University Professor and Dr. Éva Somogyiné komlósi, Assistant Professor

In this doctoral dissertation, the researcher analyzes and assesses smart city policies and regional innovation in Egyptian governorates. The main purpose of the dissertation is to provide a comprehensive analysis of the proposed smart city policy, its components, and the characteristics of the Egyptian governorates. Furthermore, it seeks to determine if it is possible to adopt efficiently innovation policies such as the smart cities concept developed by advanced economies to developing countries like Egypt in order to ease regional differences.

Based on the experiences and models of developing countries, I examine the theoretical basis and conceptual framework of regional innovation policies and smart cities. In addition, the Egyptian context is discussed in depth with regard to the factors, components, and features of the proposed regional innovation policy, smart city programs, and a case study analysis of the pioneering model of Egyptian smart city policy. For determining the regional readiness to implement smart city policies, a narrative analysis of smart city policy in Egypt and a model of knowledge production and innovation for Egyptian governorates are also provided. As part of the proposal, a policy framework for effective implementation is also included.

In two stages, the research involved (1) the presentation of the conceptual framework and synthesis of the literature, and (2) narrative and empirical analysis (quantitatively: an analysis of the spatial autocorrelation of knowledge and innovation, and modeling regional innovation and readiness levels, as well as qualitatively: narrative analysis and interviews). According to the results, the smart city policy has different applicability in Egyptian contexts. A policy based on innovation and smart cities can be implemented with different degrees of readiness within the Egyptian governorates.

Keywords: C21, O18, O30, Q01, R11, R15, R58

1. INTRODUCTION

1.1 Background

Regional development has a long history. Economists, geographers, urban planners, and policymakers have become increasingly concerned with **regional development challenges**, particularly inequalities in regional capabilities and economic opportunities. Among the many factors influencing **regional development** are high technology innovation, population growth, consumption of goods, wealth distribution, and human resources (Šabić & Vujadinović, 2017). In recent decades, **the spatial diffusion of knowledge and innovation** has attracted significant attention, particularly in the economic geography literature (Döring & Schnellenbach, 2006).

Regional development as a phenomenon is not static, since it results from the interaction of a variety of actors (business leaders, local people, policymakers, and government bodies, etc.), all of whom must confront regional challenges (Nijkamp & Abreu, 2009). The goal of policymakers is to ensure growth and prosperity in diverse regions while minimizing disparities between them. Regional development policy, therefore, has conflicting goals. Some are intended to maximize economic efficiency through focusing on competitive advantages of regions, while others are designed to promote equity by strengthening convergence across regions (Pike et al., 2017).

Regional development policy in the recent decades has emphasized endogenous factors and spatial uniqueness components (Arsmstrong & Taylor, 2000; Schultz, 1990). As a result of this uniqueness, there are differences between the regions, which in turn produce differences within the region's trajectory itself, because each type of regions has its own unique goals which are based on the nature and issues specific to that region. In most endogenous growth models, production is based on technology and innovation, unskilled and skilled labor, physical capital, as well as infrastructure and public services (Edwards, 2007, pp. 215–216). Consequently, **technological and knowledge progress within the regions is one of the internal factors and components that contribute to achieving regional goals**. These considerations prompted a shift in thinking from a typical trade-off between efficiency and equity (McCrone, 1969; Monnesland, 1994; Nicol & Yuill, 1982) to pursuing both simultaneously and in succession (Amin & Tomaney, 1995; Bachtler & Yuill, 2001; Morgan, 1997; Raines, 2001; Taylor et al., 2000). Economic growth literature has extensively studied the relationship between technological and knowledge progress and regional development, paying particular attention to **the conditions that encourage technological development** (such as the entrepreneurship ecosystem, incubator facilities, venture capital availability, etc.) (Nijkamp & Abreu, 2009). In the literature, it has been mentioned that urban areas, cities are examples of places where conditions are conducive to technological development (Matheri et al., 2019; Smith et al., 2019; Caragliu & del Bo, 2020).

There have always been issues and obstacles in cities. These issues are typically caused by unfavorable change in population, or more accurately, an environment that is unable to adjust to these changes (Anas, 1992; García-Ayllón, 2016; Rieniets, 2009; Wiechmann & Bontje, 2015). When the urban population declines, as a result of, for example, the strong absorption power of more competitive cities (Douglass, 2000; Heng, 2012) or due to historical events (wars) (Glaeser & Shapiro, 2002; Rieniets, 2009), the city is often forced into a prolonged economic stagnation, which can then lead to the vicious circle of backwardness and, rarely, to the disappearance of the city (ghost towns) (Rieniets, 2009). Alternatively, many cities in most developing countries are facing serious challenges due to their inability to cope with continuous population growth (García-Ayllón, 2016) and its consequences (eg. pollution, traffic congestion, shortages of housing, rising prices for real estate, and poor living conditions).

Urban development policies aimed to provide solutions to the above-mentioned complex problems of cities which vary in economic, social, architectural, and environmental terms. Urban development policy describes a set of administrative measures at various levels of government that are primarily target cities (van den Ber et al., 2004). Urban policies can theoretically be implemented at all levels of government; nevertheless, policies at the "national" upper administrative levels are not specialized for cities yet have a substantial influence on them. In other words, "*urban policy*" is a policy that is designed specifically for cities and can be formulated locally by local governments. In contrast, *"urban development policy"* is a set of policies that aren't directly related to cities, but are somewhat "urban" in their impact on cities, they are formulated by national governments. The distinction between an "implicit" urban development policy and an "explicit" urban policy is therefore important. The first involves formulating an urban policy that incorporates housing, transportation, infrastructure, economics, spatial planning, and environmental policies (van den Ber et al., 2004). Because of this, urban development policy is in most cases not spatially targeted, unlike clear urban policy, which deals more effectively with the complex problems of cities.

Urban development policy is structurally influenced by a multitude of trends and development ideas (Smith et al., 2019; van den Ber et al., 2004). These trends point to four major interconnected pressing matters for cities: 1) a more competitive environment among cities and regions; 2) the growth of a number of urban networks at the local, national, and international levels; the persistence of issues such as unemployment, poverty, and social exclusion, particularly in larger cities; 3) the increased importance of sustainable urban development; and 4) organizing capabilities. In the end, whether a city is attractive depends on its residents, businesses, investors, and visitors. City inhabitants (as potential customers) have very high demands on their business and living environments. A business' locational strategy is highly dependent on factors like the quality of the (potential) labor force, the local economic structure, the local knowledge base, the fiscal climate, telecommunications, (international) access, accessibility of markets, availability of financial resources, and local tax rates. Also essential for economic development is the quality of the living environment (van den Ber et al., 2004). Other important factors in determining location are the availability of green space and leisure facilities, as well as urban safety, urban services, and housing conditions. The growth of cities is also enabled by technological advancements and the integration of telecommunications and information technologies. Information is becoming increasingly important in innovative activities, and these activities must have access to it at both ends of the production process. Communication, learning, and business are all impacted by information technology. Cities are increasingly being part of a global network of information exchange, which in turn puts a high demand on telecommunications infrastructure, innovation, and education and training (Matheri et al., 2019). **The growing need for digital infrastructure, innovation, knowledge, and education in the workforce has created a new trend in urban development policy known as the concept of smart cities**. This new policy concept was first developed on the basis of this demand and large-scale technological changes in the context of the 4th Industrial Revolution (Matheri et al., 2019).

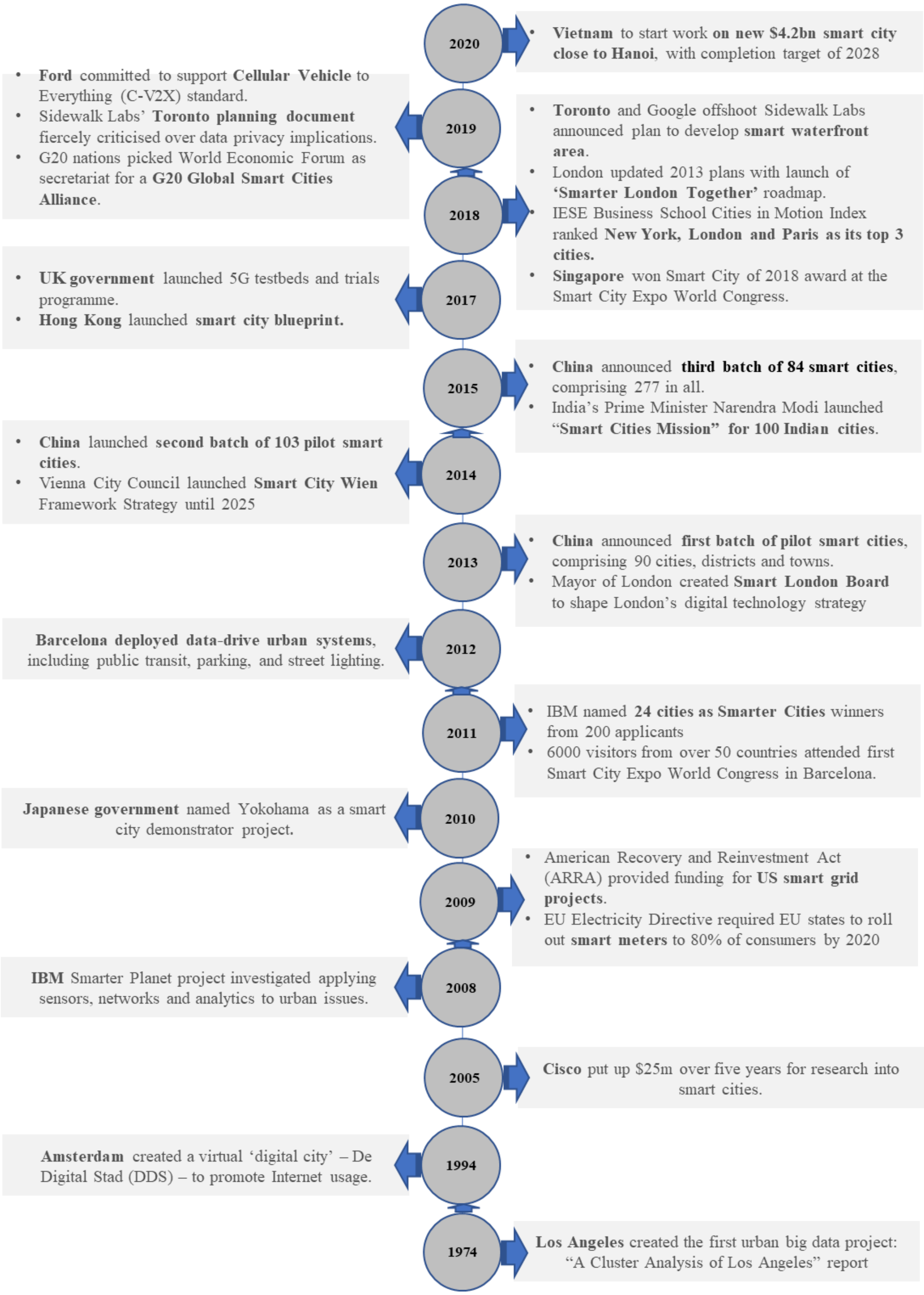
Smart city initiatives have been implemented in multiple places in the past two decades. The new concept builds strongly on technological development, community involvement, land-use planning and other methods to achieve the goal of urban development policy (Smith et al., 2019). Smart cities have acquired a lot of traction in the last two decades, despite their brief history, with several countries undertaking urban development plans under this framework. During the last several years, scientific production in the field of smart cities has gained tremendous academic and policy success. Information and communications technologies (ICTs) are ubiquitous in today's cities, and their use by city residents in collecting, sharing, and using data acquired by sensors has prompted research across multiple disciplines (Caragliu & del Bo, 2020). It is said that the first urban big data project was created in Los Angeles in the 1970s: “A Cluster Analysis of Los Angeles”. Amsterdam may have been the first smart city with the implementation of a virtual digital city in 1994. During the mid-2000s, IBM and Cisco launched separate initiatives that caused things to speed up. Barcelona hosted the first Smart City Expo World Congress in 2011, which has since become an annual event charting the development of smart cities (Verdict, 2020) (see Figure 1).

There are a number of definitions of smart city. According to the most comprehensive definition “*a city where technology is deployed and effectively used to improve the life experience ofits inhabitants*” (Augusto, 2021, p. 2). Technology is a necessary, but not sufficient component in the concept. According to this definition, technology improves the quality of life of city residents when it can meet the objectives and needs of smart cities. As well as smart cities that are defined by Caragliu et al. (2011) as a city to be 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).

Smart city concept is a controversial hot topic in the field of regional development policy despite its popularity among policymakers. There is no general definition of the concept. The concept can be understood in many ways, including the utilization of digital solutions (e.g., urban transport, energy supply) and efficiencies obtained from digitalization (digital public services), which all contribute to the economic productivity (GDP), quality of life, and overall well-being of the city. Smart cities or urban intelligence - as a new contemporary concept of innovation policy based on knowledge and innovation clusters, smart economy, and knowledge economies - **promises that even conflicting regional development goals can be achieved simultaneously and not in a tradeoff way** (Errichiello & Marasco, 2014; Schaffers et al., 2012). Smart cities is a concept of innovation policy aimed at structuring knowledge, information, and communication systems (Anthopoulos, 2017; Kraus et al., 2015; Oktaria et al., 2017; Schaffers et al., 2012). Additionally, smart economy investments in human capital lead to learning and permanent knowledge as it builds on skilled labor and smart population (Balchin et al., 2000; Kraus et al., 2015). Knowledge and innovation greatly influence the technological/physical environment of smart cities and urbanization in addition to physical capital that is founded on modern technologies (Balchin et al., 2000). Most endogenous growth models, according to Edwards (2007), assume some kind of production based on technological developments, unskilled and skilled labor, physical capital, and public services and infrastructure (Edwards, 2007, pp. 215–216). Thus, infrastructure and public services constitute one form of production that are both evident in smart city programs, which make use of smart infrastructures and smart services (Oktaria et al., 2017; Virtudes et al., 2017; Yigitcanlar, 2015). Smart cities have thus become one of the most significant contributors to the achievement of conflicting regional development objectives (such as efficiency, equity, and sustainability) by utilizing technology developments underpinned by urban intelligence and spatial engineering (Balchin et al., 2000; Kraus et al., 2015; Lombardi, Giordano, Farouh, et al., 2012; Schaffers et al., 2012).

In the last decade, smart cities concept spread from developed countries to developing countries have started a series of smart city initiatives in the past few years (e.g. China, India, Vietnam, etc.). It first appeared in China in 2013 and India in 2015 (Atha et al., 2020; Bholey, 2016; Vu & Hartley, 2018). To address congestion and urban development challenges, India has initiated the Building 100 Smart Cities program. It took the method of establishing new smart cities while changing current cities into cities that use urban intelligence as a spatial development strategy for smart cities (Bholey, 2016). In 2020, nearly $28 billion has been allocated to the smart city policy (IBEF, 2021). At the same time, China has built an expansive smart city program, with more than 800 pilot projects either in operation or planned, representing more than half of all smart cities worldwide (Atha et al., 2020). Combined with big data processing and artificial intelligence (AI) analysis, China is becoming a world supporter in smart city initiatives, integrating embedded sensors, gauges, cameras, and other monitoring technologies for better management of its cities and public spaces (Atha et al., 2020). China is aiming to improve information security and enhance digital services through the use of these programs (Yao et al., 2020). China's smart city programs are primarily based on government investments, with estimates of the volume of investments in the smart city solutions market amounting to about $1.1 trillion in 2018 and a predicted compound annual growth rate of 33% through 2022 (Atha et al., 2020, p. 24). Despite the popularity of smart city programs and initiatives in China, studies have highlighted that the presence of many empty “ghost towns” raises questions about the appropriateness of development goals, and whether smart cities will be able to attract enough people to become socially sustainable cities in the future (Angelidou, 2014).

Figure 1 The major milestones in the smart cities concept



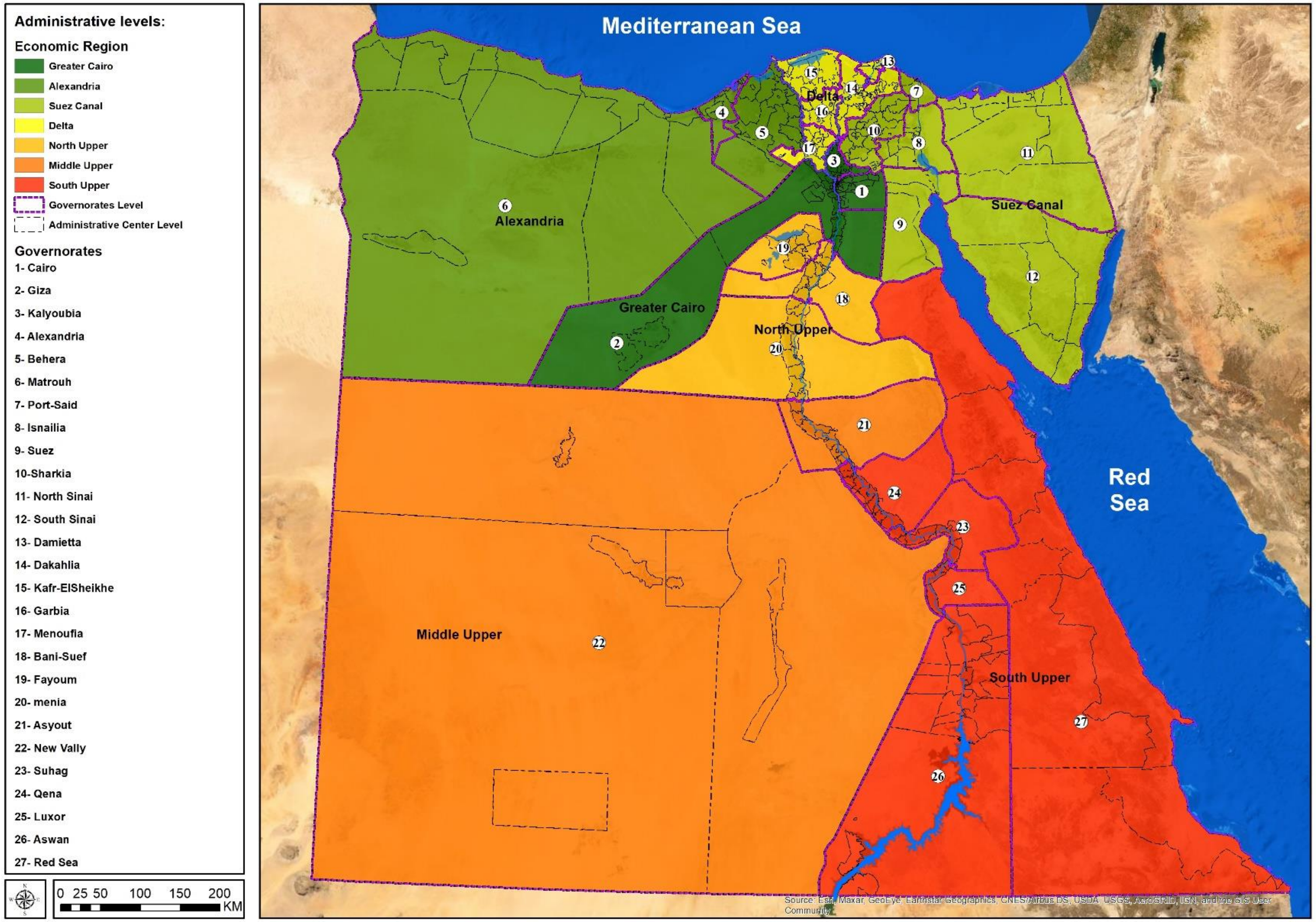
Source: Own edition based on the Smart cities – Thematic Research report produced by GlobalData Thematic Research (Verdict, 2020).

Egypt, as a developing country, also announced its ambitious smart cities initiative. These initiatives were announced by the Egyptian government in 2015 for the New Administrative Capital in the east of the Cairo region, New Alamein City in the north of Egypt, and more than 12 other cities across Egypt. Citizens, governments, and other stakeholders are all involved in shaping this policy (Konbr, 2019a). Four main objectives have been outlined for the development of these cities: first, to create new urban and cultural centers capable of achieving social stability and economic prosperity, and second, to redistribute the population away from the narrow scope of the Nile Valley. Third, the creation of new attractions beyond the existing cities and villages; and fourth, the creation of new urban centers, including financial and commercial centers, urban intelligence centers, institutions of knowledge and innovation, and the proposed fourth generation universities within those cities. It is estimated that the budget for the construction of facilities, roads, and infrastructure in these cities is approximately 57 billion Egyptian pounds (about 5 billion dollars) (Abbas, 2021). Egypt now has a promising smart city initiative, **but will it succeed? Will the smart city initiative help Egypt achieve the Strategy 2030 goals of regional competitiveness and convergence?** Throughout Egypt's development strategy, called the National Sustainable Development Strategy, or "Egypt Strategy 2030," the country has defined all of its pillars, initiatives, and development goals by 2030 (Ministry of Planning and Administrative Reform, 2014).

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 have 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 finally, the administrative center (consisting of a local city and a number of rural communities affiliated with it), which counts 185 (see Figure 2). In terms of urban settings, Egypt's urban and rural populations are approximately equally divided, with an estimated 102 million residents in 2020 and 45% living in urban areas. Cairo is Egypt's largest city, with a population of over 7 million. Alexandria, the second largest city, has about half of

Cairo, with 3.8 million. Another city, Al Jizah, has a population of 2.4 million, making three Egyptian cities with populations exceeding 14 million, this is equivalent to 40% 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 thousands 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). Economically, the Egyptian economy is considered one of the oldest economies in the world, as it started with the agricultural sector and trade exchange with neighboring countries and passed through 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 is when it depended on a high degree of centralization. The Egyptian economy flourish 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 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 the new republic.

Figure 2 administrative/regional division levels for Egypt



Sourcs: Own edition using ArcGis software based on Egypt Geoinformatics Portal (CAPMAS, 2021).

Egypt is the most populated country in the Middle East, according to socioeconomic indicators (Table 1), with an average annual growth rate of 2.06% from 2014 to 2020 (The World Bank, 2021a). Since the events of the 2011 revolution until the 2013 revolution, where 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, and the unemployment rate has decreased to 9.7% in 2019 (The World Bank, 2021a), despite high inflation rates, especially after the establishment of the Egyptian economic reform program and the liberalization of the exchange rate in 2016, where it recorded 29.51 %, it started falling, reaching a record low of 5.04% in 2020 (The World Bank, 2021a). 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 3.57% in 2020 (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 2020, to $3,570 (The World Bank, 2021a). According to the most recent edition of the Global Innovation Index (GII), which rates world economies based on their innovative capabilities, Egypt ranked 94th out of 132 countries in 2021, up 13 places from 2016. Based on Egypt's GII reports for 2019-2021, Egypt has the best performance in knowledge and technology output (one of the sub-indices of the GII), followed by infrastructure, and institutions have the worst performance (WIPO, 2021). For the year 2019, Egypt's Global Competitiveness Index (GCI) was 54.54. Egypt's GCI has risen from 53.17 to 54.54 during 2017, at a rate of 1.78 percent in 2019. Egypt's GCI ranking has risen 25 since 2015, and it is expected to reach 94 by 2020 (WEF, 2021). Global Competitiveness Report 2020 revealed that companies' perceptions of digital skills increased by 1.8% in emerging and developing economies with emerging and developing economies getting scores of 49 (out of 100) compared to advanced economies getting scores of 67 (out of 100). One of the biggest improvements in the report was seen in Egypt (Schwab & Zahidi, 2020, p. 23). Network Readiness Index (NRI) is one of the leading global indicators of the impact and application of information and communication technology (ICT) in economies across the globe. The evaluation is based on four key pillars: Technology, People, Governance, and Impact. Egypt is ranked 5 th among lower-middle-income countries in the 2021 report compared to its income group (NRI, 2021). On each of the four pillars, its score is higher than the average for the income group. Egypt has shown a significant improvement in its index rank since 2017, progressing about 23 degrees until 2021. Among the 130 economies included in the NRI report 2021, Egypt ranked 77 th.

According to the report, its greatest strength relates to Impact pillar, while the greatest area for improvement concerns Governance pillar (NRI, 2021).

Several of the above indicators are being addressed within the framework of the Egypt Strategy 2030, which was aimed at developing a multidimensional vision for achieving Egypt's sustainable development goals. **The strategy adopted unique factors contributing to its success**. *The strategic geographical location* of Egypt is one of these factors. Second, Egypt is the most populous country in the Middle East, which contributes to its *human capital*. Tertiary education enrollment ratio has increased from 21 percent in 2012/2013 to 40 percent in 2021/2022. The population under the age of 30 represents about 60% of the total population, estimated at 102 million (Capmas, 2021). The third element is the large *consumer market size* since Egypt is the most populous country in the region. Fourth, Egypt possesses a *variety of touristic components* as well as a diversity of tourism patterns. Fifth, *diversity of the Egyptian economy*, since the economy relies mainly on the services sector, revenues from the oil sector, agricultural production, manufacturing industries, tourism revenues, and revenue from the Suez Canal and its logistical zone. With greater diversity comes more opportunities for Egypt to participate and contribute internationally to production and value chains, as Egypt’s Economic Complexity Index has increased in the past ten years by about eight points (2009-2019), with an overall ranking of 67^{th} out of 130 in the latest edition of the index in 2020 (ECI, 2020). Sixth, the availability of numerous real, sustainable *investment opportunities* represented for example in the development of the axis of the Suez Canal Zone (where the current investment value of industrial zones in the SCZone is estimated at $17 billion, with 14 industrial developers) (Kotb, 2020), international investment opportunities in the western Gulf of Suez region (with expected investment values $2 billion (seeking to transform Egypt into a global logistics center) (SCZone, 2021), the North West Coast, the New Administrative Capital projects, knowledge centers, international universities, and research centers (Ministry of Planning and Administrative Reform, 2014). Seventh, the large unexploited area of Egypt. 90% of the area is still in need of utilization. While some parts of it under development, as in the case of the eastern part of the Greater Cairo Region with new modern urban communities, such as the New Administrative Capital (NAC), and also the New City of El Alamein (NCA) in Northwest territory (MHUC, 2014).

Table 1 The socioeconomic indicators for Egypt (2015-2020)

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	na	na	7.5	6.2	94	na	77

Source: The author's construction 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/

Eighth, the Egyptian *economy resilience to crises* cannot be left behind. In the past decade, the Egyptian economy has withstood two global crises. Ninth, the availability of *renewable energy resources* is also crucial as Egypt is one of the most promising countries in renewable energy production (wind and solar energy), which contributes to the generation of electric power. Today's Egypt is electrically connected and even exporting energy to different parts of the world including the Middle East and Europe. Finally, mineral resources, exemplified in energy, solid energy, radioactive, metallic, and iron ores represent another key component contributing to the strategy (Ministry of Planning and Administrative Reform, 2014).

As a result of these factors, the Egyptian state has set up development goals and projects that include three major dimensions: economic, social, and environmental (Ministry of Planning and Administrative Reform, 2014). These three dimensions are based on ten fundamental pillars: 1) economic development; 2) energy; 3) knowledge, innovation, and scientific research; 4) transparency and efficiency of government institutions; 5) social justice; 6) health; 7) education and training; 8) culture; 9) environment; and 10) new urban development. Consequently, the axis of knowledge, innovation, scientific research, and contemporary urban development based on knowledge and urban intelligence has a fundamental role in achieving the objectives of the Egypt Strategy 2030. As a result, the axis of new urban development based on urban intelligence, innovation, and scientific research has become one of the main pillars of the comprehensive development strategy of 2030. Developing these axes is considered a new phase on the road to Egypt's comprehensive sustainable economic development. The State has proposed and established a set of projects supporting innovation and knowledge policies and smart cities to develop the regions of these projects to benefit from the ingredients and factors of innovation, knowledge, and smart cities.

Based on the above-mentioned strategy, to meet major challenges (population growth, balanced regional developmen, etc), a smart city concept has been adopted by the Egyptian government. In theory, there are currently two regions (Cairo and Alexandria) implementing smart city concepts, featuring fourth-generation universities, research centers, and technology industries. According to the concept, smart cities attract knowledge, innovation, and high-growth job opportunities to bringing about development booms in the regions of these cities (Matern et al., 2020). What is the likelihood of this happening in Egypt, or to put is simply: *How likely is it that Egypt will be able to support balanced regional development based on a smart city concept that supports innovation and growth based on technology and* *knowledge?* I address these issues in the following sections through a review of the theoretical background, the results of a case study, and the findings of the empirical section to evaluate the ability and readiness of the Egyptian regions to achieve regional development through smart cities and innovation policies.

1.2 Motivation and research relevance

My dissertation is relevant, as it provides a clear answer about how innovation policies such as smart city policies developed in advanced economies can be effectively adapted to developing economies, such as Egypt, to enhance regional development. The adoption of smart cities as a policy for urban development in Egypt has been accompanied by many differing opinions about the policy's feasibility, since it was introduced in 2015. As the implementation of the smart city policy in Egypt has begun and its first phase is almost completed, the NAC will be able to accommodate 5 million people, and US$45 billion has been spent on construction, opinions between supporters and opponents of the programme has remain divided. During an interview with a newspaper in September-2021, Tarabieh, associate professor at American University in Cairo (AUC), said that the current activity and trend are sound in terms of moving toward a greener Egyptian economy that is resilient and able to grow in spite of economic challenges. Nevertheless, he said that the provision of energy and water, as well as the delivery of water, raises questions about the extent to which appropriate technology is provided. In order to handle new challenges and integrate new technologies, he stressed how smart cities would operate and the degree of governance that would be utilized (Tarek, 2021). Elsaadany, a real estate analyst with the Egyptian Investment Bank, on the other hand, expresses reservations in the same interview about smart city plans focusing on high-income groups while disregarding the needs of upper-middle-class individuals (Tarek, 2021). Other experts mentioned that smart cities, in particular the NAC, are unique for their green architecture pioneer projects in Africa (Hutt, 2019). In other press articles, it was mentioned that there is uncertainty about how far the center of gravity will move from Cairo to the NAC located 45 kilometers away east of Cairo (El-Zobaidi, 2021). In a interview, planning expert Seif El-Din Farag said that Egypt definitely needs to build this type of city using the latest technologies to give more land for urban development in Egypt and that these cities will improve the quality of life for Egyptians (CGTN, 2018). In this sense, even the Egyptian media do not represent a unanimous opinion about the smart city initiative: **even though Egypt's monumental**

mega-project has already begun, there are still doubts about whether it will be able to accomplish the desired goals, whether it will succeed in its intended manner. Consequently, in my research, I **aim to identify the strengths, weaknesses, and concerns associated with the smart city program of Egypt in order to avoid potential pitfalls and contribute to its successful and successful implementation**. In the Egyptian context, my dissertation is unique in that it examines regional development using a smart city approach as an innovation policy.

As an Egyptian researcher, I was motivated to conduct this study because, to my knowledge, no study has examined in depth the effectiveness of state-supported innovation policies and smart cities **by examining whether or not the conditions for these smart city projects are available in the selected regions**. Studies have examined the concept and proposition of smart cities from different points of view, such as from the perspective of megaprojects (Hussein & Pollock, 2019), barriers to smart cities (Hamza, 2016), smart city architecture (Hassanein, 2017), and the Information and Communication Technology (ICT) aspect of smart cities (Konbr, 2019b). Due to this, my focus differs, therefore **I introduce the policy aspect of regional development, its dimensions, challenges, and present a political framework to ensure the achievement of development goals in a context where no prior study has examined this topic from a policy perspective, consequently my contribution can be valuable**.

As an urban and regional planner with an interest in regional development projects, I have noticed that in Egypt, the regional aspect is always viewed from an economic standpoint, while the smart city approach is always viewed from an urban standpoint, with no regard for the interaction between the two. In my dissertation, I have looked at both the economic (via regional innovation) and urban (as smart city policy is a sort of innovation) aspects, as well as the circumstances for smart city and innovation policies in the chosen areas.

My motivation for conducting this research turns out to be twofold: first, to fill a research gap, and second, to investigate a regional development policy based on smart cities and innovation in a systematic and integrated manner.

1.3 Statement of the problem and research gap

Given the current importance of policies based on knowledge, innovation and sustainable development goals (United Nations, 2021), studies have shown that the application of these policies is more challenging in developing countries or emerging economies than in developed countries (OECD, 2004, p. 26). These countries have limited resources, development issues, and economic and social challenges. Many studies have dealt with smart cities and smart urbanization, especially recently in developing countries. Many developing countries in East Asia and the Middle East have adopted the smart city approach as a contemporary urban development policy to meet the challenges and issues of urban management in developing countries (Baldascino & Mosca, 2016; Fromhold-Eisebith & Eisebith, 2019; Joia & Kuhl, 2019; Pereira et al., 2018; Yadav et al., 2019). Hence, the research problem for the thesis is formed through ***is it possible to adapt efficiently innovation policies like the smart cities concept developed by advanced economies in developing countries like Egypt in order to promote regional development policy? Or is this kind of adaptation inappropriate in developing countries like Egypt, where the conditions are very different? In the case of Egypt, does this original smart city concept need to be adapted?***

There appears to be a research gap in Egypt where the state promote greatly several innovation, knowledge, and smart city programs and believe in its success/successful implementation, but **no thorough scientific investigation has been conducted in the Egyptian context to evaluate the experience by evaluating the ability of regions to implement smart city and innovation policies**. This is also in line with Caragliu, A., and Del Bo, C. (2020), who state that while smart cities have attracted the interest of numerous policymakers at all levels of government, and appropriate financing has been granted, the landscape of policy evaluation is very scarce. This study is unique in that it aims to fill a knowledge gap by examining and assessing the Egyptian smart city policy in order to create a set of policy suggestions for the future. Additionally, the study will shed light on the potential of applying the smart city approach to grow designated regions in Egypt so as to boost the nation's overall economic development, on the one hand, and to enhance regional convergence, on the other.

1.4 Research questions

In Egypt, the state has started implementing several projects and programs aimed at regional and urban development based on knowledge, innovation, and urban intelligence since 2014. The new innovation policy of Egypt is part of the *Egypt Strategy 2030* issued in 2014 by the Ministry of Planning and Administrative Reform. For achieving these goals of the new innovation policy, smart city projects, fourth-generation cities, and fourth-generation universities within the Egyptian governorates were launched. Smart urban communities are largely intended to support the rapid increase of existing cities' populations. Furthermore, this expansion has negative repercussions for current urbanization, such as raising population pressures in Cairo and producing environmental problems. These new urban communities hope to establish a more equal allocation of economic activity within Egyptian regions by supporting economic growth and strengthening regional convergence. On the other hand, due to these projects, the country seek to enter into the era of urban intelligence based on knowledge, technology, and the Internet of Things. The State also tends to establish knowledge and research cities and cooperation among the components of innovation systems in terms of industry, university, and the private sector. The above-mentioned national strategy aims to exploit opportunities within smart cities to create an environment for innovation and knowledge.

I intend to conduct an in-depth study of the implementation of smart city and innovation policies in the Egyptian context, with the aim of identifying the potential for regional development using smart city and innovation strategies. During my research for the topic, I focused mainly on the central question, which, of course, raised several sub-questions:

- *Is it possible to adapt efficiently innovation policies like the smart cities concept developed by advanced economies in developing countries like Egypt in order to enhance regional development?*

This question raised the following sub-questions:

- RQ1: How does innovation (policy) support regional development?
- RQ2: Can smart city policy be applied in general to any developing country?
- RQ3: Are there any preconditions that need to be met before Egyptian governorates can adopt the smart city concept?
- *RQ4*: *Which Egyptian governorates have the conditions to adopt the political concept of the smart city?*
- RQ5: *Which Egyptian governorates's RIS is the readiest for the implementation of the SC concept*?

Table 2 shows which chapters in the dissertation provide answers to the research questions, and what kind of methods were used (see Table 2).

Table 2 The research methods used for answering the RQs in the research sub-chapters

RQs	***Research methods***	***Sub chapter***
RQ1	Systematic Literature Review (SLR)	2.2
RQ2	Systematic Literature Review (SLR)	2.3, 2.4
RQ3	Narrative analysis, Case study, Interviews	3.2, 3.3, 3.4
RQ4	Case study, Interviews	3.3, 3.4
RQ5	Narrative analysis, Case study, Interviews	4.3, 4.4

1.5 Structure and methodology

In terms of the methodological framework, the thesis consists of theoretical sections (Chapter 2), analytical and empirical parts (Chapters 3, 4), and finally, policy proposals (Chapter 5) followed by the theses of the dissertation (Chapter 6) as shown in Figure 2. Regional innovation policies and smart city policy in developing countries will be described first to provide a theoretical basis and a conceptual framework for the subject. Then the empirical and analytical chapters are built on the theoretical part of the dissertation.

Chapter 2 consist of five sub-chapters. Sub-section 2.1 introduce the methodology of Systematic Literature Review (SLR), which is recently a very popular method in order to identify – in a transparent way – the most relevant papers of a given topic. A systematic literature review is used as a robust method for exploring relevant literature to provide that conceptual basis, theoretical framework, and experiences of policy practice in developing countries. It aims to identify, evaluate and synthesize the best available evidence. The systematic review is also characterized by specific research questions, a specific set of methodological features, and information that can be extracted in table forms to summarize the data. Therefore, this chapter adopts the methodological approach to explore the theoretical and conceptual framework and experiences of developing countries' innovation policies and smart city cases. The motive for adopting this approach is to identify and select all relevant sources relates to the particular research questions addressed. In Chapter 2, I explore the theoretical background of regional innovation systems (RIS), innovation policy generally, and smart city concepts with a special focus on developing countries. Sub-section 2.2 offers a comprehensive summary of the theoretical background of the regional innovation system in three parts, which are: (1) role of innovation in regional economic theories; (2) the role of innovation policy to regional development; and why innovation has become important for regional development by illustrating traditional and contemporary policies; (3) innovation systems through the concept of regional innovation policy, its components, and measurement. In sub-chapter 2.3, I introduce smart cities as a novel concept in innovation policy. The concept of smart cities is discussed from the standpoint of innovation: definitions and components of smart cities concept are included and discussed, along with requirements, expectations and potential effects of smart city development. In the fourth sub-chapter (2.4), I offer a thorough investigation of the experiences of regional innovation systems and smart city policy implementations in several developing countries. Here I focused on the following questions: (1) What challenges have these countries faced when setting up their smart city development programmes? Was the original concept adapted to the circumstances in the regions? How they evaluate the efficiency of their achieved smart city programmes in term of regional development? Finally, the second chapter concludes with a set of conclusions and a summary of how innovation and smart cities contribute to regional development, in general and in developing countries (sub-chapter 2.5).

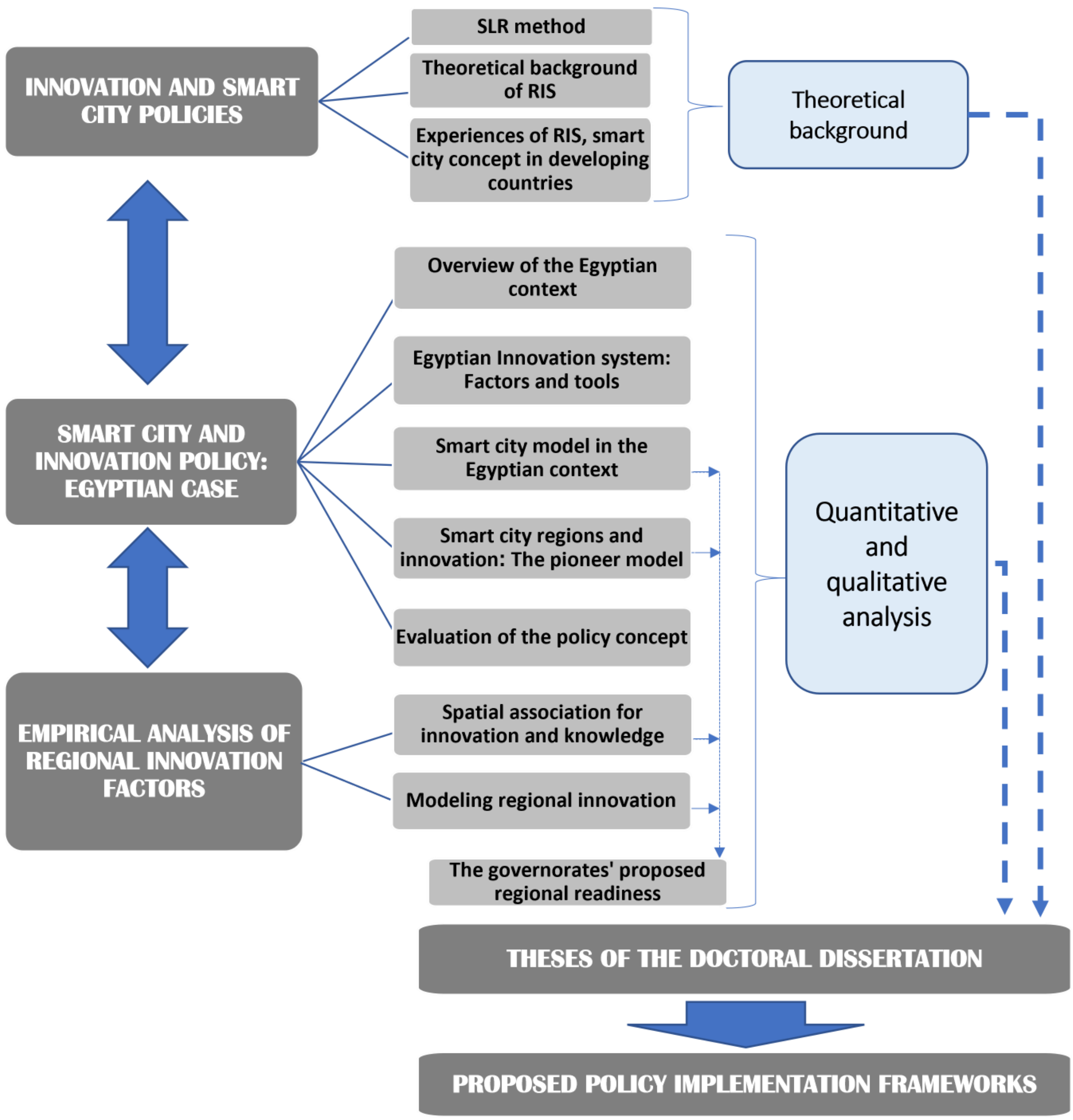
In Chapter 3, I describe the RIS of Egypt in general, its components, and its performance in the Egyptian case. In the second part, I describe the components, aims, and expectations for the Egyptian smart city concept. In order to do so, I give a comprehensive overview of the nature of the Egyptian context through the levels of regional development in Egypt and the characteristics of the state from a geographical, population, and economic development standpoint (Sub-chapter 3.2). After discovering the Egyptian features and regional characteristics in sub-chapter 3.3, I summarize the factors and tools of the Egyptian innovation system. Sub-sections of this chapter present both the development path, innovation indicators, and regional components at the national and regional level. This sub-chapter aims to present the Egyptian innovation system – both at the national and the regional level – by comparing it with other developing countries. In sub-chapter (3.4) I discuss the smart city policy concept in Egypt from the perspective of the components and factors that drives innovation. This sub-chapter outlines the framework of the Egyptian policy for smart cities by presenting the proposed city projects their objectives and expectations. The NAC, which is the leading smart city initiative in Egypt, is discussed in this part as a case study (Sub-chapter 3.5). I present how the smart city model works, the driving development components and the framework model for the smart city in the Egyptian case. Finally, I evaluate the policy concept within the Egyptian framework in sub-chapter 3.6.

In chapter 3, I use a qualitative methodology to analyse the components and frameworks of Egyptian smart city policy. The first method is the *narrative analysis*, while the other method is the *case study analysis.* First, as a part of the narrative analysis, I describe and analyse policy documents and data provided by the relevant authorities and ministries related to the Egyptian regional innovation policy and smart city concept, as well as the strategic plans of the various authorities. Secondly, as part of the case study analysis, I conducted interviews with two Egyptian officials - one is the Technical Advisor to the Minister of Housing, Utilities and Urban Development, and the other is the Chief Technology Officer (CTO) at Administrative Capital for Urban Development Company - ACUD, in order to gain a deeper insight into the pioneering Egyptian smart city policy model. The purpose of these analyses is to offer a comprehensive picture of the policy framework because it is not clearly specified by one administrative government entity. Consequently, I collected policy papers and data from multiple ministries in the form of national strategies, urban development plans, and project proposals to help answer the raised question. In order to understand policymakers' perspectives of smart city model, I conducted a "*semi-constructed interview*". I use this method in order to develop an inductive and descriptive picture of smart city policy in the Egyptian context, but not to identify stakeholders' reactions to the beneficiaries of the policy. Because of this, I sought out as much information and data as possible from government officials and policymakers. By utilizing the above-mentioned methods, I was able to gain a comprehensive understanding of smart city concepts, from policymakers' views to experts' opinions, expectations, and concerns. Nevertheless, there is a question that still arises*: do the regional innovation system work effectively in Egypt in order to achive the main objective of the smart city proposal?* Hence, I have an incentive to conduct an empirical analysis at the regional level to answer this question.

In Chapter 4, using an empirical approach, I examine the relationship between the highly-associated variables of the innovation system and the innovation outcomes of the Egyptian regions in order to answer the question whether the requirements and expectations of the Egyptian smart city policy can be achieved. In this chapter I identify regions that are most capable of integrating innovation policies and smart cities concepts, and identify the variables that are most related to knowledge and innovation output in Egypt. To achieve this goal, in sub-chapter 4.1, I use a two-pronged empirical methodology, 1) exploratory spatial data analysis (ESDA), and 2) modelling the knowledge production function (KPF). The first part of the analysis explores the governorates that have a spatial autocorrelation of the innovation and knowledge production outputs. The second part of the empirical methodology seeks to identify the variables highly associated with innovation and knowledge outputs. The first goal is achieved by using the global spatial autocorrelation analysis (Moran's I statistic) and the Local Indicators of Spatial Associations (LISA) founded on significance and cluster analysis. In order to accomplish the second objective, I run parsimonious models on cross-sectional data using Ordinary Least Squares regression (OLS). Considering the nature and limitations of the data and sample size, this model is more appropriate than other econometric models. In this case, the regional analysis is conducted based on 27 governorates in Egypt. Therefore, the less ambitious models were resorted to, which deal with small samples in econometric models. In the sub-chapter 4.2, I explain the model and variables used with an accurate and detailed description of the data and its sources. Results of the analysis are presented in two parts: the first is the spatial autocorrelation, while the second is the regional innovation modelling (Sub-chapter 4.3). This chapter is considered the most exciting part of empirical results determining the spatial importance of the governorates and their relationship to knowledge outputs. Moreover, it identifies clusters of spatial autocorrelation of both types, positive and negative. This part determines the spatial distribution and concentration of innovation outputs in the Egyptian context. The last subsection also identifies the variables and innovation factors that are most relevant to the regional innovation outputs. In the last sub-chapter (4.4), **I present a synthesis of the regional readiness of the Egyptian governorates, based on the empirical analysis and analysis of narratives in the third chapter. In this analysis, governorates are evaluated according to their readiness for innovation and smart cities based on their capabilities and components**. Based on this readiness degree, decision-makers can get an accurate picture of how prepared Egyptian regions are for implementing the smart city policy based on the development of the innovation system.

Chapter 5 presents theses and policy implementation framework. I present the theses for the doctoral dissertation in chapter 5.1. Subsequently, I describe a policy implementation framework in sub-chapter 5.2. **Chapter 6** summarizes the study's limitations, both in terms of the data and models used, as well as a vision for future research that can be explored to open up new research possibilities.

Figure 3 Dissertation structure



2. INNOVATION AND SMART CITY POLICIES: THEORETICAL BACKGROUND AND EXPERIENCES

Over the last three decades, innovation, knowledge, and technology have all played a part in regional development (Navarro et al., 2009). In recent decades, Regional Innovation Policy (RIP) has become one of the most important fields of regional economic development. Growing attention is being paid to RIP in both developing countries and in less developed regions (LDRs) of developed countries (Ali, 2021a). To catch up, these lagging regions try to implement innovative, novel policies tailored to their local conditions in order to tackle local problems (Hu & Mathews, 2005). **Smart city** as an urban development innovation policy can be regarded a new solution. Recently, governments have adopted **smart cities**, or so-called **urban intelligence** measures, as a way to increase urban development and innovation. Kraus et al. (2015) explained that innovation, creativity, and entrepreneurship contribute to the economic growth of smart cities. Entrepreneurship in smart cities differs from entrepreneurship in other cities in that it takes into account an appropriate ecosystem, innovative business solutions, and the introduction of innovative products and new knowledge-based services (Kraus et al., 2015).

As a goal of the current chapter, I aimed to provide a conceptual framework for the research topic. As part of this, I investigated how the concept of smart cities can be applied to developing countries as an innovation policy. Consequently, I conducted a *systematic literature review (SLR)* to understand the following:

(1) What does the smart city concept mean as an innovation policy?
(2) What is the role of the smart city concept in regional innovation policy?
(3) What examples or experiences from developing countries can be provided with regards to its application?
(4) What conclusion can be drawn from its application?

The following sub-research questions are addressed in this chapter:

- RQ1: How does innovation (policy) support regional development?
- RQ2: Can smart city policy be applied in general to any developing country?

2.1 SLR method: documentation of the searching, selection, and assessment process

Literature relevant to this chapter's research questions (RQ1 and 2) was identified using systematic literature review (SLR) method. The SLR aims at finding, appraising, and synthesizing the available evidence for (a) specific research question(s). In addition, the clear, explicit, and rigorous research method provides evidence-based answer, with clearly defined and understandable steps (Booth et al., 2016; Gough et al., 2017). The SLR method is: (1) *systematic*, as it follows a consistent methodology; (2) *methodical*, as it comprehensively describes the intended review procedure; (3) *focused*, as it examines specified research question(s); (4) *transparent*, as it offers a detailed documentation of the whole process, with clear inclusion and exclusion criteria, and an explicit quality assessment method.

The process was divided into the following three stages: first, identifying the need for a review, establishing (preliminary) research questions (RQs), organizing the scope search, and finally, developing a research protocol. Second, conducting literature reviews, identifying (potentially) relevant studies, screening, selecting, and evaluating those studies, and ultimately collecting data from those studies. For the SLR review, two areas of research were identified: one on *regional innovation policy*, and another on *smart city policy*. The literature reviews' findings were arranged into three sections:

- theoretical background of the RIS (sub-chapter 2.2),
- smart city approach as a new innovation policy concept (sub-chapter 2.3), and
- RIP of developing countries and their smart city experiences (sub-chapter 2.4).

As a first step, the SLR was conducted to identify, evaluate and synthesize the available evidence regarding the question: *"What is the regional policy pursued in developing countries*?". The question is centered around regional innovation policy and regional development in developing countries. Research questions must be clearly stated from the beginning, since clarity contributes to two-thirds of the right results (Booth et al., 2016). The CIMO concept (Denyer & Tranfield, 2009), which refers to the main components of well-formulated research questions in social science, is one of the techniques used to develop my research question (Table 3).

Table 3 Research question formulation method (CIMO concept)

C – Context	Which **regions** in **developing countries** can be appropriate (applicable, relevant) for regional innovation policies?
I – Intervention	What are the **regional development policies (procedures, approaches)** related to the regional innovation system?
M – Mechanisms	What **mechanisms** explain how these policies/procedures achieve/apply innovation policies?
O – Outcomes	**Structure (pattern, formation)** of regional innovation policies in the regions of developing countries. **How to measure the outcome?**

Source: own edition.

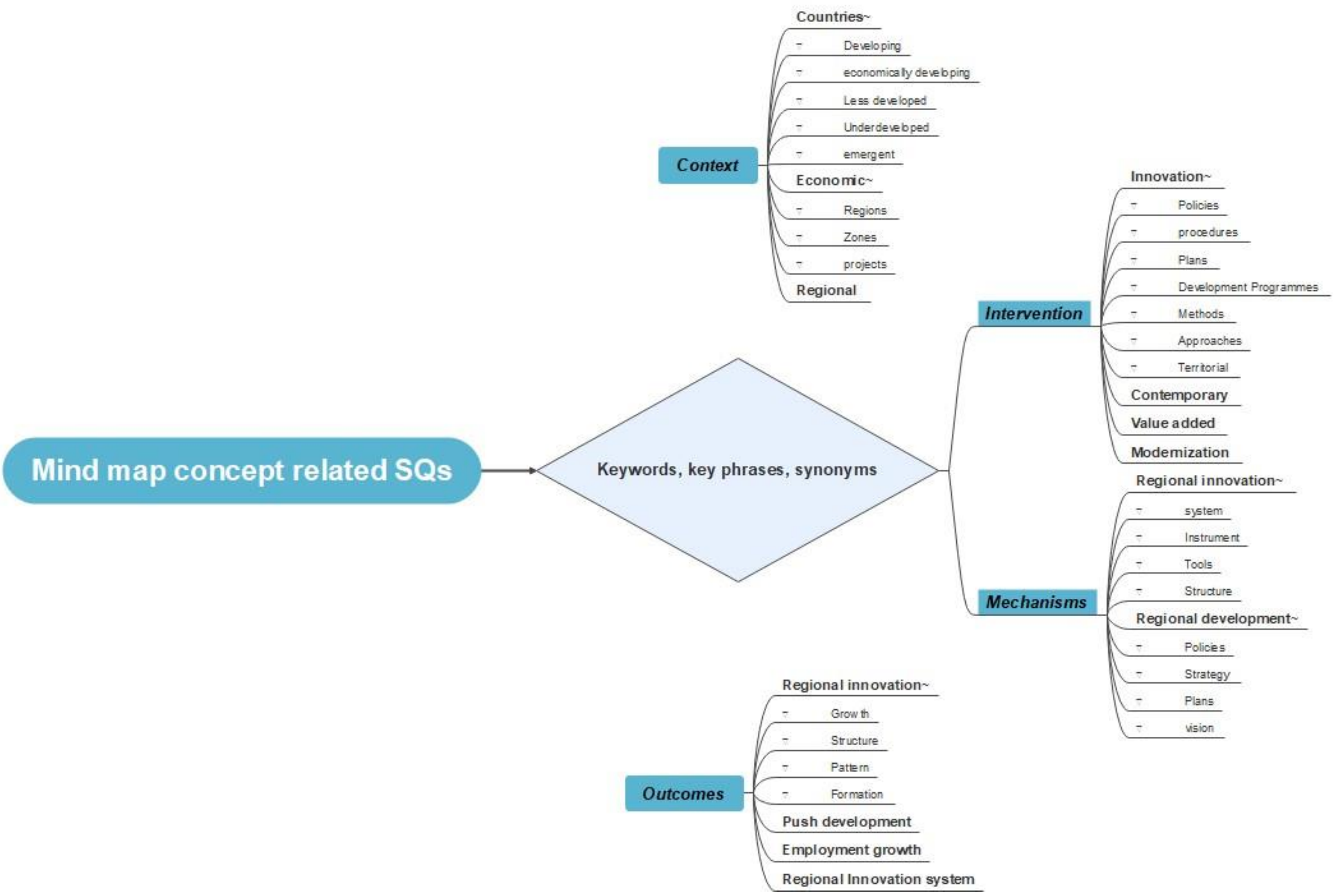
The primary keywords, such as *innovation policies*, *developing countries*, and *regional development*, were selected based on the RQs and the research topic. Synonyms for keywords were found at *www.thesaurus.com.* Following that, search queries (SQs) were created using a mind map technique (Figure 4, and see in detalied in Appendix 1). Each search query should contain a keyword which corresponds to each CIMO component. As part of the second step, I search bibliographic databases through search queries in order to locate relevant publications that address the review question. During this step, some additional inclusion criteria for the study were defined (Table 4).

Table 4 Inclusion criteria for the study of the literature review

[WHO]:	Kind of regional innovation policies
[WHAT]:	Application/impact
[HOW]:	Regional innovation policies/procedures/plans
[WHERE]:	Less developed countries

Source: own edition.

Figure 4 Keywords, key phrases, synonyms related to the Search Queries



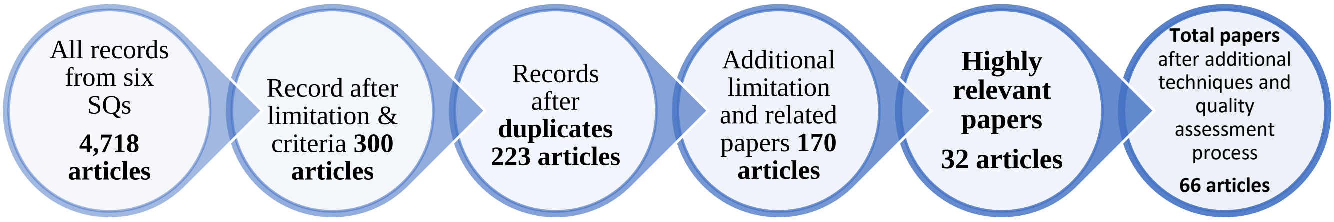
Source: Own construction, based on edrawsoft mind-mapping software, available online: https://www.edrawsoft.com/mindmaster/?gclid=EAIaIQobChMIrprKzI_43QIVyp3tCh0SfgkEAAYASAAEgJ3ZfDBwE

The litearture search was conducted in 2019 and includes only English language articles from 1995 to 2019. To include papers published between 2020-2021, I conducted additional "author search": I selected the most recent publications of relevant authors/researchers in the fields of RIS, innovation policy, and other related fields. Only journals with high impact factors were used (three or above based on the Academic Journal Quality Guide[1]) with a minimum citation score of 50. Initially, a minimum reference score of 70 was used, but it was later reduced to 50, as the RQs target the case study papers pertaining to developing/lagging countries which are not usually highly cited. The search

[1] https://charteredabs.org/academic-journal-guide-2021/

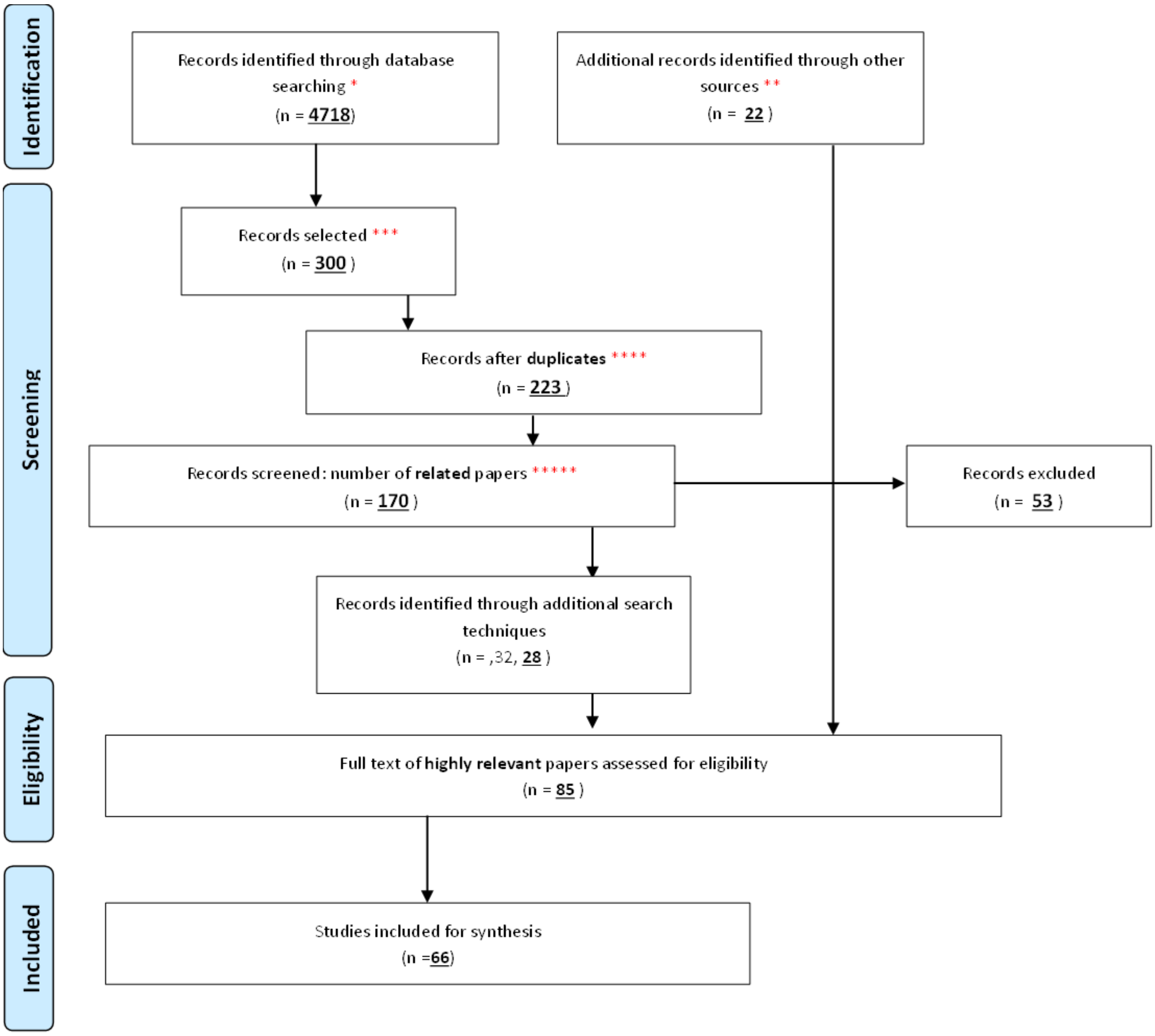
queries were tested using three different online access databases: (1) Web of Science (WOS), (2) Academic Search Complete (EBSCO), and (3) Business Source Premier (EBSCO). Through the use of the exclusion criteria and limitations, 4718 articles were reduced to 300 after being identified through the search queries. The duplicate papers were eliminated using reference management software, which reduced the number of research papers to 223 papers. Nevertheless, additional exclusion criteria were applied on the databases in order to exclude not relevant documents related to the topic, which included fields of research such as "economics", "regional economics", and "urban economics", and "social sciences", finally resulting in a total of 170 articles. Additional classifications have been applied based on the degree of relevance. Accordingly, the search results for high-relevant articles has recorded 32 articles, as shown in Figure 5.

Figure 5 The process selection of highly relevant articles



Additional search techniques were used as well, including (1) the investigation of the reference lists of highly relevant papers, (2) author search: selection of papers published by the top five most-cited authors, and (3) other techniques, such as keywords and papers suggested by the supervisor. Due to these solutions, additional 50 high-relevance publications were identified. Thus, a total of 82 papers were selected as potentially relevant. In the second stage of the quality assessment process, the research papers were critically evaluated. In this step, I read the titles, keywords, and abstracts of papers identified in the previous step and classified them according to their relevance (highly relevant, relevant, not relevant, and others not identifiable from just the title or abstract) to the research question. The process identified **66 articles that were highly relevant to the research question**. The PRISMA Flow Diagram (Figure 6) illustrates the whole identification and selection process.

Figure 6 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, 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.

***** Evaluating each paper by relevance and selecting only highly cited articles published in leading journals.

Source: own edition (based on http://prisma-statement.org/prismastatement/flowdiagram.aspx).

Second, a thorough literature review related to *smart city policy concept* was conducted to understand the concept from both a regional development and urban planning perspective, especially for developing countries. In addition, this review examines the application of smart city policies in some cases of developing countries. Based on a primary research question, this review examines *"How smart city programs have been implemented in developing countries?"*. I also used the CIMO method to pinpoint the research question (Table 5).

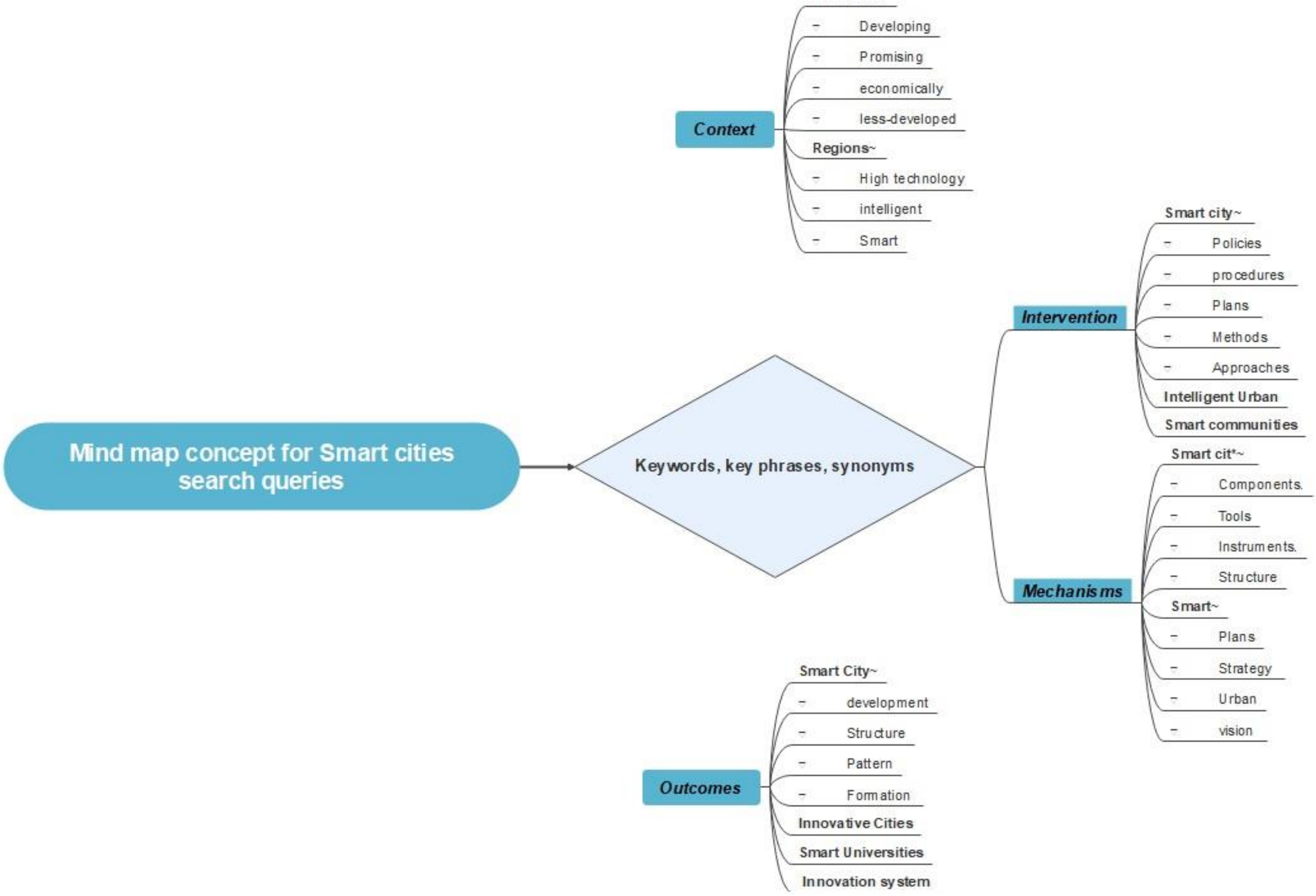
Table 5 Research question formulation method (CIMO concept)

C – Context	**Which regions and zones in developing countries may be appropriate (applicable, relevant) to smart city policy concept?**
I – Intervention	How are **programs** (**approaches**, **interventions**) designed to enhance innovation in the development of **smart** / **innovative** cities?
M – Mechanisms	What **mechanisms** demonstrate that these policies/procedures are suitable for the implementation of smart cities?
O – Outcomes	**Structure/ plans/programs/strategies** of smart city concept in the regions of developing countries. **How are these programs designed?**

Source: own edition.

The RQs and the research field have determined the keywords for smart city search queries. *Smart city policies*, *developing countries*, *experiences*, and *case studies* are the four primary topics from which the keywords were derived. As a next step, I determined the potential synonyms that have the most robust relation to the above-mentioned topics. The search queries (SQs) were formed by combining the identified keywords (see in detailed in Appendix 2) based on the mind map in Figure 7.

Figure 7 Keywords, key phrases, synonyms related to the Search Queries



Source: Own construction, based on edrawsoft mind-mapping software, available online: https://www.edrawsoft.com/mindmaster/?gclid=EAIaIQobChMIrprKzI_43QIVyp3tCh0SfgkEAAYASAAEgJ3ZfD_BE

Next, the inclusion criteria were determined. In terms of geographic scope, I included, in addition to smart city regions in developing countries, developing countries in general, and the Egyptian case in particular. Moreover, with regard to the approach used to analyze smart cities, studies should address smart city policies and programs as urban development policies. In Table 6, the scope of the research was determined by asking a set of questions, and each research question was formulated so that it addressed the four components to identify literature and potential sources (who, what, where, how). Following are the questions that were asked:

(1) *What are the smart city policies for regions in less developed countries?*
(2) *In regards to smart city policies, what is the experience of Egyptians?*
(3) *How can smart city programs be used as an innovation system framework?*
(4) *Can smart city approaches be applied to Egypt's regions?*
(5) *How do fourth-generation universities work in smart city regions?*

Studies examining smart cities by focusing primarily on IT design, information technology and computer science, as well as case studies investigating smart cities in developed countries, were excluded from the study.

Table 6 Inclusion criteria for Smart city literature

	RQ1	RQ2	RQ3	RQ4	RQ5
WHO	Less developed countries	Egyptian case		*Egypt's regions*	Smart city regions
WHAT	Policies identifications	*Experience*	Using smart city programs	Appropriate programs implementation	Working fourth-generation universities
HOW	Smart city policies	Smart city policies	Smart city programs	Smart city approaches	Smart city regions
WHERE	Multicase studies	Egypt	-	Egypt	Multicase studies

Source: own edition.

The SLR research was conducted in early 2021. The review consists only of English language papers published between 1995 and 2020. In this case, academic journals, book chapters, and conference papers with at least 20 citations were prioritized. Because the smart city concept is relatively new, I relaxed the citation requirements to expand the collection of potentially relevant papers. The variety of studies comprised case studies, literature review papers, and comparative studies. In order to test the SQs the following electronic journal databases were used: Academic Search Complete (EBSCO), Business Source Premier (EBSCO), OpenDissertations (EBSCO), Regional Business News (EBSCO), Web of Science WOS (Clarivate Analytics), and SCOPUS (Elsevier). There were 564 articles, while 269 articles were selected according to the criteria and limitations. I used reference management software to exclude duplicates, and had 211 documents after eliminating them. Further filters – *urban planning*, *economics*, *regional economics*, *urban economics*, and *social sciences* – were applied to exclude publications that are not related to the topic. A total of 173 papers were produced as a consequence of this process. Finally, classifications based on the degree of relevance were formed. There was a total of 60 key papers that remained high relevant papers left (Figure 8).

Figure 8 Summary of the selection process stages for highly relevant papers.

The conceptual framework of the dissertation is based on a thorough literature review of (1) *regional innovation policies* and (2) *smart cities*. The key findings are divided into three sections in this chapter: first, *the theoretical background of RIS*; second, *the smart city approach as a novel innovation policy concept*; and lastly, RIS experiences, and smart city concept in developing countries. This is followed by a few concluding remarks.

2.2 Theoretical background of RIS

The findings of the systematic literature review are presented in this chapter. This chapter of the dissertation provides a *theoretical background of regional innovation system and policy*. A theoretical framework for conceptualizing regional innovation policies includes the following subtopics: (1) regional economics theories of innovation, (2) innovation policy and regional development, and (3) innovation systems: RIS components and concept.

2.2.1 Regional economics theories of innovation

As well as emphasizing their unique characteristics and disparities, 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 examine how it appears in regional economic theories. Further, I examine how these theories view innovation as a contributor to regional development.

In order to describe innovation in regional economic theories, a variety of concepts have been developed in the literature. 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). Explaining how "innovation" could originate from existing systems was one of Schumpeter's key concerns (novelty, new variation) (Witt, 2003). Mainstream economics assumed the function of entrepreneurship was unnecessary in a world with comprehensive knowledge and rationally acting economic subjects, despite Schumpeter's intention to include a general theory of economic development in his theory of innovation and entrepreneurship. It is more 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 a policy for innovation. Furthermore, other EU policies, such as those on employment, competitiveness, the environment, industry, and energy, are all strongly linked to innovation 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 in order 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 harmonise 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 to the outcome of the activity. It provides the following general definition as: *"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).

Understanding innovation as a phenomena has grown increasingly essential in recent decades. Innovation has become a crucial aspect of economic development and knowledge, as well as one of the primary contributors in domestic economic growth, as a result of the rapid pace of technological change. The fundamental explanation for regional imbalance, on the other hand, was thought to be the uneven geographical distribution of innovative activity (Capello, 2016). Knowledge, intangibles associated with culture, skills, and innovative capacities, according to Capello (2016), remain crucial in determining the viability of local economies in times of overmobility of labor and capital. From this perspective, I can introduce the following theories that discuss the importance of local knowledge and innovative capabilities to regional development: the theory of *"technological spillover"*, the *"milieu innovateur*" theory, the *"learning region*" theory, and finally, the *"evolutionary economic geography"* theory.

The *"technological spillover"* theory, which was established in the 1990s, looked at the relationship between the *concentration of creative activities* and the growing returns created by such activities. Concentrated locations make it simpler to take use of research institutions' and universities' technical and scientific achievements, to get uncodified tacit information that can be utilized for imitation and reverse engineering, 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). Advanced enterprises contribute to the betterment of the environment, as well as the environment that supports their activities, by utilizing their technological and organizational knowledge. As a result, research and innovation are becoming increasingly polarized, furthering the trend towards 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 own 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).

To investigate the regional distribution of technology spillovers, several empirical analyses, including econometric analyses, were provided. The estimate of the aggregate knowledge production function (KPF) at the regional level is the most well-known of these measures. One of the KPF's primary goals is to see if there are any technological spillovers, or, to put it another way, if research and development efforts inside and outside the area impact one another (Varga & Horváth, 2015).

Cappello (2016), on the other hand, stated that the theory could be criticized in a variety of ways. It is critical to note that R&D expenditures and the number of patents are simply selective measures of innovative capacity that only capture product innovations, and that discoveries are often credited to major corporations rather than small businesses. Secondly, the theory is also founded on the concept of space. There is a primarily geographical container for spillovers that emerge from physical interaction between actors in this space. It is impossible to explain how knowledge spreads locally since it solely examines the chance of interaction among innovators as a source of spatial diffusion. Furthermore, it focuses solely on innovation diffusion rather than knowledge production. It overlooks the most important aspect of the innovation process: how individuals (or the environment) learn.

In essence, the theory of technological spillover has stressed the relevance of innovation via increased returns that arise from the concentration of innovative activities within certain spatial regions. In this manner, technology and innovation can be used to promote performance and growth returns, as suggested by the theory.

Local economic and social interactions, according to the *"milieu innovateur"* theory, determine the innovation ability and economic performance of certain localized areas known as *"*milieux innovateurs*"* (Camagni & Capello, 2002, 2005; Moulaert & Sekia, 2003). In the theory, local economic and social relations can interact in these areas, thereby promoting economic growth. Spatial proximity, economic homogeneity, and cultural homogeneity all play a role in this interaction (Enrico & Grandi, 2005). As a result, small enterprises can acquire competitive advantages by encouraging learning and knowledge sharing (Amin & Thwaites, 1986; Camagni & Capello, 1999). A key element of the theory is that innovation happens through the creation of economic entities comprised of partnerships between large multinational corporations and local institutions, such as research centers, training institutes, banks, and local governments (Baldwin et al., 2005; Evenson & Singh, 1997; Moulaert & Sekia, 2003). The entity's economic prosperity is heavily influenced by its location. Without being explicitly tied to its geographical dimension, the interaction between the components of an economic entity indicates its network. When the site of an economic entity becomes regionally important, however, the concept of milieu innovateur and its function becomes critical in driving the region's growth (such as when Apple is located in Cupertino, Silicon Valley) (Camagni & Capello, 2002). The more interactive the network-building relationship, the greater the impact on local economic development (Vale, 2011). As a result, the theory indicates that the importance of partnership and relationships among actors has an influence on innovation processes in local environments, rather than individual companies' efforts to promote innovation (Camagni & Capello, 2005; Moulaert & Sekia, 2003). In light of the milieu innovateur theory, collective learning is a regional equivalent to learning that occurs within companies (Camagni & Capello, 1999, 2002). The empirical econometric analysis of the production function is used to examine this theory as well, as in the theory of technological spillover. In addition, researchs studying this theory has emphasized the importance of social and cultural proximity in ensuring the continuity of small businesses (Capello, 2016; Enrico & Grandi, 2005; Lalrindiki & O'Gorman, 2021; Morgan, 2004). In addition, the "milieu innovateur" theory is distinctive in explaining how knowledge is spread as well as not only the possibility of communication or interaction, but rather based on well-established local regional phenomena. The theory of technological spillover has been criticized for its inability to explain how knowledge spreads locally (Capello, 2016). In this sense, the *"milieu innovateur"* theory focuses on local and regional characteristics that influence a region's potential to innovate, as well as how to utilize space to promote economic growth (Camagni & Capello, 2002, 2005; Moulaert & Sekia, 2003).

In summary, the *"milieu innovateur"* theory emphasizes the importance of space in economic development by highlighting interactions among partnerships inside an economic entity defined by a certain spatial scale. Local economic and social ties are critical to a community's capacity to innovate and succeed economically. The theory emphasizes the importance of collective learning in the innovation process, arguing that it has a greater influence on innovation than individual learning procedures that occur within firms to encourage innovation. Last but not least, the theory's ability to explain how knowledge spreads by adding local variables and economic phenomena unique to an area and subsequently enabling regional innovation, or *"milieu innovateur"*, is what sets it apart.

I provide one more theory of those theories, namely the *"learning regions"* theory, in order to follow the context of this sub-chapter and explain how innovation arose and its importance to regional economic theories. The theory differs from earlier ones in that it considers *institutional aspects* as well as social, economic, and cultural standards in the context of the region (B. Asheim, 1996; Cooke & Uranga, 1997; Morgan, 1997). In order to illustrate this point, I would like to present a number of basic considerations for the theory: first, knowledge is the most valuable resource of modern economies. Specifically, the ability to learn and acquire knowledge represents two of the determinants of economic competitiveness (Cooke & Schienstock, 2000). Furthermore, innovation is a complex and systemic phenomenon, and in light of the recent developments in technology, a collaborative learning process is necessary (Landabaso et al., 2003). Lastly, innovation is often the result of informal learning processes motivated by specific concerns directed at a particular market or market structure and based on direct experience or the experiences of others (Capello, 2016; Morgan, 1997). Innovation arises from this diversity of features: the wide range of traditions, norms, practices, and social conventions that constitute what has been referred to as 'institutional thickness' (Amin, 1999; Enrico & Grandi, 2005; Morgan, 1997). This diversity of features is responsible for the localization of innovation. It is crucial to examine the cultural (Enrico & Grandi, 2005) social, and institutional contexts of a region to be able to localize innovation, specifically those that support institutional aspects for it to succeed

(Capello, 2016; Cooke & Uranga, 1997). 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 impossible, the concept of learning region has gained widespread acceptance, not only in a specific scientific community (that of Britain and the United States), and also at the organizational level, given the European Union's necessity to develop new policy instruments to support regional cohesion (Capello, 2016). However, the outcomes of translating the notion of a "learning region" into 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 weak regions (Landabaso et al., 2003; Moulaert & Sekia, 2003; Simmie, 2012). While "the learning region theory" promises a system of homogenous social, political, and institutional conditions in regions, as well as collaboration and participation among actors, according to Cappelo (2016), its apparent fundamental shortcoming is notably non-spatial. The theory offers no explanation for why and how these interactions must be local, what territorial conditions must exist for the 'organized market' to arise, or what territorial components drive the active learning process.

In sum, learning and knowledge acquisition must be supported in order to localize innovation within regions in line with the learning regions theory, as they are the primary components that define an economy's competitive capability. According to the theory, innovation is the consequence of a variety of factors including regional traditions, standards, social and cultural practices, and institutional considerations.

The *"Evolutionary Economic Geography Approach"* is another innovation 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 on *the dynamics of local areas* was one of its distinguishing aspects. (Boschma & Iammarino, 2009; Neffke et al., 2011; Tödtling & Trippl, 2005). In accordance with this theory, innovation and new knowledge development result from a process of discovery that builds on existing competencies, within specific technical paradigms, along with specific path dependency (Boschma & Frenken, 2006; Boschma & Martin, 2007; Kogler, 2015). The idea of cognitive proximity is introduced as a critical component in explaining innovation capacity in this theory (Feldman, 1994). Close proximity is an important concept that is often employed in several scientific domains. Authors have always concentrated on geographical proximity. For example, some authors have determined proximity based on the distance between actors or the actors' impression of their distance. Others have concentrated on the existence of clusters or agglomerations of businesses in a specific location (Boschma, 2005; Molina-Morales et al., 2014). Cognitive proximity, on the other hand, is becoming increasingly important for the study of knowledge and innovation processes. Similarities in the way actors see, interpret, comprehend, and assess the environment can be connected to this form of proximity. Through the firm's absorptive ability, cognitive proximity helps not just the collection of environmental knowledge, but also its absorption and utilization (Molina-Morales et al., 2014). The development of new and innovative technology solutions requires that firms possess complementary knowledge. Developing a common language and mutual understanding by utilizing a common knowledge base is the first step towards this (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. Thus, based on the evolutionary economic geography approach, it is obvious that the proximity of knowledge within regions has the greatest influence on innovation.

The major focus was to examine the relevance of innovation in regional development by examining innovation and knowledge in regional economic theories. Also, how can diverse theories be used to help regions to create economic and development growth based on innovation? After analyzing the theories offered in the current sub-chapter (2.2.1), I came to the conclusion that innovation and knowledge play a significant role in promoting regional growth and innovative activities within regions. Innovation and knowledge contribute significantly as a result of the increased returns they generate through the concentration of innovative activities as well as the partnerships that emerge between effective actors within economic entities, social and cultural factors, and institutional factors, as well as taking into account the evolutionary dimension of local capabilities' cognitive and innovative capabilities. By reviewing the literature, the following evidences can be provided:

- Evidence from the theory of knowledge spillovers suggests that increasing the returns from the concentration of innovative activities can explain the importance of innovation.
- The relevance of innovation, according to the "Milieu innovateur" theory, is explained by local economic and social relations, as well as the integration of economic phenomena within the region, which permits regional innovation.
- On the other hand, the theory of learning regions emphasizes that innovation can be demonstrated through the process of supporting learning and acquiring knowledge. This is due to their importance in determining the competitiveness of an economy. Moreover, when it comes to localizing innovation within regions, the theory emphasizes that institutional considerations must be taken into account.
- In this context, evolutionary economic geography proposes that innovation is explained by a process of creative discovery that has historically been developed based on local capabilities, as well as paying attention to the concept of cognitive proximity in regional development.

As a consequence, all of these theories highlight the relevance of innovation and knowledge within a regional context, as well as their function in enhancing regional competitiveness, emphasizing the importance of local elements in regional development. Differences can be noticed in the dimensions that each theory uses to understand the significance of innovation. Innovation and knowledge-oriented sites provide a higher return on innovative activities, economic and social relations within regions are the most important factors in determining innovation possibilities, and diversity in terms of traditions, standards, social practices, and institutional elements are important factors in localizing innovation. Finally, the evolutionary approach of local abilities has a significant impact on the capacity to innovate within regions. Thus, the next sub-chapter discusses how innovation policy supports regional development.

2.2.2 Innovation policy and regional development

As indicated in the preceding subchapter, regional economic theories and trends were connected to innovation in the 1990s. The main purpose of the current chapter is to examine how regions can be developed utilizing *innovation policies*, as well as why they are so crucial in regional development. To answer these questions, we will first discuss the concept and goals of regional development, then look at how regional policies have evolved over time and how innovation has become a primary driver of contemporary regional development, and finally, we will discuss the role and importance of innovation policy in regional development.

The objectives of regional development include improving the growth of underserved (agricultural and industrial) areas, increasing employment (by retraining and combating structural unemployment), and engaging youth employment. Therefore, regional development programs and measures are primarily designed to promote entrepreneurship, economic development, and innovation at the local level (Šabić & Vujadinović, 2017). Regional development, according to Sengenberger (1994) is *endogenous* (employing the region's own resources), *balanced* (by coordinating the activities of nearby units in a mutually beneficial manner towards cohesion). It 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 growth rate and employment), but also qualitative ones (participation in decision-making, equality and the preservation of the environment). 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). Morrison (2000) asserts that entrepreneurship and innovation are important factors affecting regional development. Researchers contend that social capital, wide local participation among local citizens, and the proximity of entrepreneurs and stakeholders play an important role in regional cross-networking, which has a positive impact on regional development (Amin, 1999). This proximity resulting from local identity and trust in local actors contribute significantly to collaboration, knowledge transfer and innovation (Sammarra & Biggiero, 2001). Reduced regional disparities is one of the aims of regional development. These differences can be seen in regional innovation performance (Hu & Mathews, 2005; Rodríguez-Pose & Crescenzi, 2008; Zabala-Iturriagagoitia et al., 2007a), different diffusion of knowledge spillovers (Ács & Varga, 2005; Fritsch & Franke, 2004; Simmie, 2003) , and tacit knowledge for regions (Hanson, 2014). There are differences across regions based on proximity considerations (Rodríguez-Pose & Crescenzi, 2008) and localization factors, necessitating the adoption of innovation policy that supports regional development.

Therefore, each region is unique in its own way, but differences are also possible because of this uniqueness. Tödtling & 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 conditions. To address these differences according to different goals (equilty, efficiency, sustainability) or regions requires *tailor-made policy* interventions (Rodrguez-Pose, 2013).

There has been a shift from a classical to a modern model of regional policy based on knowledge, technology, and innovation to resolve these disparities and work towards regional development goals. The regional development paradigm shifted as a result of a shift in regional development theories, which highlighted the relevance of both the spatial framework and endogenous factors in regional development. Regional competitiveness and the region's ability to generate economic development activities were determined by regional characteristics, internal interactions, social and economic characteristics, and knowledge acquisition within local areas, according to the previous chapter's analysis of economic theories. Following that, a paradigm shift in regional development occurred as a result of conceptual shifts in the elements that impact local area development. Therefore, it became necessary to create new policies for using regional endogenous growth, knowledge-based development and innovation (Barca et al., 2012; Etzkowitz & Klofsten, 2005), besides the provision of infrastructure to address the problems of regional development under these new policies for regional development. Thus, innovation plays a significant role in changing the paradigm of regional development by being an important factor of internal growth. According to Bachtler and Yuill (2001), the paradigm of regional policy has shifted. In this paradigm shift, there are *new objectives*, a *new geographical scope*, a *new governance system*, and *new policy instruments* for regional development. This "new paradigm of regional policy" is "place-based, multi-level, innovative and geared to the needs of different types of regions" (Vanthillo & Verhetsel, 2012). In Table 7, ten characteristics are outlined. *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 theories, 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, skills). Innovation and innovation policy became apparent in the renewal of regional development goals as a result of a shift in the idea of regional policy. A change has also taken place in the **modus operandi of politics** in that classical policies were always reactive to regional issues, but that has shifted to one based on pro-activeness, strategizing, planning and acting strategically. A prominent example of this trend is the development of regional development programs to implement the EU's structural funds, as well as the development of regional innovation plans financed by the EU (RTPs, RITTS, RIS) (Bachtler & Yuill, 2001). In the context of the shift in the **policy structure**, traditionally, the policy has focused on problem regions and their treatment, while policy shifts have targeted all types of regions spatially.

Knowledge-based policy development has become a clear stepping stone in the establishment of new regional policies in this regard. These projects 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 quality of life (Šabić & Vujadinović, 2017). The traditional way of **evaluating policies** in the context of policy evaluation was ex-post, which meant that the policy objectives had been achieved or not, but after the paradigm shift, policies are evaluated using a tripartite approach (ex-ante, interim, ex-post). Despite the fact that **traditional policies could be measured**, measuring tacit knowledge and innovation became more challenging.

Changing conceptual bases, objectives, methods of implementation, and structures of regional policies have led to a growth in innovation in contemporary regional development. Therefore, the focus of research has shifted to endogenous growth policies and innovation (Ács et al., 2002a; Barca et al., 2012; Etzkowitz & Klofsten, 2005; Varga & Schalk, 2004) such as clusters, networking, and institutional cooperation (Asheim et al., 2011a; Calignano et al., 2018; Hanson, 2014).

Table 7 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 (eg. 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/centralised	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)

As a result, the contemporary regional development model has been altered by the innovation process, which has necessitated interacton among the various actors involved. Throughout the process, it became evident that innovation was not an end in itself, 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"*. 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). The idea of adopting a 'one size fits all' approach would be inefficient given these differences (Hanson, 2014). In regional development policies, support institutions for innovation play a significant role. These institutions (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); and to play an important role in economic development. Therefore, the innovation policy is supported by systems, factors, and institutions. Thus, innovation policy has been identified "*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).

This concept of innovation policy makes it clear that interaction patterns and tools will vary among these policies. Nevertheless, there is some evidence in economic development theories that innovation occurs as a result of interactions within the local context and that proximity to knowledge is an important factor in explaining innovation. Porter (2000) explains how clusters of closely related companies can build a competitive advantage by sharing resources and developing a singular competence that needs to be replicated and improved with continuous innovation. Therefore, the interaction of the innovation policy, or more precisely, the policies comprising the innovation policy, has become a concern in a regional spatial framework, reflecting the concept of the regional innovation policy that represents the innovation policy within the regional or local context. The reason for this is that economic theories and the concept of innovation policy emphasize that the regional context has a major effect on the interactions among the participating actors in the innovation policy ecosystem. The next subchapter describes the regional innovation system as an ecosystem that fosters innovation policy interactions.

2.2.3 Innovation systems: RIS concept and components

Innovation policy has interactions and tools, as explained in the previous subchapter. According to the economic theories presented, interactions have an impact on the local area and may enhance the capacity of regions to innovate and develop economically.

Consequently, an increased interest has been shown in discussing innovation systems that include those interactions and components that contribute to innovation, including regional innovation systems (RIS). Over the last three decades, a variety of factors have fueled increased interest in this topic, including advances in theoretical analysis, increased attention to innovation as a source of competitive advantage, and the need for new policies to address regional disparities and divergences (Asheim et al., 2011b). This subchapter presents an overview of the theoretical framework for regional innovation systems, including an explanation of regional innovation systems' origins, numerous definitions, and a summary of their components.

Literature analyses have discussed innovation systems at a number of different levels (Carlsson, 2003; Lalrindiki & O'Gorman, 2021). In the beginning, there were studies looking at the innovation system at the national level. The *National Innovation System (NSI)* was designed with the purpose of determining the differences in technological development among countries (Lalrindiki & O'Gorman, 2021). When it was discovered in the 1990s that technological systems vary from all other fields in terms of interrelationships, the notion of innovation systems was rethought (Carlsson & Jacobsson, 1994; Jacobsson & Carlsson, 1997). Other 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 regional and local settings being important to the innovation process, and it is thought 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 diffusion plays a large role in the innovation process, it is often influenced by regional factors (Anselin et al., 1997; Feldman & Florida, 1994; Gertler, 2009; Morgan, 2004), in accordance with the theoretical concept used to understand regional growth, such as the place-based approach, which emphasizes that context plays a critical role in the development of a region. Moreover, it is perceived as a key element of the innovation process to add localized and endogenic factors (Uyarra, 2007; Varga, 2017; Varga & Schalk, 2004b). Additionally, the regional innovation system has been regarded as an integrated system encompassing economic, institutional, social, and organizational elements (Muller & Zenker, 2001; Navarro et al., 2009). Thus, the regional innovation system perspective sheds light on the regional dimension of knowledge production and exploitation, which may explain why innovation capabilities differ across regions (Lalrindiki & O'Gorman, 2021).

Thus, the concept of regional innovation has been broadly defined and has multiple definitions, one of which is the following: *"the localised 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 8 shows that various definitions and concepts of regional innovation systems contain similar characteristics. Similarities of these definitions: *they all refer to the interactive and dynamic nature of the regional innovation system*, where the interactions occur within the confines of the system. Generally, all of these definitions agree that regional innovation systems are interrelated and that their aim is to facilitate economic development based on *knowledge* and characterized by *competitiveness*. Furthermore, these definitions agree that innovation in the regional system is an *evolutionary*, non-linear, and *interactive process*, and this interaction 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 for their understanding of how knowledge and innovation are generated, as 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. Using these definitions, we can deduce that the regional innovation system is a complex and interconnected system that can be applied to regions with the potential and capability to innovate, and it is made up of components that support innovation, such as universities, industry, government, and local businesses. As a result, the components can be linked and collaborate to build innovative regional economic development that meets the demands of the regions (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, participation and cooperation of the regional actors (the so-called triple helix)(Lalrindiki & O'Gorman, 2021; Saad et al., 2008; Shin et al., 2012).

Table 8 The definitions of regional innovation

Cooke et al. (1998, p. 1577)	*"Regional system in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness."*
de Bruijn & Lagendijk (2005b, p. 1155)	*"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."*
Tödtling & Trippl (2005, p. 1205)	*"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."*
Harmaakorpi & Pekkarinen (2002, p. 13)	*"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."*
Esparcia (2014, p. 2)	*"As the group of elements which, by themselves and via mutual interaction, have an effect on the introduction, the adoption and the development of different types of innovation at a given spatial scale."*
Varga & Sebestyén (2017a, p. 2)	*"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."*

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).

According to Porter (2000) research on clusters, geographically close clusters with closely allied companies and organizations can develop a competitive advantage based on the utilization of resources and the development of unique efficiency, which must be reproduced and developed through continuous innovation. *Local (or localized) competitive advantages* are what drive regional innovation systems, which are seen as driving forces for economic development. Having defined and discussed the concepts and terms, we can now move on to discussing actors, agents, institutions, and innovation capabilities of the system, which are the competitive advantages of the innovation system within a region.

The above discussion noted that the innovation context may vary in terms of educational institutions, research institutes, knowledge spillovers, and local elements that facilitate innovation (Kaufmann & Tödtling, 2000a; Varga & Schalk, 2004b). With regard to the notion of a triple helix, this idea has gained considerable attention in the literature as a way of exploring the complex and complicated dynamics of the knowledge environment and, thus, motivating policy makers at all levels (national, regional, and local) to design new strategies for innovation and development (Lalrindiki & O'Gorman, 2021). Using the triple helix or three-dimensional system, the interrelationships among the university, industry, and government institutions that support innovation policy are identified through interaction among and within these institutions (Borkowska & Osborne, 2018; Lukovics & Zuti, 2018; Saad et al., 2008; Shin et al., 2012). Some regions are considered more advantageous than others according to these components. Therefore, the components of the RIS determine the capabilities of innovation. Moreover, this capacity can be analyzed and measured through institutional structures in the areas of learning, finance, and production (Cooke & Uranga, 1997). RIS components interact due to the networked relationships that exist among them. These networks provide an explanation of the relationship between innovation processes and knowledge dissemination (Calignano et al., 2018; Esparcia, 2014; Kolehmainen et al., 2016).

As a result, the concept of a regional innovation system and the elements that drive its interactions show that it is a system that explains the nature of these interactions and affects on regional innovation activities. According to the literature review in Chapter 2.2, *innovation policy is a comprehensive concept that encompasses a variety of policies conducted within the context of a regional or local system, where innovation policy has a greater impact*. This emphasizes the significance of the regional innovation system in terms of combining the components and activities of innovation policy that affect regional development.

In summary, the analysis of the theoretical underpinning of innovation policy and regional innovation was designed to show how innovation has become a significant driver of contemporary regional development. Using the literature review described in sub-chapter 2.2, it was discovered that *innovation and knowledge are not ends in and of themselves, but rather engines for regional development through the accomplishment of economic, social, and political objectives.* The results of the literature study reported in the current subchapter backed up this conclusion:

- Innovation and knowledge have a significant role in encouraging regional development and innovative activity within regions, as evidenced by a study of how different economic theories connect to innovation and knowledge (as described in subchapter 2.2.1). The increased returns it creates owing to the concentration of innovative activities, as well as partnerships among players within economic entities, as well as social, cultural, and institutional factors within the region, demonstrate its value. These theories emphasize the relevance of innovation and knowledge in the context of regional development, with an emphasis on local characteristics and aspects, in addition to providing light on regional competitiveness.

- It has been demonstrated through the analysis of the literature (in subchapter 2.2.2), which discusses innovation policy and its role in regional development, that innovation is the result of interactions within the local context, and cognitive proximity is an important consideration when interpreting innovation policy. As a result, interactions in innovation policy – or the policies that make up innovation policy – are significant sources for attaining regional development through the activation of innovation within the system.
- It was clear from an examination of the literature on the regional innovation system (Chapter 2.2.3), that the interactions among the actors in the innovation ecosystem had an influence on the regional innovation policy setting. The regional innovation system, according to the literature, is an ecosystem that increases innovation policy interactions and describes the forms of interactions among the system's components (universities, government, business sector, and local community) and how they affect regional innovation. As a result of the literature review, it was determined that innovation policy comprises a broad variety of policy actions carried out within the context of a regional system, where innovation policy will have the strongest influence on contemporary regional development.

As a result of discussing sub-chapter 2.2, I can respond to the question presented at the beginning of the chapter concerning the concept and goals of regional development by stating that contemporary regional development is significantly impacted by the utilization of local capacities and endogenous factors. The advent of economic development theories, innovation, and knowledge transmission have all contributed to transforming the regional development policy paradigm. Internal capabilities and components of the regions, as well as localization and distribution of knowledge within the regions, are employed to promote regional competitiveness. *If innovation policy is to have a bigger influence on regional development, it requires more interaction among the actors.* Therefore, I will describe a smart city in the next subchapter as a novel policy notion of innovation that can be utilized to enhance innovation within areas.

2.3 Smart city approach as a novel innovation policy concept

Throughout this chapter, I present the basic *concepts of smart cities, components of smart city programs, spatial strategies for developing smart cities*, and *concepts of the smart city as arising from innovation* in order to complete the development of the theoretical background for the dissertation. Within the first part of this chapter, I provide answers *what smart cities are and what definitions are offered in the literature on smart cities*. I also elaborate on *why the smart city concept is now seen as a contemporary innovation policy*. In addition, I demonstrate that innovation and knowledge are essential to the smart city approach, as well as the use of technology and modern technologies among and within the components of smart cities such as the economy, population, environment, society, government, and intelligent transportation.

2.3.1 Smart city concept, definitions, and components

Globally, cities are increasingly responsible for supporting innovation, entrepreneurship, competitiveness, and knowledge (Kourtit et al., 2012). Research in urban smartness has been conducted in response to these urban transformations to adapt to new urban elements, such as smart urban management, smart transportation, and land use using new technologies. Several definitions of what a Smart City is have arisen throughout time, each different in terms of the most important smart characteristic believed to constitute urban smartness. ICTs were seen as the key pillar upon which a city's smart route should be built (Caragliu & del Bo, 2020). A smart city is defined by the European Parliament (2014) as *a place where the traditional networks and services are enhanced through the use of digital and telecommunication technologies, in order to benefit the citizens and businesses within it*. Multidisciplinary concept, the smart city uses ICT to address urban growth issues, provide a better future for its citizens by utilizing smart economy, smart environment, and smart mobility as well as providing quality of life. In the United States, the term "smart" first arose in urban planning in the 1990s in the context of "smart growth" to deal with urban agglomeration expansion. Meanwhile, the associated scientific research began to grow significantly in 2010 when the EU has started using the term "smart" for qualifying sustainable urban development projects (Milošević et al., 2019).

Using ICT as its backbone, San Diego has considered to be a 'City of the Future' in the USA. During the Smart City Expo World Congress, Singapore won the award for Smart City of 2018. This is considered the first ‘intelligent island’ in Southeast Asia based on information technology (IT) (Verdict, 2020). India built the region of Bangalore, which is known as India’s Silicon Valley, as well as many other cities throughout the world that have been recognized as intelligent in recent years, from developing countries (Hollands, 2008). In general, smart cities in Europe refer to a policy concept aimed at converting all knowledge centers into innovation clusters to support the socio-economic development of European countries (Lombardi, Giordano, Farouh, et al., 2012).

Chintagunta et al. (2019) mentioned that ICT played a crucial role in the global economy and business in the fourth industrial revolution. Furthermore, Yigitcanlar (2015) asserted that smart cities are contributing to modern urban development in an era of knowledge and innovation. In this situation, human capital, infrastructure, social capital, and entrepreneurial capital are the components of the model. According to the literature about smart cities (SC), the concept has been interpreted as a strategy for integrating modern urban production factors to enhance competitiveness in cities (Caragliu et al., 2011).

In their definition of smart cities, Harrison and Donnelly (2011) mention that smart cities are not novel. Bolier noted in the late 1990s that its origin comes from Smart Growth, which applies new policies to urban and regional planning (Bholey, 2016). Many authors see that the concept of smart city is based on ICT and needs a comprehensive and multi-dimensional view (Gil-Garcia et al., 2015). In addition, others have noted that smart cities can be defined differently depending on the development approaches (Angelidou, 2014; Echebarria et al., 2020). As a result, the difference between the definitions is determined by; the *humanistic approach*, through the continuous updating and strengthening of social knowledge; this approach emphasizes the role of human and social capital in urban change (Caragliu et al., 2011; Hollands, 2008; Kourtit et al., 2012), while the *technocentric approach* highlights ICTs’ potential to enhance the urban system, emphasizing (explicitly or implicitly) that technology is a defining characteristic of smart cities (Angelidou, 2014; Bibri, 2018; Lombardi, Giordano, Farouh, et al., 2012). The third *collaborative approach* emphasizes the importance of collaboration among the different networks of urban actors, which generates productive interactions among them as in (Gil-Garcia et al., 2015). The first smart city definition was offered by Hall et al. in 2000. According to this defintion a smart city

> *“monitors and integrates conditions of all of its critical infrastructures including roads, bridges, tunnels, rails, subways, airports, sea-ports, 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, 2000, p. 642).

The definition was later developed using ICT and knowledge-based approaches (Manitiu & Pedrini, 2016). Those who rely on ICT to develop smart cities state that ICT provides agents with particular advantages in terms of intelligence, communication, and efficiency. According to Washburn et al. (2010)

“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 For Cios, 2010, p. 2).

Caragliu et al. (2011) also attempted to define urban smartness comprehensively and operationally. As stated in their study, the city is 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).

Many studies have examined the role of human capital and education, social capital, and environmental concerns in urban development (Caragliu et al., 2011; Lombardi, Giordano, Farouh, et al., 2012). For example, Lombardi et al. (2012) noted that 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, Giordano, Farouh, et al., 2012).

Recent research suggests that a smart city is more than the efficient management of the city’s components (infrastructure, networks, buildings, economic activities), but rather a process of utilizing data science to assist with suggesting solutions and finding effective ones through data-assisted decision-making. 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 in an interactive way"(ROTUNA et al., 2019, p. 42).

According to Echebarria et al. (2020), a literature review of smart city concepts leads to differential development approaches based on different definitions (see Appendix 4). According to a previous explanation, definitions can be technology-centric, humanistic, or cooperative.

While smart cities have been a huge success on the academic front and there has been significant development at all levels of government, many works have failed to provide a clear description of what a smart city is, especially by extending their characterization beyond the purely technical and contextual components (Caragliu & del Bo, 2020). The literature has provided an interesting view that argues that different stakeholders have argued for different views about smart cities. As complicated systems, smart cities contain multiple facets, as seen by technologists. Architects and planners may approach it from the point of view of urban and spatial planning. Those who are sociologists might see smart cities as places where they can live and socialize. Considering smart cities from a governmental perspective, smart cities are presented as economic growth opportunities and modern city services to improve urban development indicators (Bholey, 2016). Accordingly, there is no consensus among scholars on what constitutes a smart city. The scholars' current common view is that ICT, as well as innovative components, along with architecture, infrastructure, and human elements, can be used to address urban development issues (Virtudes et al., 2017).

Policy applications of smart cities have been described as intelligent cities, information cities, digital cities, and ubiquitous cities. Yigitcanlar (2015) explained the concept of smart cities as one based on a comprehensive combination of human capital, such as a skilled labor force, and infrastructure capital (exemplified by high-tech infrastructures, and entrepreneurial capital) (Yigitcanlar, 2015); this last model considers an ideal model for the city. On the one hand, Ela (2016) mentioned that the smart city is an inclusive concept that characterizes cities with urban governance, intelligent communication, people, and the environment leading to smart living. In addition, if a city is going to be smart, its components (e.g. services, water, energy, etc.) need to be smart as well (Ela, 2016). Through the use of digital and information technologies, Baldascino & Mosca (2016) provide the smart city concept from two-fold to more holistic, increasing traditional network efficiency and services. In the second, data processing tools are used to implement social, economic, and environmentally sustainable development for the city. Multidisciplinary in concept, smart cities emphasize competitiveness of the smart economy, social capital of the smart people, ICT and smart mobility, natural resources of the smart environment, and wellbeing of the smart living (Baldascino & Mosca, 2016).

In summary, according to the various definitions and concepts of smart cities, the concept varies depending on a number of factors, including: first, the *method 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). As a result, the next section will attempt to illustrate the components and requirements of smart cities from several perspectives.

2.3.2 Smart city and innovation

Several studies indicate that innovation plays an important role in activating smart cities (Errichiello & Marasco, 2014), as these cities are positioned as centers of innovation and learning (Kraus et al., 2015). New urban activities are intersected and intermingled in urban areas, including smart cities. At the global level, there are five forces that influence urbanization trends: (1) economic growth and development, (2) technological change, (3) population growth (the size of the local population), (4) extensive and comprehensive migration from the countryside to urban areas/regions/cities, and (5) population migration from cities to twin and dependent towns or larger villages (Balchin et al., 2000). Hence, it is clear that technological changes and locally endemic innovation factors are among the main drivers of new growth and development trends.

In their article, Errichiello and Marasco (2014) argue that the smart city approach could encourage the development of urban innovation systems, fostering collaboration among businesses, citizens, and governmental/public services. As a result, open innovation serves as a powerful operator for smart diversification of cities (Errichiello & Marasco, 2014). Increasingly, cities are being involved in open innovation as a powerful driver of smart transformation. Organizations that engage in open innovation leverage knowledge flows outside their borders to accelerate innovation processes and grow external markets for innovation, emphasizing inter-organizational collaboration and networking for innovation success. In smart cities, several studies have focused on public-private partnerships. These studies highlight the importance of technology in the development of smart cities (e.g.

modern technologies and smart services applications). Essentially, these views emphasize the importance of technological innovation in smart city planning.

Development of smart cities depends on the interaction of the various components, where the interaction relations open horizons for government, companies, universities, and society to transfer innovation within and outside urban areas and promote research and development for user satisfaction in smart urban environments (Paskaleva, 2011). A smart city, as proposed by the European Commission, is ideally suited to be a testing ground for innovation ecosystems, as they provide a conducive environment for experimenting with innovative solutions based on collaboration among citizens, companies, and knowledge universities (Errichiello & Marasco, 2014; Schaffers et al., 2012). A smart city, according to Errichiello and Marasco (2014), has two distinct levels of cooperation – the regional level of institutional cooperation and the operational level of collaboration within the innovation process. One of the biggest challenges of urban and regional collaboration is to create **a system of sustainable partnerships among the active stakeholders to maintain the innovation ecosystem**. Another challenge in the second level of cooperation is **the effectiveness of these networks in urban innovation processes through the sharing of resources, management of development processes, and work to enhance the flow of knowledge in smart city projects**. In order to achieve sustainable development, smart city policies require both institutional and operational cooperation (Errichiello & Marasco, 2014).

In many studies on the development of innovation in smart cities, the focus has been on institutional cooperation (Bakıcı et al., 2013; Emerson et al., 2012; Ng et al., 2013), showing how collaborating between the public and private sectors can help advance the development of smart cities. It has been shown that the necessity of an innovation network for smart cities depends on technology, specifically on the development of smart services resulting from new technologies. On the other hand, imitating modern technologies without focusing on technological innovation could compromise the viability of smart city models (Errichiello & Marasco, 2014).

Anthopoulos et al. (2017) argue that a city's innovation capacity can be measured using an alternative benchmark. Smart cities can be viewed as a quadruple helix: University, Government, Civil Society, and Industry, similar to innovation triple helix, but adding society (Anthopoulos, 2017; Lombardi, Giordano, Farouh, et al., 2012). Consequently, the civil society added helix highlights the social element and its role in generating innovation (Borkowska & Osborne, 2018). In addition, smart cities require innovation to become competitive in global and national markets, and urban development generally, and smart cities specifically, require an environment that promotes innovation and entrepreneurship. In order to become smart cities, these kinds of cities emphasize the importance of investment in urban quality (Chintagunta et al., 2019). Innovative practices enhance a city's competitiveness on a national, regional, and global level through their components and factors. In this sense, innovation and entrepreneurship are essential to creating smart cities. The pyramid model of regional competitiveness asserts that regional competitiveness requires innovation, research, and innovative activities, as well as technological proficiency and development. Lengyel (2000) emphasizes that in order to achieve regional competitiveness, continuous innovation, research, and innovative activities are essential, alongside technological knowledge, and their development. Throughout the concept, it appears that technology and innovation play a prominent role in achieving competitiveness, especially in areas that benefit from competitive advantages, such as urban intelligence areas and smart cities.

Thus, universities and other educational institutions are becoming increasingly important players in knowledge-based cities, where they have a significant impact on economic, social, and cultural development (Anttila & Jussila, 2018; Lukovics & Zuti, 2018). Therefore, universities play an important role not only in education and research, but also in influencing the economy and society in developed economic regions. In later years, universities have taken on a prominent role in fulfilling knowledge-based societal needs. Accordingly, the fourth-generation universities can be distinguished from other types of universities by their strategic approach to the urban environment (Lukovics & Zuti, 2018). As stated by Wissema (2009), the first generation of universities revolves around professionals and aims at education, the second revolves around professionals and researchers and aims at education and research, while the third generation revolves around (creating added value) and aims – in addition to previous duties – to utilize knowledge (Wissema, 2009). Thus, the fourth generation of universities contributes to the local development of the university environment and the establishment of a global presence through proactive strategies to shape the university's region and environment based on knowledge and innovation (Lukovics & Zuti, 2018).

As a summary of my analysis of the literature review in the current sub-chapter, I have attempted to highlight the importance of innovation policy in implementing the smart city approach. Implementing innovation policies in smart cities requires the development and improvement of services and urban features in the smart city, not only the transfer of technology. According to the smart city definition determined by Caragliu et al. (2011), the urban smartness is precondition for urban economic performance, based on an urban production function model. Accordingly, urban intelligence is essential to stimulating economic development and enhancing city performance (Caragliu & del Bo, 2020). Thus, smart cities aim to improve the quality of the elements and components of cities, which requires us to take a holistic approach to innovation in terms of institutional, organizational, human, and political changes. In developing countries, this challenge is becoming increasingly urgent in comparison to other regions or countries. Lastly, smart cities can be viewed as an opportunity for urban and regional development, given that they can serve as appropriate environments for innovation and entrepreneurship, where information and technology play a significant role. In other words, to create innovation, a wide range of other factors are needed, as discussed in the preceding subchapter, in addition to innovation as the "engine" of the city. Furthermore, the notion of smart cities today must take into consideration local and sociological aspects, particularly in less developed countries, which will be examined in greater depth later, as well as a number of challenges and constraints that obstruct knowledge-based urban development. In the next section, I will discuss the components and requirements of smart cities, aiming to establish the conditions necessary to create smart cities.

2.3.3 Requirements and components

In a smart city, technology is used to invent a new way to modify urban functions relying on modern development process (Borsekova et al., 2016). Smart city services is one of the functions of smart urbanism. According to Oktaria et al. (2017), researchers have held diverse views about smart city services. Economy, service providers, and communities have been involved in discussions of smart city services. Furthermore, from a spatial perspective, each city in various regions or countries prioritizes different smart services. Stockholm, London, Amsterdam, and Barcelona are European cities with a strong focus on transportation and energy services. In contrast, American cities, such as San Francisco, focus on transportation, while Seoul, Korea, emphasizes public services management and transportation (Oktaria et al., 2017). Accordingly, we conclude that smart city services can only be achieved if a well-defined strategy is outlined based on the city's priorities.

Smart city governance is another factor that influences smart urban function. From the perspective of collaboration among actors, Pereira et al. (2017) explained differences between smart electronic government and smart governance concepts. Interacting with stakeholders intelligently is considered an important component of smart city research. Smart governance, then, is the process of involving all stakeholders in city decision-making and deciding what services the city should provide (Viale Pereira et al., 2017). 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). 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.

Smart cities, as previously mentioned, are complex systems with multiple aspects. Additionally, smart cities combine issues of urbanization and sustainable development. Smart cities have high levels of productivity, educated citizens, knowledge-intensive businesses, planning systems for output that emphasize innovation, and many initiatives that focus on sustainability (Kourtit et al., 2012). Consequently, it is crucial to provide various indicators and components that can provide an informed picture of the production process in smart cities. Based on the work of Lombardini et al. (2012) and Yigitcanlar (2015), various core indicators can be used to evaluate smart cities' performance. These indicators include smart employment, human capital, governance, living, and the environment. Additionally, the smart city economy was identified in Vinod Kumar & Dahiya (2017) as having 19 characteristics, the most important of which were: innovation-driven and supported by universities, enlightening the entrepreneurial leadership, enhancing the participatory economy with a range of economic opportunities, and presenting diverse economic opportunities.

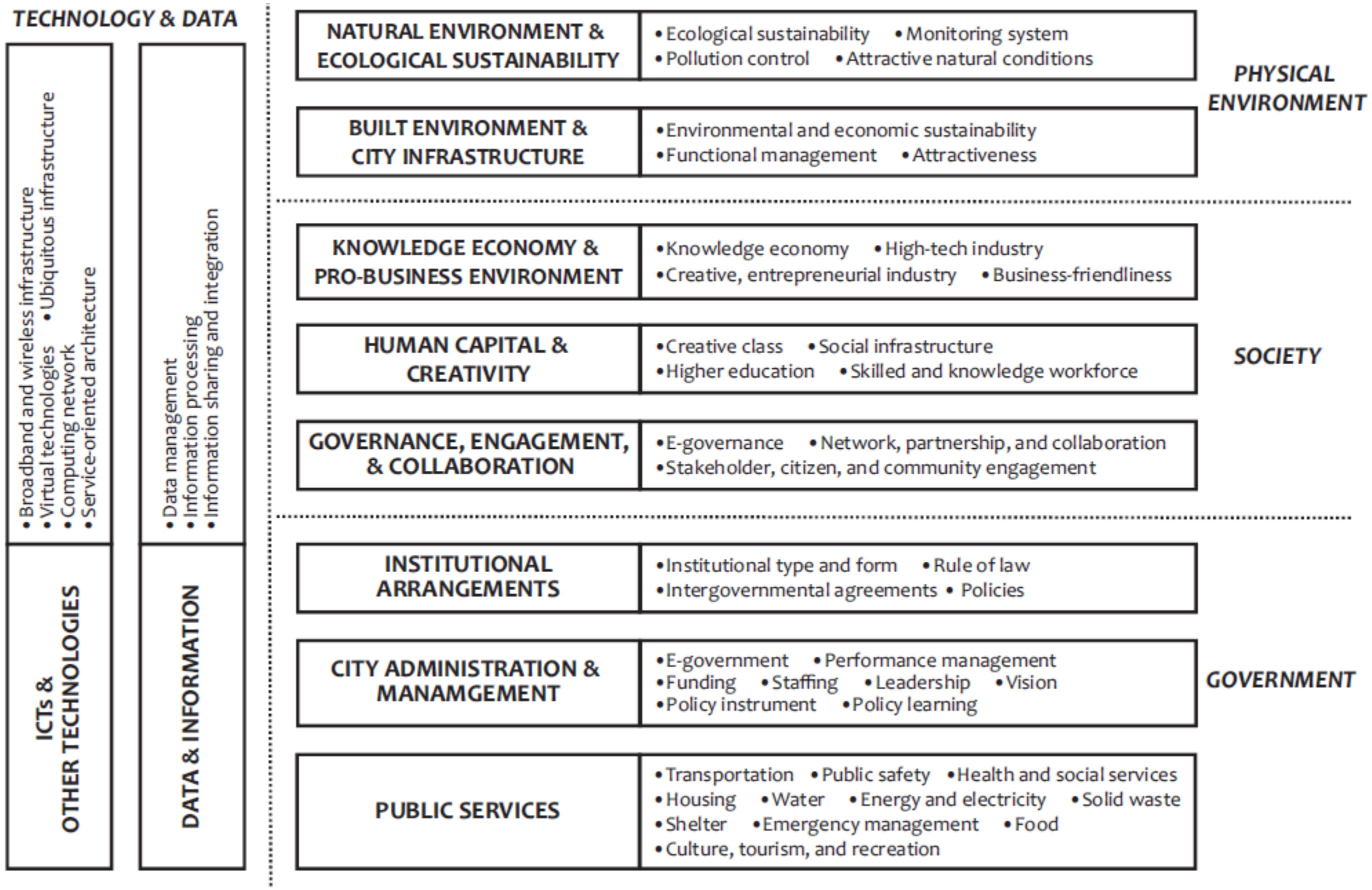
The literature on smart city components discusses eight pillars that have been established by the Singapore-ETH Center for Global Environmental Sustainability, which views the city as an urban metabolism. Water, materials, energy, finance, density, people's positions, information, and space make up these pillars. The factors 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).

As for the smart city, some core components have been identified as a comprehensive view based on the literature and a practical perspective. Literature has outlined components that can be used to evaluate the smartness of a city. There are three components to the government: (1) administration and management of the city, (2) public services, and (3) administration and management. The components of society 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: (7) natural environment and ecological sustainability, and (8) built environment and city infrastructure. In addition, there is a (9) data and information component, 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 9 (Gil-Garcia et al., 2015).

In addition, other scholars have identified six smart city characteristics called the *"smart city wheel"* (Alderete, 2020; Virtudes et al., 2017), which include smart economy, smart people, smart mobility, smart governance, smart living, and smart environment (Figure 10). For smart cities in both developed and developing countries, there are also standard components: data analysis, information, and ICT (Viale Pereira et al., 2017). Therefore, smart cities require multidimensional requirements (Chang et al., 2018), where smart city systems are continually evolving. Additionally, tangible and intangible assets determine smart city components (Huovila et al., 2019). The next part of the study presents different policy approaches to developing smart cities from a spatial perspective to describe the advantages and disadvantages of these approaches.

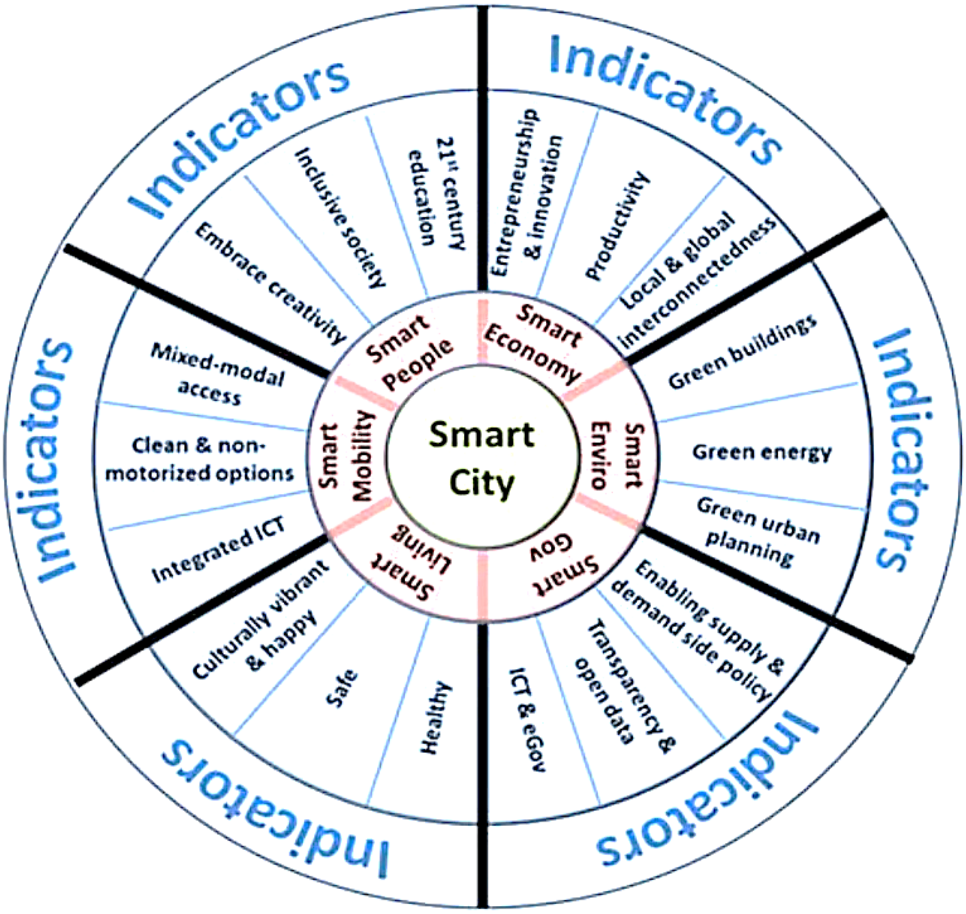
In summary, the literature review in this subchapter suggests that *smart cities are comprehensive and multidimensional in nature*. ICT was adopted as a core drive to deal with urban growth issues, develop a better future for its citizens from the smart economy, smart environment, smart mobility, and provide a quality of life, not only by using information technology for its services but also by offering an innovation ecosystem through innovative universities (Anttila & Jussila, 2018; Lombardi et al., 2012; Lukovics & Zuti, 2018), intelligent people, and smart governance, with a concentration for high-tech industries (Caragliu et al., 2011; Gil-Garcia et al., 2015; Lombardi et al., 2012). I have attempted to provide a comprehensive view of the concept of smart city policies and their components, as well as the requirements for cities to be considered smart. Based on a literature review, I identified the determinants of different definitions of smart cities, as well as the main components of smart cities, including economy, population, environment, government, society, and smart transportation. Following the review of the concept, definitions, components, and requirements, I present in the third and final part of the literature review of smart city policy and approach the different spatial strategies for developing and creating smart cities.

Figure 9 A comprehensive view of smart city components and elements



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

Figure 10 Smart city components “Smart city wheel”



Sources: The author editing based on (Virtudes et al., 2017, p. 5)

2.3.4 Strategies for smart city development

According to Angelidou (2014), smart cities develop and are implemented according to spatial strategic patterns. Four spatial strategic alternatives for smart cities were identified in the study. Firstly, national versus local strategies, secondly, building new smart cities versus adapting existing ones to urban intelligence, thirdly, soft versus hard infrastructure-based strategies, and lastly, geographic versus sector-based strategies and approaches. In the first place, *national versus local strategies*, implementation level is a determinant of smart city strategy. It depends on whether local strategies are set at the city, town, or metropolitan level or if national strategies are set at the national level. In terms of the local level strategies, innovation is more effective in creating smart cities where knowledge and innovation are geographically based. Moreover, urban problems are manageable and of a known nature, and they are suited to local objectives, so overcoming them is not as difficult. In the meantime, local strategies suffer from the competition for resources among small and medium-sized metropolitan areas and megacities. More efforts must also be made from the local level to align its strategy with the complex national policy agenda (Angelidou, 2014). According to the national level strategies, the state is supported by resources and a comprehensive viewpoint. In smart cities, top-level management clarifies roles and responsibilities, which facilitates the effective implementation of strategies. Ineffective use of local resources is one of the disadvantages of this type. Due to national measurement from the top-down, there is also a possibility of doubt in identifying opportunities and obstacles (Angelidou, 2014). Singapore is considered one of the most famous cases for national-level strategies (Bris et al., 2019; Tay et al., 2018).

A second alternative of strategies is to *create new smart cities versus adapting existing ones to urban intelligence*. The New Smart Cities (NSC) strategy is usually adopted by emerging and developing countries, such as Cyberport Hong Kong (China), Songdo International Business District (South Korea), Cyberjaya (Malaysia), and Skolkovo Innovation Center (Russia) (Angelidou, 2014). In addition to that, the study will refer to the New Administrative Capital (NAC) (Egypt) (Hamza, 2016; Hassanein, 2017; Hussein & Pollock, 2019), as well as the other 14 new smart cities. The NSCs are ambitious strategies that involve a lot of construction, land, and high-tech infrastructure. It is one advantage that these NSC strategies provide the opportunity to create a SC vision from scratch with clear requirements and development objectives. Further, this type of spatial strategy for smart cities provides an opportunity to develop a modern vision of smart infrastructure based on high-tech solutions, from the planning phase to the implementation and follow-up phases. In addition, the SC can be located in a strategic location that achieves the objectives of the national urban system (Angelidou, 2014). However, this approach has highlighted concerns regarding the possibility of failure due to a lack of investment and budget. Nevertheless, technological solutions have inherent risks. If the country implemented the same NSC model elsewhere, it may not be feasible to apply the same solution across all cities (Angelidou, 2014; Tödtling & Trippl, 2005). As opposed to this, existing cities that embrace the urban intelligence approach consider their distribution of innovation factors as an opportunity to enhance innovation.

Thirdly, there are *the soft versus hard infrastructure-placed strategies*. Smart cities target either high-tech infrastructure or soft infrastructures, such as skilled workers and innovative society, with this approach. Soft infrastructure strategies take a more holistic approach than others, employing innovation, knowledge, and qualified and professional people (Angelidou, 2014; Baldascino & Mosca, 2016; Caragliu et al., 2011; Joia & Kuhl, 2019). Furthermore, there is concern that infrastructure-oriented policies may lead to social disparities and inequalities in how ICTs are used and how knowledge is transferred across urban areas.

Finally, smart city strategies could also be adapted based on *geographically-based strategies versus 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, smart cities are geographically based strategies that focus on specific locations, such as CBDs, attractive tourism areas (NEOM Company, 2021), and smart villages for research and development (WIRED, 2000), which are determined by the user group. In closing, some research recently concluded that selecting an appropriate smart city development strategy should take into account the *"dichotomous"* pattern of research on smart cities. Clearly, these are divergent approaches to strategic principles. It includes *technology-led* and *holistic* strategy, *top-down* or *bottom-up* approach, *mono-dimensional* or *integrated* logic, as well as *double-helix or quadruple-helix collaboration* models (Mora et al., 2019).

In summary, the literature review analysis shows that variations in development strategies result from the local goals and capabilities in each case. Smart city strategies, from the researcher's perspective, are made-tailored policies based on regional characteristics and comprehensive development goals within each region. In most cases, a tech-led approach is based on a double-helix strategy (Mora et al., 2019). The case studies that use a holistic approach employ a quadruple helix that integrates bottom-up and top-down interventions. For example, in the Egyptian smart city case study, top-down interventions are integrated with bottom-up ones. The strategy employs a quadruple helix approach to build an urban system that attracts knowledge and innovation.

In the next subchapter, I discuss the experiences of developing countries when it comes to regional innovation policies and smart cities within the context of understanding the theoretical background. In this part, I will examine the development goals for smart cities in these countries, how smart cities are implemented in these countries, and how those smart cities are being utilized. Following a review of its theoretical framework, the next part complements the theoretical background for smart cities and innovation policy.

2.4 Experiences of RIS, smart city concept in developing countries

The present subchapter examines the experiences of developing countries with regard to RIS and the smart city concept. The literature review indicates that a number of characteristics distinguish developing countries from developed ones. These differences require different policy and strategy approaches. Due to their limited capabilities, characteristics, and resources, developing countries face many challenges when implementing knowledge-based policies of regional development. In this regard, it is imperative to stress that the purpose of reviewing the experiences of developing countries in smart city adaptation is not to determine whether or not these adaptations are successful. I noted earlier in this chapter that smart city policies do not have a standard model that can be applied and assessed across all instances. Moreover, smart cities are a relatively new concept, especially in developing countries, as can be seen in the major milestones presented in the introduction chapter, which shows that China was one of the first developing countries to implement this concept in 2013. Therefore, it is too early to tell whether the policy has succeeded in adapting. By reviewing those experiences, I would like to determine what strategies were employed to implement the smart city approach, and what the goals of each case were. In addition, I describe how each country approaches development, and the concept of smart city applied to each country in the experimental framework. In other words, all of these are aiming to create a theoretical and experimental background for smart cities and innovation policies.

2.4.1 RIS experiences in developing countries

Regional innovation systems (RIS) and innovative policies vary as we move from the core to the periphery (Calignano et al., 2018), from one region to the other, from developed countries to less developed ones (LDRs). The developed countries are interested in maintaining innovations globally in knowledge, research, and production. Nevertheless, developing or less developed countries focus on new policies to promote economic and regional development (Hu & Mathews, 2005). Consequently, there is no solution or policy that is suitable for all (Tödtling & Trippl, 2005). Besides examining the challenges faced by these countries, this section examines the regional innovation system characteristics in developing countries as well as the regional innovation policies employed.

Furthermore, developing countries have two types of knowledge-based development, one based on advanced countries' knowledge (Li, 2009), and the other encompassing local knowledge. The contribution of university research to regional growth in India and Taiwan is implicit in trained university graduates rather than the transfer of research results (Ali, 2013; Saxenian, 2004). Activating innovation systems in these countries is based on the relation between local factors and innovation activities in economic development (Morgan, 1997). In a less developed economy, it is not appropriate to have one policy for all. Innovation-based development differs from one region to another in the country (Kolehmainen et al., 2016).

Three models were identified to describe the components, features, and characteristics of the regional innovation system in developing countries. Criteria were used to identify those case studies. The first was that the models had been included in the systematic literature review. Secondly, they were similar to the Egyptian case in developmental terms. Third, the large population size, as in Egypt, where high population density is an issue for most developing countries. Lastly, a case study from the Middle East should be included since it has programs applicable to smart cities. Chinese, Indian, and Saudi experiences are described based on these criteria.

According to Table 9, China's innovation model relies heavily on the so-called triple helix, which combines universities, industry, and government. In the Indian model, the Quadruple Helix is implemented through Global Innovation Hubs (GIHs), and in the Saudi model, the Triple Helix is as well applied, though to a lesser degree in the industrial sector (Li, 2009; Liu et al., 2011; Wang et al., 2015). GIHs in India are formed through an environment of university and industry collaboration, as well as community-based research on the fourth helix. This model emphasises the importance of increasing R&D investment through multinational enterprises (MNEs) in many industries sectors (Malik et al., 2021). In this respect, it becomes obvious that the Indian model relies on local and transnational knowledge to formulate the components of the innovation system through MNEs, which strengthens the localization of the innovation system. Innovation policy in China is different from that in India, as it experienced rapid growth in research, development, and innovation in the late 1990s. Therefore, the Chinese innovation model coexisted with both the national and regional models (dual innovation model) (Li, 2009). Therefore, many organizations participate in the policy of innovation, research, and development, especially in regions that have been undergoing transitions in the different components of the system. Research and development in China has traditionally been dominated by universities and research institutions, but lately companies have begun to take over their role of innovators (Li, 2009).

Saudi Arabia, like most Arab countries, has two characteristics of regional innovation systems: a lack of influence on certain subsystems of education, science, technology and research and development, and a small contribution by the private sector in research and development (Osman & Nour, 2013; Shin et al., 2012). In Saudi Arabia, innovation is dependent on the expansion of fourth-generation universities in the regions and the investment in technology incubators (Shin et al., 2012). As part of its transition from a resource-based to a knowledge-based economy, Saudi Arabia has developed a policy to develop a knowledge-based economy in the Middle East. Saudi Arabia used the triple helix model in collaboration among universities, industry, and government (Shin et al., 2012). The policy also focuses on establishing fourth-generation universities in the regions and cooperating with the industrial sector by investing in research parks and technology incubators throughout the region (Shin et al., 2012). As Lukovics and Zuti (2018) mentioned in the study about the triple helix strategy for universities in Malaysia and Algeria, the primary differences for this generation of universities are that it has a strategic approach and the ability to structure the region based on its knowledge and networks (Lukovics & Zuti, 2018).

Table 9 Components and characteristics of the regional innovation system for some developing countries (China, India, Saudi Arabia)

Countries	***China*** (Li, 2009; Liu et al., 2011; Wang et al., 2015)	***India*** (Malik et al., 2021)	***Saudi Arabia***(Shin et al., 2012)
System components	***The triple helix*** University and research, government, and industry and firms.	***The Quadruple helix*** (Global Innovation hubs GIH) Academia, industry, government, and Communities of practice.	***The triple-helix model*** university, industry, and government
System features and characteristics	China co-exists with two systems of innovation (RIS and NIS) because it is in transition and going through rapid developmental stages.	The Quadruple Helix in the Indian case stressed the need for sustained growth in several industry sectors, especially such R&D investments by MNEs.	Most of the growth in research publications has been accounted for by the university sector.
	China's transitional regions are characterized by strong research and development performances, involving many organizations, including companies and universities.	Developing innovative solutions in these Global Innovation Hubs involves applying multidisciplinary knowledge in a transdisciplinary way and drawing on a combination of hard and soft tacit knowledge.	The heavy concentration of R&D activities within both the public and university sectors and a minimal small contribution of the private sector to R&D activities.

	The innovation system is dominated by universities and research institutes, where firms are only beginning to take the lead in R&D expenditures.		Policy focuses on establishing the fourth-generation universities in the region and cooperating with the industrial sector through investments in technology incubators and research parks.
	The disparity in regional innovation systems may be attributable to differences in innovation efficiency among firms across regions, as well as variations in government support.		
	Conventional explanations have pointed to the drastic expansion in R&D spending, foreign direct investment, improved legal systems, and ownership reforms as significant forces behind the rapid expansion of regional patent activities.		

Source: The author’s construction based (Li, 2009; F. C. Liu et al., 2011; Malik et al., 2021; Shin et al., 2012; Wang et al., 2015).

Additionally, in developing countries, the shift to new economic and localization-based knowledge contexts does not necessarily follow the path to development, but rather depends on the accumulation of knowledge and development factors within the region (Asheim, 2019). However, universities in these countries must develop flexible capabilities that enable them to combine continuity and change in a sustainable manner (Saad et al., 2008). The literature on less developed regions stresses the role of localized factors, features of the region, as well as leading universities in the integration into the regional innovation system.

As a consequence, while the system's components may be similar across developing countries, its effective components differ, and the mechanisms for activating innovation systems vary according to the nature of the nation and its development stage, local knowledge, and knowledge networks, internal and external, and therefore the characteristics differ. Economic growth in these countries is determined by local factors, internal development components, and regional networks within them, where local factors are an important element for localizing innovation policies spatially (Vale, 2011). Additionally, the regional variation in performance in these regions represents an important characteristic of innovation policies in developing countries (Li, 2009). The differences arise from differences in the actors of the innovation elements of companies, universities, research institutes, and the local community (Kolehmainen et al., 2016). As a result of this interplay, regional innovation activities within developing countries are stimulated substantially along with the participation of numerous institutions (Aidis, 2017; Fritsch & Slavtchev, 2011; Morgan, 1997). In summary, based on the literature review, developing regions are distinguished from developed ones by unique characteristics. Innovative systems, internal networks, institutions, and the social environment all play a role in the way regional innovation systems function in developing countries.

Developing countries face some challenges, according to the literature review analysis of regional innovation systems. Three major challenges have been identified: (1) *the human capital challenge* (Sotarauta, 2004; Varga, 2015, 2017), (2) *infrastructure and structure challenges* (Kaufmann & Tödtling, 2000a), and (3) *the knowledge flow challenge* (Hanson, 2014). In light of the first challenge, one of these regions' weaknesses is the lack of human capital to help them create innovative activities. A challenge might appear in the following areas: increasing organizational capability within institutions, collecting limited resources, strengthening distinct human elements, and transcending "lock-ins" that require development efforts (Sotarauta, 2004).

Secondly, these regions could face difficulties with infrastructure and structure, which are evident in old industrial cores in less developed regions. There is an urgent need for innovation in these cores. In other words, the structure and infrastructure must be renewed on a technological level as well as in terms of production processes (Kaufmann & Tödtling, 2000a) and through the development of virtual networks for innovation (Vale, 2011). Through the use of "path-dependent regional industrial development", this challenge can be overcome since it considers the inner components as endogenous factors and can be used to develop innovation activity based on these inner components (Isaksen & Trippl, 2017). In consequence, the main elements of RIS develop and follow specific trajectories (Hassink & Klaerding, 2011). A final challenge is the flow of knowledge from one region to another. Study on this challenge has focused on how knowledge flowed to regions to create innovative regions and contexts, in addition to making clusters of knowledge-based industries, and to what extent knowledge spillovers were observed (Hanson, 2014).

In summary, the goal of this subchapter of the thesis was to give insight into the second part of the literature review by evaluating the experiences of several developing countries in regional innovation policies, based on the literature review analysis and by examining the policy's components and features, as well as the challenges that developing countries have in adopting it. According to my research, **developing countries employ two types of knowledge for innovation: local knowledge and knowledge derived from developed countries**. As a result, the effectiveness of RIS in these three countries varies depending on whether emphasis is placed on universities, government, or businesses. While the components of the system may be similar across developing countries, its components that are effective differ, and the mechanisms to activate innovation systems vary according to the type of nation, its development stage, local knowledge, and knowledge networks, internal and external, and, as a consequence, their characteristics. These countries' economic growth is influenced by local factors, internal development components, and regional networks, where local factors play a significant role in localizing innovation policies. According to the literature review, developing regions differ from developed ones by their unique characteristics. Regional innovation systems in developing countries are shaped by innovative systems, internal networks, institutions, and the social environment. In the context of the experiences of developing countries, I will examine the policy of smart cities, its forms, the approach to development, and its objectives.

2.4.2 Smart city experiences in developing countries

I discuss in this sub-chapter how smart cities can be a source of innovation, information, and knowledge in contemporary urban policy, with a view to demonstrating how they can be implemented in developing countries. The aim is not only to identify challenges associated with smart city approaches, but also to compare and contrast the development goals of developing countries. Smart cities are becoming a research focus in developing countries, as well as in some Middle Eastern countries such as Dubai in the United Arab Emirates (Virtudes et al., 2017). Developing countries typically search for effective tools for urban development to overcome infrastructure inefficiency, continuous environmental degradation, and deficient governance tools (Fromhold-Eisebith & Eisebith, 2019). A city's smartness can be measured, for instance, with SC's smart transportation features, but also with technological, ICT-oriented, and instrumental prescriptions (Fromhold-Eisebith & Eisebith, 2019). It is suggested by Chang et al. (2018) **that instead of applying models from developed countries, we should focus on models that adapt to the developmental characteristics of each region through the transfer of knowledge and information technology**. Knowledge and information technology translate into higher productivity in developed countries, whereas in developing countries, the influence of ICT is more valuable, addressing urban development issues, enhancing public involvement in plans, and addressing climate change issues (Joia & Kuhl, 2019; Viale Pereira et al., 2017).

Smart city initiatives contribute to the economies of many developing countries, such as China, India, Vietnam, and Indonesia (Bholey, 2016; Oktaria et al., 2017; Yao et al., 2020). Baldascino & Mosca (2016) state that smart city strategies within developing countries should be integrated into regional development policies to utilize urban capabilities and functionalize regional resources into the smart city. Many emerging countries have launched ambitious national plans to promote smart city initiatives at the national level, while China and India are considered pioneers (Oktaria et al., 2017).

In selecting specific cases from developing countries, the following reasons were taken into consideration: first, smart city policies should be a part of a nation's strategic plan (top-down approach), as in Egypt. Secondly, some of these countries have been creating new smart cities as well as making existing ones smarter. Moreover, one of the selected countries should have an urban intelligence policy that is applied to existing cities to meet the needs of existing cities, since the Egyptian government intends to apply smart city policies to existing cities in the future. Based on these criteria, three cases from developing countries were selected: **India**, **China**, and **Indonesia**.

Indian smart city programs were launched in 2015, where the vision was shifted to a defined strategy with a mission (Smart City Mission) (Ministry of Housing and Urban Affairs, 2015). According to the smart city strategy, there will be 100 smart cities by 2030 (Vu & Hartley, 2018). In order to construct new smart cities, the government intends to connect them to the larger cities or mega metropolitan area (Bholey, 2016). The Indian model of smart cities revolves around addressing overpopulation and their subsequent urban development implications through policymaker collaboration (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. Using the Smart City Mission for India model as a guide, six fundamental principles describe the concept of Smart Cities: (1) communities are at the center of planning and implementation; (2) 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). Bhattacharya et al. (2000) note that the application of sustainability to smart city models in India, or any rapidly developing or emerging economy, must consider several 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 transport*, through improvements to public transport, improvements to vehicle infrastructure, improvements to infrastructure for pedestrians, cycling, etc.
3) Effectively *managing demand*, especially through the use of urban intelligence in managing energy demand.

To activate the concept of urban intelligence in China, **the Chinese model** relied on the new smart city strategy's implementation methodology (Angelidou, 2014; Vu & Hartley, 2018). In 2009, China began introducing the concept of building smart cities, in which local and central governments developed policy measures aimed at encouraging the development of smart cities of a high level, in cooperation with IBM (Bris et al., 2019). As a pioneer in smart city technology, IBM presented the "Smarter Planet project" in 2008 to examine how sensors, networks, and analytics can be applied to urban issues (Verdict, 2020). Consequently, China sought to incorporate those experiences into its own smart city program. A total of 154 plans were introduced for the development of smart cities by the end of 2013 (Angelidou, 2014; Yao et al., 2020), developing 311 cities starting from sub-provincial levels (Vu & Hartley, 2018). Following the implementation of smart city pilot policies in 2012, the Chinese government heavily promoted the creation of smart cities. By 2018, China had 500 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 (Yao et al., 2020).

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 cities as a new approach to urban planning, the Chinese state believes eco-cities will be replaced by smart cities. According to Chinese thinking, smart cities are an important consideration for policy makers since new urban science not only promotes sustainable, smart, and livable cities but also spurs urban economic growth and improves the quality of urban workers (Bris et al., 2019). In short, smart cities are more comprehensive than cities that concentrate only on the environment, as they also contribute to economic growth, so they are becoming the next urban trend to achieve this. Additionally, through the use of 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 fact, smart cities have been the subject of numerous programs and initiatives, however some literature indicates that many "empty ghost cities" raise concerns regarding their development purpose, affordability, construction quality, and ability to attract residents (Angelidou, 2014). For the Chinese experience, I believe that it is important to follow up on the achievement of the goals set for these major smart city initiatives in order to determine how well they are contributing to the new urban development.

The Indonesian smart city program focuses on improving and developing existing cities, as is the case in Jakarta, by involving urban intelligence and information and communication technologies, in order to address urban development issues as well as environmental concerns. The state has begun the 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. In order 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 through the use of 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 develop urban intelligence 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. 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 to promote urban intelligence. Local government authorities, for example, have made it possible for businesses and individuals to connect with citizens by providing basic infrastructure. In order 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).

The Indonesian smart city approach differs from the other models (China and India) as it utilizes information and communication technologies for urban intelligence to address problems in existing cities. Several sectoral initiatives are being implemented in partnership with the private sector in order to improve the urban environment.

In comparing the three smart city models in developing countries, some common characteristics emerge (e.g. dealing with urban challenges, promoting sustainability), but there are differences in the tools used to implement the policies (see table 10). 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 information security. 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 concepts.

A smart city approach involves a variety of objectives, such as responding to overpopulation and development concerns in India, 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. As a result of their development strategies, India opted for the establishment of new smart cities, whereas China opted for an amalgamation of both strategies that was based on developing existing cities and establishing new smart cities, while Indonesia opted for the development of existing cities approach. According to a comparison of smart city programs, the Indian model employs a social-centric approach to address social and demographic issues, the Chinese model adopts a technology-centric approach, while the Indonesian model incorporates sustainability principles and addresses urban challenges.

In developing countries, smart city development programs have gained popularity recently, but they face challenges. Tan and Taeihagh (2020) have determined some barriers to smart city development in developing countries, namely: (1) smart cities are expensive to develop, which puts considerable strain on the budgets of developing countries with diverse challenges and a number of urbanization issues (Hamza, 2016), (2) shortage of investment in requisite infrastructure, (3) unreadiness of existing infrastructure for dealing with technology, (4) multiple authorities involved in the development process in developing countries is a barrier for program implementations, which require different governance model for smart city approach (Anthopoulos, 2017; Hamza, 2016) , (5) lack for qualified and skilled human capital, (6) it is a concern is that not all citizens are included in smart city programs, especially low-income groups, (7) environmental issues, and (8) lack of technical knowledge among citizens especially in smart city strategy set for existing cities (Angelidou, 2014).

In summary, **smart city experiences from developing countries indicate that concepts, goals, model characteristics, and development approaches may differ depending on local characteristics, challenges, and technological capabilities**. The literature analysis suggests that Smart city development in developing countries can be driven by several factors, including: 1. financial capacity of the government; 2. building a regulatory environment that fosters citizen and investor confidence; 3. readiness of the infrastructure and technology, 4. availability of human resources, 5. the economic stability of the country, 6. the active participation of citizens, 7. knowledge transfer and private sector participation, and 8. establishing an ecosystem that encourages innovation and learning as well as technology development (Tan & Taeihagh, 2020). Furthermore, smart city models in developing countries have different characteristics and obstacles, **which necessitates tailoring policies rather than adopting models from developed countries**. According to Hamza (2016), developing countries require a three-layered alternative framework for smart city development: *smart city structure* which consists of environment, infrastructure, resources, services, social systems, and economy. *Smart city factors* include the six smart city dimensions (economy, governance, people, environment, mobility, and living), as well as institutions that contribute to smart city management and smart infrastructure that integrates and enhances environmental protection. The framework also includes *smart city strategy*, which is based on assessing city capacity, setting objectives, identifying city indicators, recognizing and engaging stakeholders, formulating strategies, and implementing strategies (Anthopoulos, 2017; Hamza, 2016). As a result, smart city development is a critical strategic option for cities today (Vu & Hartley, 2018).

Based on my research of smart city experiences in developing countries, I found that most of these countries depend heavily on technology and knowledge, but they use different tools based on their *development goals*, *financial resources*, and *local issues*. At the end of the chapter, I summarize a number of significant conclusions based on a review of the literature on smart cities and innovation policies, both theoretical and experimental, in preparation for the case study analysis and empirical analysis to follow.

Table 10 A comparison of the smart city approach in the experiences of developing countries

	India's Model	***China's model***	***Indonesia's model***
The 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 the overpopulation and consequent urban development issues	New approach aim to urban planning in China to replace "eco-cities".	To improve city services and infrastructure using ICT.
Spatial development strategy	Establishing new smart cties.	Combination 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 taking 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.

2.5 Conclusions

The following conclusions can be summarized after examining the theoretical background and the experiences of innovation policy and smart city approaches:

- Considering the literature analysis presented in this chapter, I am able to conclude that the answer to the *question posed regarding the role of innovation in regional development* is that **knowledge and innovation play an increasing role in promoting innovation activities within regional economic development**. **Innovation determines whether a given region can develop in a competitive economy**, according to knowledge spillover, learning regions, milieu innovateur, and evolutionary economic geography theories (Nijkamp & Abreu, 2009). The theories emphasize the role local factors play in regional development, highlighting the importance of innovation and knowledge in a regional environment. The dimensions of innovation that each theory illustrates differ according to its perspective. Innovation localization occurs in three dimensions: knowledge-oriented sites are able to deliver greater returns on their innovative activities, economic and social ties within regions determine innovation opportunities, and local diversity is determined by tradition, standards, social practices, and institutional characteristics. Lastly, innovation within regions is greatly affected by the evolution of local competencies.
- Further, the conclusion that is to be drawn in response to the question of *whether innovation policies may contribute to regional development, depending on the extent of their support*, is that institutions that promote innovation are of great significance for regional development (Caniëls & van den Bosch, 2011; Liu et al., 2011; Morgan, 1997; Rodriguez-Pose, 2013; Vale, 2011). As these institutions work together, they facilitate innovations that assist regional economic development. These institutions include **higher education**, **government-funded research institutes**, **industry**, and **government**. As I reviewed the literature, I discovered that policies have also evolved from old to new approaches. In terms of regional policies for innovative development, **knowledge**, **innovation**, and **endogenous factors** contribute to paradigm shifts. Moreover, the shift in regional development paradigm is the result of a change in regional development theories and the recognition of the importance of spatial frameworks and endogenous factors. According to the analysis of economic theories, regional competitiveness and the ability of a region to generate economic growth are determined by **regional characteristics**, **internal interactions**, **socioeconomic characteristics**, and **knowledge acquisition within local communities**.

- Based on findings of literature review of this chapter, I believe the question of what smart cities are and how they differ depends on a variety of factors. Firstly, how they are developed (cooperatively, technologically, socially). Second, the perspectives of stakeholders (technicians, architects, planners, sociologists, and government representatives), and third, the approaches for designing smart cities (encompassing or sector-based). Accordingly, smart cities are considered to be a ***multifaceted concept***. Thus, the term "smart" is seen as ***comprehensive*** from competitiveness within a smart economy, social capital within a smart society, participation within a smart government, innovation in ICT and mobility within smart mobility, natural resources within a smart ecosystem, and wellbeing within a smart home (Baldascino & Mosca, 2016). By analyzing the literature, I also found that the sub-question (RQ1), which was raised at the beginning of this chapter, namely *what smart cities are in relation to new innovation policies that support regional development*, was answered by stating that **smart cities cannot succeed without innovation, as innovation is the "engine" of urban development**. Moreover, the study found that innovation systems could promote collaboration between businesses, citizens, and governments/public services, as discussed in Chapter 2.3.
- Having thought the literature analysis results showed that the answer to the sub-question (RQ2*): can smart city policy be applied in general to every developing country* showed that most developing countries implement a smart city model, but they differ in the tools they can use depending on their **development goals and local concerns**. As outlined in the literature review, smart cities face a number of challenges, including financing, a lack of infrastructure investments, an infrastructure that is unprepared to deal with technology, and a multitude of stakeholders involved in the development process. As evidenced by the literature review findings in sub-chapter 2.4, **smart city policies are policies tailor-made to the local context**, based on *local characteristics*, *efficiency*, *information resources*, and *technological advantages*.

I attempted to integrate the theoretical background and experiences of smart city policy and innovation in chapter two of my thesis to answer the sub-questions RQ1 and RQ2 outlined in chapter one. In Chapter 3, I will discuss a case study of Egypt in the context of developing smart cities and innovation policies.

3. SMART CITY AND INNOVATION POLICY IN EGYPT

This chapter discusses *smart cities and innovation policy in the context of urban economic development in Egypt.* Furthermore, I provide an overview of Egypt's 2030 strategy, which emphasizes the development of innovation, knowledge, digital transformation, and urban intelligence. The previous chapter examined the theoretical background of smart cities and innovative policies. It also examined smart city innovation policies in developing countries. According to the review, developing countries implement innovation policy differently, with different characteristics, tools, and objectives. The following sections examine how Egypt is *implementing this new type of policy and examine the major components of the smart city program, its objectives, and how it is currently being implemented*. The following two sub-questions will be addressed:

- RQ3: *Are there any preconditions that need to be met before Egyptian governorates can adopt the smart city concept?*
- RQ4: *Which Egyptian governorates have the conditions to adopt the political concept of the smart city?*

I use two research methods in this chapter to find out how the Egyptian government is adopting this new type of policy and to identify what the aims of smart cities are and how they are being carried out at present.

The Egyptian innovation system and smart city strategy are first identified using the *policy narrative analysis method*. Data on the components of the innovation system were created using data provided by several ministries and government agencies, as well as statistics collected by the Central Agency for Public Mobilization and Statistics (CAPMS). As part of the narrative analysis, I conducted two online interviews with policy officials. Wael Moussa, a technical advisor for the Minister of Housing, Utilities, and Urban Development, was one of my interviewees. He is on a national committee charged by Egypt's Prime Minister with developing a model for Egyptian smart cities, which would be implemented in 14 of Egypt's fourth-generation cities. This interview centered on policy instruments and the development strategy for their implementation. Dr. Mohamed Khalil, one of the national committee members and Chief Technology Officer of the Administrative Capital for Urban Development company (ACUD), the company in charge of administering, operating, and developing the New Administrative Capital, was the second interviewee. In this context, the interview centered on questions on the Egyptian smart city model's components in terms of utilizing information technology, data analysis, and the model's organizational structure. The narrative interview approach was utilized for the interviews with officials (Leong & Tan, 2013) , and the complete text of the interview reports can be seen in Appendix 4.

Secondly, the Egyptian smart city model was studied using the *case study method* so as to determine the components, aims, and instruments of the model. Case study analysis is widely used in studies (Bhattacharya et al., 2020; Bholey, 2016; Bris et al., 2019; Ela, 2016; Pratama, 2018; Virtudes et al., 2017; Vu & Hartley, 2018). Case studies examine contemporary phenomena within their real-life contexts, with four different goals: (1) to provide descriptions, (2) to develop new theories, (3) to refine existing theories, and (4) to test the validity of existing theories (Mora et al., 2019). As a result, the current study utilizes a case study to accomplish the first objective. In addition, to gather data for the case study, I requested official documents from ACUD Company concerning the NAC, specifically the proposed urban plan, the proposed land use, the service distribution network, and the proposed development strategy. Furthermore, the study relies on data and indicators gleaned from the websites of the various ministries (the Ministry of Housing, Utilities, and Urban Development, and the Ministry of Planning and Economic Development, and the Ministry of Higher Education and Scientific Research).

There are five sub-chapters in the current chapter. By presenting several indicators and summarizing the Egyptian socioeconomic setting in general, sub-chapter 3.1 provides an overview of the Egyptian context. The factors and tools that define the features of the Egyptian innovation system are discussed in sub-chapter 3.2. In sub-chapter 3.3, the smart city model in Egypt is studied, followed by a detailed examination of the NAC case study in sub-chapter 3.4, which serves as a leading model for smart city development in Egypt. Section 3.5 closes with a discussion of the policy's concept and components.

3.1 The economic context of Egypt

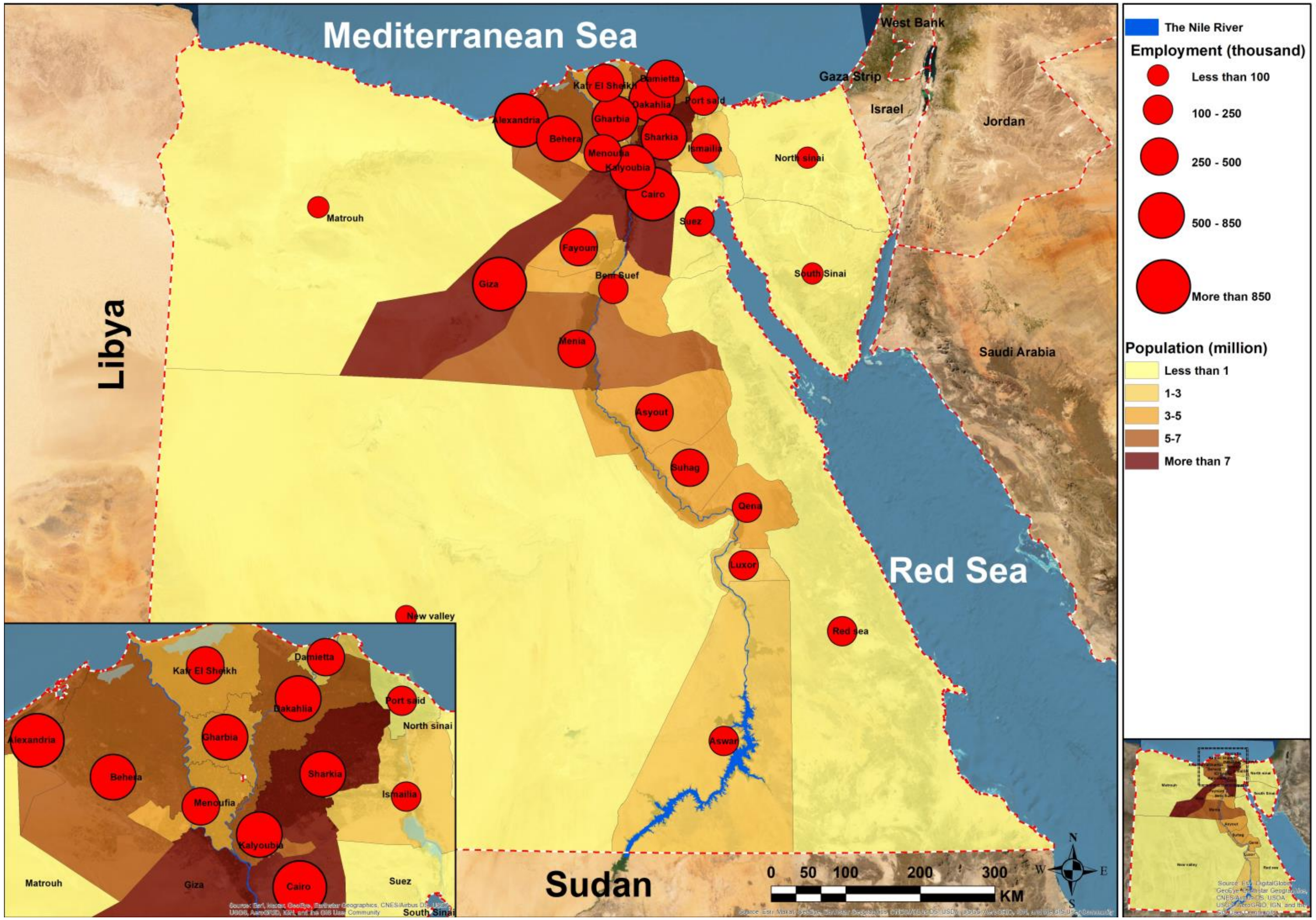
The first section of this sub-chapter focuses on the administrative structure of Egypt and the characteristics of its governorates, whereas the second examines the socioeconomic situation in Egypt in general as well as the economic reform program (2016).

The introduction chapter summarizes the economic, social, and geographical conditions. Following are more detailed descriptions of the Egyptian governorates.

The administrative division of Egypt was presented in the introduction chapter. There are three levels of administrative division: (1) economic regions, (2) governorates, and (3) municipalities, which are either *markaz* or *kism*[2]. In Egypt, there are 27 governorates, which are diverse in terms of their geographical context, population size, geographical area, and classification (urban or rural). 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, or 7.8 percent. Near the Nile River is the most populous area, while the rest is desert. In general, governments differ according to these characteristics, particularly in terms of innovation and knowledge. Due to the components and factors of intelligence and innovation, it is assumed that these differences will affect the concentration and clustering of innovations in these governorates as well as their urban intelligence policies. According to Figure 11, the population and employment of the Cairo region are concentrated in the governorates of Cairo (Cairo, Giza, Kalyoubia), their surroundings, and in Alexandria in the north. 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 south (Ministry of Planning and Administrative Reform, 2014). During the fourth World Youth Forum, which kicked off recently in Sharm el-Sheik, President al-Sisi revealed that in the past seven years the Egyptian government had invested six trillion Egyptian pounds (approximately 400 billion dollars) in infrastructure and development (Al-Sisi, 2022).

[2] 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*: is a police-administered area, usually divided according to city size.

Figure 11 Population and employment in economic activities for Egyptian governorates, 2018



Source: Own edition using ArcGis software. Based on the official Census 2018 data by the Central Agency for Public Mobilization and Statistics (CAMPUS).

Egypt has carried out comprehensive national economic reforms since 2016, as discussed in the introduction chapter. The Egyptian government is reviewing this reform, including its success rates, challenges, and roadmap. In August 2016, Egypt began negotiations with the International Monetary Fund (IMF) that 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 so that macroeconomic indicators would be stabilized. As well, the goal was to create a stable environment so that high investment rates could be attracted 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 supposed to be restored and the balance of payments gap was reduced. Further, the program would have resulted in Egypt's Central Bank being better able to manage flexible exchange rates while progressively shifting away from an inflation-increasing system in order to maintain Egyptians' real incomes and the country's competitiveness (UNDP, 2021). Egypt requested emergency financial assistance from the IMF under the Rapid Financing Instrument (RFI) in May 2020 in order to address its urgent balance-of-payments needs (COVID-19). In response, the IMF granted the loan. By June 2020, the IMF approved a 12-month Stand-by Arrangement for Egypt worth $5.2 billion. Egypt issued $5 billion in dollar-denominated bonds in three tranches of four years, twelve years, and thirty years. In January 2021, the IMF concluded that the government's measures to combat COVID-19 had less impact on Egypt's economy than expected. The IMF has consequently raised expectations for growth in 2020/2021. According to the IMF report, in order to achieve more inclusive growth, structural reforms and governance reforms need to be continued, as well as improving transparency around state-owned enterprises, providing equal opportunity to all development partners, and removing bureaucratic barriers (Abouleinein, 2021). The first report for Egypt's Voluntary National Review was submitted in 2018. The second report was launched in 2021 in accordance with Egypt's strategy 2030 and the United Nations 2030 sustainable development goals (MPED, 2021). Through structural reforms, Egypt implemented a comprehensive development plan aimed at achieving economic goals. Compared with 2013/2014, real output growth increased by 2.9%, as shown in Table 11, but improved by 5.3% in 2017/2018 and 5.6% in 2018/2019 after reform measures were implemented. From 2013/2014 to 2018/2019, the unemployment rate decreased from 13.3% to 7.5%.

Reorienting government subsidies in the direction of energy subsidies, financial control, and rational and successful implementation of value-added tax led to a decrease in 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. 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). On the whole, it can be said that Egypt's large-scale reforms have resulted in increasing growth rates and lowering unemployment rates, which support the achievement of the comprehensive development goals of Egypt's Strategy 2030, which are further reflected in the development of smart city policies and innovations.

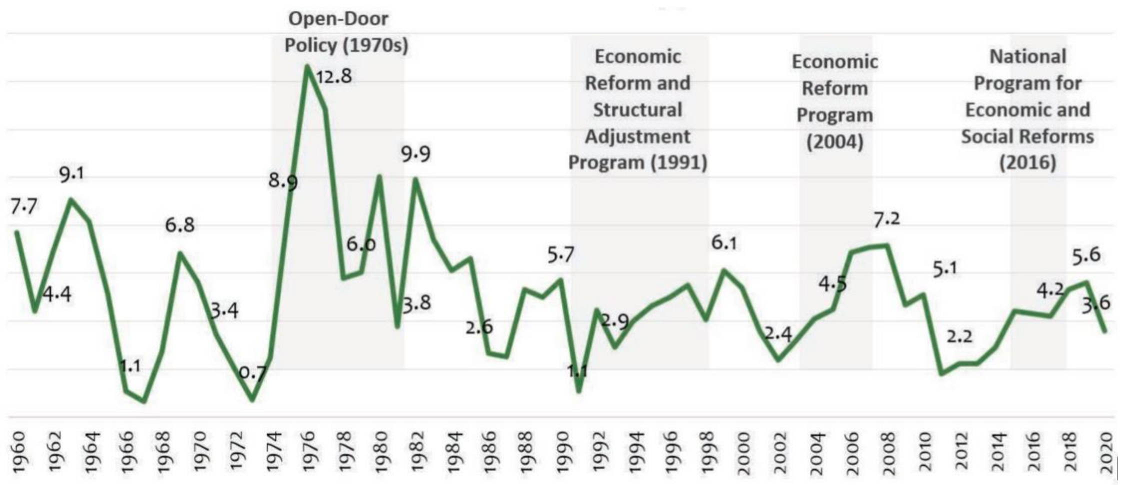
Table 11 Trend of Economic Indicators (2013-2019)

	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.

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 12. 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. Adapted to the *Egypt Strategy 2030*, programs and projects were implemented across all sectors. 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). Egypt's government responded by implementing a series of policies and approving a stimulus package worth EGP 100 billion (USD 6.4 billion), or almost 2% of GDP. *Protection*, *mitigation*, and *resilience* (PMR) were the main concepts of these proactive policies. The *protection* policies were designed to safeguard the entire population, especially the most vulnerable; the *mitigation* policies dealt with the effects of the negative shock across the economy; and the *resilience* strategies strengthened the economy to prevent the shock from happening again (MPED, 2021).

Figure 12 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 towards 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 to transform the economy into a knowledge-based economy**.

The Egypt strategy 2030 emphasizes innovation, knowledge, and urban intelligence. Through innovation and knowledge, it also hopes to develop its economy. Egypt could, as part of its reform process (general goals of the Egypt Strategy 2030), enhance its innovation potential. Understanding and evaluating the performance of the Egyptian RIS is therefore crucial to achieving the goals of the Egypt strategy 2030. The key to determining how innovation can occur in Egypt is a clearly defined and specific policy. In the following section, we discuss the elements of Egypt's innovation system, identify key factors and tools, and examine the types of working tools used in governorates.

3.2 Egyptian Regional Innovation System (RIS): Factors and tools

This section will discuss the *Egyptian innovation ecosystem* after presenting the Egyptian context and economic and social indicators. I will introduce a few performance indicators for the RIS. The purpose of this investigation is to identify the elements and components of an innovation ecosystem from an Egyptian perspective, through comparisons with a group of countries as well as at the governorate level, to see what is possible within an innovation ecosystem at the Egyptian regional level.

3.2.1 Old and new framework of Egyptian RIS

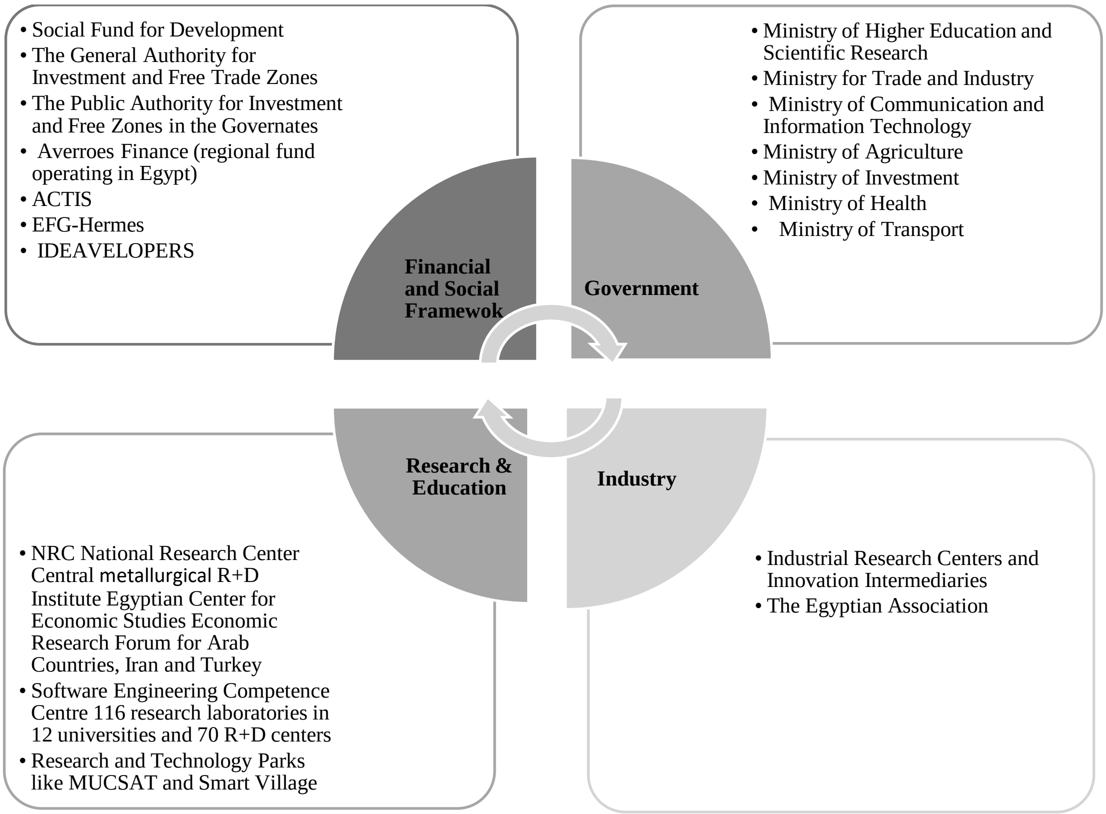
The Egyptian government recognized the importance of long-term innovation policies between 1985 and 2005. Egypt's innovation policy was described as clear but incomplete in the Annual Innovation Policy Trends Report for Countries – supported by the European Trend Chart on Innovation (MEDA-Zone, 2005). In Egypt, a number of 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 is 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 to 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. **The innovation system began to emerge in Egypt at the beginning of the 2000s**. It consists of four main structures: 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. The result of these interactions is the transfer, modification, and importation of new technologies (Freeman, 1987).

In Figure 13, these four frameworks show a set of networks among different institutions that include: first, the governmental framework as defined by the ministries of higher education and scientific research, commerce and industry, communications and information technology, agriculture, investments, health, and transportation. Second, the framework of research and education is represented in national research centers, research laboratories in universities, research and development centers, research and technology parks, in addition to smart and technological villages. Third, the industrial framework is represented in industrial research centers and innovation proxies. Finally, the financing framework is set up through the Egyptian Social Fund for Development, investment agencies, and regional investment fund (Hahn & Meier zu Köcker, 2008). Despite this, neither the research community nor the industry have been very effective at interacting. In addition, projects that were financed by the Social Fund for Development tended to be commercial products projects centered around consumer products rather than industrial R&D projects (Hahn & Meier zu Köcker, 2008).

Thus, Egyptian industry had to import technology and innovation products from abroad. Egypt's Technology Transfer and Innovation Centers (ETTICs) were established as part of the program so as to encourage local innovation rather than simply importing technology. In Chapter 2.3, the experiences of developing countries are discussed in relation to local aspects of innovation systems. 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 was necessary, as well as the integration of regional development. The policy was described as having clear components but **not being integrated or cooperative**. **Egypt developed a long-term strategy for science, technology, and innovation in 2016** called *National Strategy for Science, Technology, and Innovation 2030* (NSSTI) (Update 2019) (Ministry of Higher Education and Scientific Research Egypt, 2019). This national strategy is designed to develop an adequate scientific and technological environment based on knowledge, innovation, intelligence, and information technology policies. Its goals include achieving sustainable development, increasing knowledge production, improving quality of life, addressing societal challenges, and increasing competitiveness.

The government has recently focused on how it can use the spatial dimension to localize its innovation and knowledge policies in regions that support research, innovation, and knowledge. Therefore, the Egyptian state established the city of knowledge and Egyptian Knowledge University (inside the new administrative capital) with the aim of promoting innovation and knowledge in the new cities. This direction aims to localize the concept of knowledge and innovation clusters in order to promote cooperation, integration, and linkages among the different aspects of innovation, which have been lacking in previous initiatives and programs (Ministry of Higher Education and Scientific Research Egypt, 2019). Therefore, smart city policies have been considered as a way to localize regional development through knowledge and innovation by focusing on services, transportation, economy, and smart people.

Figure 13 Innovation policy pillars for the Egyptian context.



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

3.2.2 Elements of RIS and innovation indicators

Egypt developed the *Egypt Strategy 2030*, which outlined some of the goals it needed to accomplish by 2030. One of the main sectors of the strategy is scientific research and innovation. In the strategy, the country seeks a plan to achieve economic growth while focusing on innovation and knowledge. *Higher education* and *scientific research*, *industry*, *government*, and *the social dimension* were identified by the strategy as elements of regional innovation in Egypt. The strategy outlined the following objectives in order to facilitate collaboration among these elements:

(1) *Reviewing and developing laws and legislation related to the empowerment of knowledge and innovation.*

(2) *Developing and restructuring the knowledge and innovation system.*

(3) *Adopting a comprehensive program to instill the innovation and knowledge culture in society.*

(4) *Developing a comprehensive program to encourage small and medium-sized enterprises to innovate.*

(5) *Activating the state and private sector partnership in supporting and motivating innovation* (Ministry of Higher Education and Scientific Research Egypt, 2019).

In 2019, the *National Strategy for Science, Technology, and Innovation* 2030 (NSSTI) was developed based on these goals. The **regional innovation system components** for Egypt are included in the Strategy. According to the strategy, innovation components include **higher education**, **R&D inputs**, and **R&D outputs**, as well as **scientific research expenditures**.

Higher education indicators in Egypt have grown over the last 50 years, from a public university and a private university to 52 universities by 2018, 50% private and the same percentage governmental. Academic specialization in colleges of governmental universities is as follows: 51.6% work in scientific academies (medicine, natural science, agronomy, engineering, and the social sciences, with 48.4% in theoretical academies. Considering higher education's quantitative aspects, 39% of students were enrolled in higher education in 2019, an increase of 9% since 2000. 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. The Global Talent Competitiveness Index 2021 (GTCI) also scored Egypt 40.39 on the vocational and technical skills pillar, while the average for countries with similar income groups was 34.34, despite the significant decline in the Relevance of education to the economy indicator of 53.26 (Lanvin & Monteiro, 2021). As far as quality is concerned, Egypt stands out in the global knowledge skills pillar of the Global Talent Competitiveness

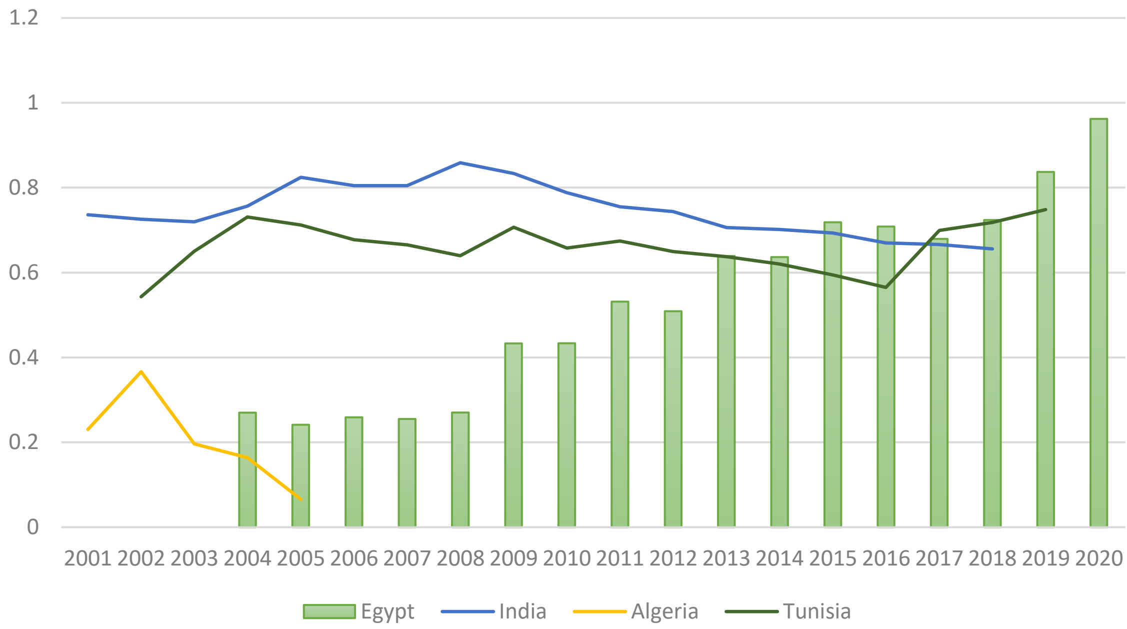
Index 2021 report, as Egypt was ranked among the top 10 regional countries (North Africa and West Asia 19 countries) and also among lower middle income countries (36 countries) for that pillar, and 65th globally (Lanvin & Monteiro, 2021). As well, the "Attract" talent pillar of the Global Talent Competitiveness Index demonstrated improvements, ranking 77th in the world at 26.17. Additionally, the Brain Gain Index ranked 67th globally at 47.11, a remarkable improvement. Despite this, the indicator of women's contribution to higher education recorded some decline at 89th globally at 57.4, while the indicator of leadership opportunities for women showed remarkable progress in building the global talent competitiveness index, ranking 26th globally at 67.9. In addition, the university ranking indicator performed at the highest level ever in the context of higher education quality when building the global talent competitiveness index for Egypt, which scored 38 globally at 42.35, with two universities in the top 500 universities.

In Egypt, **R&D inputs** are divided between the public and private sectors. There are 25 research centers in the public sector. From 2017 to 2018, the number of researchers for the public sector increased by 11%. In addition, 79% of the public sector's researchers are found in the higher education sector. With a value of 62.4, Egypt comes in 59th in the GTCI 2021 regarding the number of researchers (Lanvin & Monteiro, 2021). Science and engineering availability showed notable progress, ranking 45th among the participating nations. In 2018, the business sector's researchers were the fewest. 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). The government policies are aimed at attracting these types of companies, especially with smart city programs and with the NAC.

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. From 2014 to 2018, the number of patent applications submitted to the Egyptian Patent Office (EPO) increased by 5.6 percent, with companies filing the greatest number of patent applications, followed by individuals, and then research centers. In regard to 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).

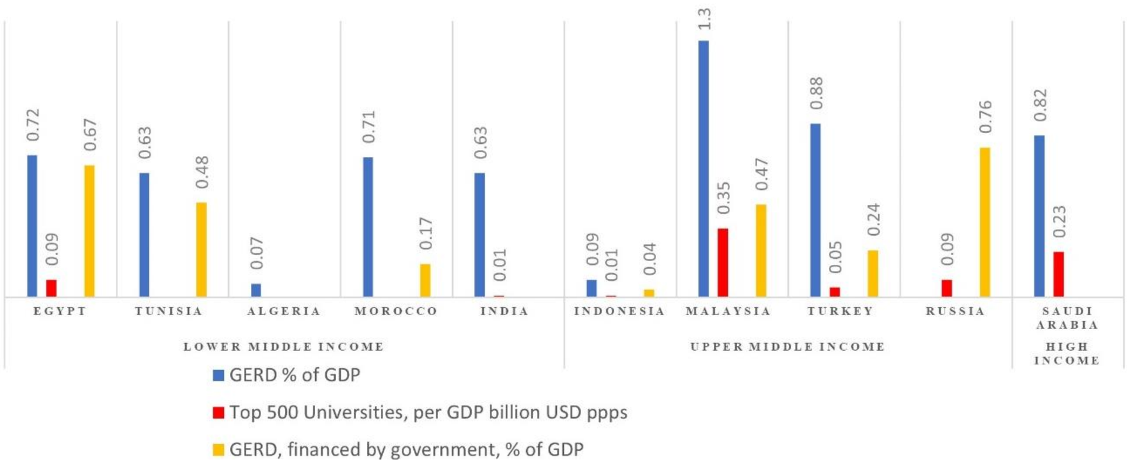
Egypt's gross expenditure on research and development (GERD) increased by 276% from 8.52 billion (N.C.) in 2012 to 23.6 billion (N.C.) in 2018, according to the Ministry of Higher Education and Scientific Research (2019). **Comparing Egypt with other countries**, it has made significant progress in terms of research and development expenditures (percentage of GDP), showing the significant progress when compared to Algeria, India, and Tunisia (see Figure 14). The Innovation Policy Platform (IPP) shows that **Egypt's innovation system is both strong and weak, when compared to those in other Middle Eastern and North African (MENA) countries**, including those at a comparable economic level. The **Gross Expenditure for Research and Development** (GERD) as a percentage of GDP has improved more than in lower-middle-income countries (see Figure 15). The new constitution estimates that the percentage of higher education and scientific research will reach at least 1% of GDP within five years (Ministry of Higher Education and Scientific Research Egypt, 2019). In comparison with other countries in the same category, **government-funded R&D** is improving, but private sector investment is lacking. Cairo university is ranked among the top 500 universities in the world, despite Egypt's low income, and further improvements are expected with the policy tools proposed. There are differences in the components, capabilities, and driving forces of the Egyptian regions and governorates. Innovation is influenced by different factors and components in Egypt's seven economic regions. Additionally, within the same region, the governorates differ in terms of innovation, knowledge, and urban intelligence.

Figure 15 Comparing research and development expenditures (% of GDP) among a set of countries



Source: own edition on World Bank data, 2022.

Figure 14 Innovation supportive indicators for some MENA and upper-middle-income countries



Source**:** own representation, based on IPP data, last available 2016 (M. A. Ali, 2021a).

As part of the NSSTI strategy, the government has also begun introducing some new tools and programs to support innovation policy. One of these programs involves creating 25 universities to emulate the 4th generation universities focusing on technology, nanotechnology, and mechatronics. Furthermore, Egypt started developing smart city programs in 2015 by building 14 fourth-generation cities. A fourth-generation city is based on the principle that city leaders should be empowered to make a difference in their communities. The devolution of power allows local authorities to formulate a long-term vision for cities. Economic activity is a major aspect of a city's vitality. A city's competitive advantage needs to be enhanced in order to compete on a global scale and not just within its borders. The second most important factor is connectivity. Today, digital connectivity is as essential as ancillary infrastructure, such as reliable electricity. Third, cities need to take into account the social fabric of the city, including income distribution, access to government and commerce, healthcare, education, and security. Last but not least, cities should be sustainable (WEF, 2016). Mousa (2021) stated in an interview that *"process management"* will play a critical role in developing decision-making processes in fourth-generation cities (Khalil & Mousa, 2021). The long-term efficiency of business processes is continuously monitored in process management. Properly implemented, it can significantly boost business growth. Process management differs from project management by focusing on repeated processes rather than a single project. Identifying bottlenecks, finding areas of improvement, and analyzing current systems are components of system analysis (BPM, 2021). Providing market opportunities for innovations, ideas, and solutions by setting up the Egyptian Innovation Bank is another policy tool (EIB, 2020). Once I have presented the components and performance of the RIS in general, I will discuss the components and performance indicators in the Egyptian governorates and regions.

According to Table 12, **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. At the national level, the creative industries account for about 80% of employment in the innovative industries. In addition, the region hosts more than half of the universities, 43% of research centers, and 24% of all patent and scientific workers, and 50% of all business incubators within Egypt. Thus, Egypt's innovation system is completely controlled by the region in terms of its components and factors of innovation. The 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**, which represent ten governorates out of 27 governorates, each have only 1% of the total innovative industry of Upper 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 lack of effectiveness of research centers and universities reflects the absence of innovation and development labor in 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**, where 23% of the population lives, agriculture and complementary logistics are the main economic activities. In spite of the presence of seven universities and 91 research centers, local innovation and policies are considered weak. Due to the presence of some ingredients 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 a number of 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.

Ultimately, **it is clear that some components of the RIS function fairly well in some regions but poorly in others**. This makes sense for a country like Egypt with its economic, social, and political conditions. On the other hand, some governorates, including Cairo, Giza, Alexandria, and some governorates in the Suez Canal Region, have favourable RIS. This provides promising governorates with the set of tools they need to implement their innovation policies. In spite of this, the Egyptian government views the SC policy as a way to foster innovation in cities via information and technology. Programs in this area will focus on educating and enhancing innovation in universities. In order to set policy, it is important to identify governorates that have elements of innovation and urban intelligence. **Since the RIS performs differently in different regions, the SC concept is unlikely to succeed everywhere**. There are some governorates or regions without effective regional innovation components, indicating a lack of system requirements that promote innovation and knowledge. Thus, until these requirements and conditions are met, smart city programs should be reconsidered. This view will be discussed in more depth in the following chapters.

Table 12 Regional Innovation potentials, capabilities, and smart cities for Egyptian governorates

N	Economic Regions	Governorates	Population	Pop(%)	Proposed Smart cities	Urban Or Rural	Startups	Accelerators/incubators	Research &Innovation	University	institutes	TTOs/TICO(transfer tech. offices)	Number of Scientific & Research Centers by Governorate	Total Scientific Research & Invention Patents workers	Innovative industries workers
1	Greater Cairo	Cairo	10075320	9.71	2	Urban	205	9	6	11	4	6	135	124512	6935
2		Kalyoubia	6007371	5.79	–	Urban/Rural	1	–	–	1	–	–	30	20634	9009
3		Giza	9293336	8.96	1	Urban/Rural	47	4	2	9	1	4	80	69730	4783
Total region			25376027	24.46	3		253	13	8	21	5	10	245	214876	20727
4	Alexandrea	Alexandria	5458055	5.26	2	Urban	29	2	3	4	1	1	24	42523	1397
5		Behera	6708441	6.47	1	Urban/Rural	4	–	–	1	–	–	13	12452	64
6		Matrouh	508553	0.49	–	Urban/Rural	–	–	–	–	–	1	9	1551	4
Total region			12675049	12.218444	3		33	2	3	5	1	2	46	56526	1465
7	Suez canal	Port-said	782634	0.75	1	Urban	–	–	–	1	–	–	12	7489	64
8		Suez	776960	0.75	1	Urban	–	1	–	1	–	–	7	4008	4
9		Sharkia	7721991	7.44	–	Urban/Rural	3	–	–	2	–	1	22	34995	1848
10		Ismailia	1418121	1.37	1	Urban/Rural	2	–	–	1	–	–	13	9382	376
11		North sinai	450528	0.43	–	Urban/Rural	1	–	–	1	–	–	5	1922	20
12		South Sinai	112835	0.11	–	Urban/Rural	–	–	–	–	–	–	–	1088	–
Total region			11263069	10.86	3		6	1		6		1	59	58884	2312
13	Delta	Damietta	1590104	1.53	–	Urban/Rural	–	–	–	1	–	–	11	8721	22
14		Dakahlia	7916763	7.63	1	Urban/Rural	7	–	–	2	1	–	23	37121	149
15		Kafr- El -Sheikh	3727427	3.59	–	Urban/Rural	1	–	–	1	–	–	15	13665	126
16		Gharbia	5330839	5.14	–	Urban/Rural	4	–	1	1	–	–	17	30716	85
17		Menoufia	4628408	4.46	–	Urban/Rural	6	–	–	2	–	–	25	17890	134
Total region			23193541	22.358019	1		18	0	1	7	1	0	91	108113	516
18	North Upper	Beni- Suef	3482188	3.36	1	Urban/Rural	1	–	–	2	–	–	20	16127	341
19		Fayoum	3963163	3.82	–	Urban/Rural	–	–	–	1	–	–	15	5248	56
20		Menia	6102418	5.88	1	Urban/Rural	3	–	–	1	–	–	19	10289	4
Total region			13547769	13.059725	2		4	0	0	4	0	0	54	31664	401
21	Middle upper	Asyout	4879025	4.70	1	Urban/Rural	2	1	–	1	–	1	26	24355	40
22		New valley	264521	0.25	1	Urban/Rural	–	–	–	–	–	–	6	4055	–
Total region			5143546	4.9582554	2	0	2	1	0	1	0	1	32	28410	40
23	South upper	Suhag	5581827	5.38	–	Urban/Rural	–	1	–	1	–	1	13	14731	110
24		Qena	3549747	3.42	1	Urban/Rural	1	–	–	1	–	–	14	13943	2
25		Luxor	1371816	1.32	–	Urban/Rural	–	–	–	–	–	–	2	2113	6
26		Aswan	1639498	1.58	–	Urban/Rural	–	–	–	1	–	1	17	7430	156
27		Red sea	395124	0.38	–	Urban/Rural	–	–	–	1	–	–	1	724	–
Total region			12538012	12.086344	1	0	1	1	0	4	0	2	47	38941	274

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

3.3 Smart city model in the Egyptian context

Egypt is one of the emerging economies in the MENA region with a powerful transformation path (Mabrouk et al., 2020; UNCTAD, 2019). In 2013, the country began over-ambitious plans for all sectors, accompanied by political and economic changes, as well as urban and regional development as top priorities. The interventions and policies aim to improve Egypt’s urban network, which is characterized by its diversity and inequality. The last three decades have seen several challenges for urban development – from increasing population, rural pressure on the city, weak economic bases, and unbalanced roles of cities within the urban network. Egypt’s population is concentrated in just 7% of the country’s area (1.01 million km^2) and has more than 100 million residents. There is not enough housing capacity in Cairo right now to meet future demand, given Cairo’s rapid growth rate and the negative agglomeration economies. Agglomeration can negatively affect energy demand, informal settlement growth, air quality, and transportation (Abd Alla et al., 2021). Egypt, therefore, sought to expand urban development areas. Building 14 new smart cities, upgrading infrastructure, and creating a steady investment climate are just some of these megaprojects (Hussein & Pollock, 2019). As part of Egypt's smart city initiatives, it plans to implement the smart city approach in New Alamein, the new administrative capital, and more than 12 other cities. This policy is developed in collaboration with several stakeholder groups, including citizens, the government, and real estate developers (Konbr, 2019a). The four main goals of developing these cities are:

- first, to create new urban and cultural centers that are capable of achieving social stability and economic prosperity, and
- second, to redistribute the population away from the narrow scope of the Nile Valley.
- Additionally, the establishment of new attractions outside of the existing cities and villages, and
- fourth, the creation of new urban centers that may include financial and business centers, urban intelligence, knowledge and innovation, and the proposed fourth-generation universities within those cities in order to make them production centers for knowledge and innovation (Abbas, 2021).

According to Abbas, the Deputy Minister of Housing, Utilities and Urban Development, these cities will be intended to accommodate 30 million people in order to deal with the increased overcrowding and population growth in Cairo and Alexandria. A total budget of approximately 57 billion Egyptian pounds (approximately 5 billion dollars) is allocated for the construction of facilities, roads, and infrastructure in these urban areas (Abbas, 2021). Overall, Egypt wants to support its economic growth by creating innovative urban centers (*efficiency goal*) and geographically dispersing its people (easing the high concentration of people in some regions, *equity goal*). Furthermore, smart cities use technological innovations to enhance urban life (*sustainability goal*).

The purpose of this sub-chapter is to investigate the concept of smart city policy, the requirements for implementing it, and the methods used by decision-makers in Egypt to make it work. The discussion of smart city policies as tools for regional development is divided into two main sections: the first presents a review of papers and strategies on this topic, and the second presents the spatial distribution of these cities and their proposed innovation features. Throughout this chapter, information and data are drawn from interviews (see Appendix 4), as well as related strategies and working papers prepared by authorities.

3.3.1 Policy Documents

Egyptian smart cities are still in their infancy, so there are not many studies, strategies, or working papers that discuss the policy framework. Nevertheless, there are a number of policy documents that address smart cities in Egypt, with various objectives and concepts, but all aimed at implementing smart cities policies. The related strategic documents are the followings:

(1) The Egypt Strategy 2030 (Ministry of Planning and Administrative Reform),

(2) The National Urban Development Plan 2052 (Ministry of Housing, Utilities and Urban Development),

(3) The National Science, Technology and Innovation Strategy 2030 (Ministry of Higher Education and Scientific Research), and

(4) The Regulatory Framework for Provision of Internet of Things Services (Ministry of Communications and Information Technology).

The **Egypt Strategy 2030**, a strategy document that was released in 2015, is based on review studies and sectoral strategies at the international and domestic levels. As such, this strategy is considered an integrated development framework in general and sustainable development specifically. The strategy is based on selected pillars that address the most important challenges and issues facing the Egyptian society (Ministry of Planning and Administrative Reform, 2014). In the Egypt Strategy 2030, urban intelligence is mentioned as an integral part of the establishment of new cities that aim to promote urban development. These cities' development depends on an intelligent use of urban infrastructure, transportation, and services, including the establishment of financial and business centers. According to the Egypt Strategy 2030, the NAC will be established in East Cairo, the New City of El Alamein, the city of Toshka, and the city of East Port Said. According to the national strategy, this project is designed to create a new economic and administrative center that contains financial and business centers, sustainable industries, and high-quality services. Therefore, smart cities were not defined as they were in the literature, but rather as new cities dependent on technology and infrastructure to grow (Ministry of Planning and Administrative Reform, 2014).

In the National Urban Development Plan 2052, smart cities are proposed as new urban centers based on environmental sustainability. In Egypt, the new city of El Alamein uses alternative and renewable energy sources, water desalination technology, a contemporary urban environment, and an environmentally friendly industrial area. It is important to note that the idea of a smart city in the new capital was not a part of the 2014 National Urban Development Plan, which was written in 2014, but was proposed in 2015/2016. Despite this, the new administrative capital emerged from the strategic plan of development for East Cairo to accommodate the growing population and economy (MHUC, 2014)

Under the National Strategy for Science, Technology, and Innovation 2030, smart cities are characterized by the implementation of technology infrastructure, improved performance of digital networks, and the promotion of connectivity through ICT. Utilizing big data, localizing universities of the fourth generation, and utilizing technology and innovation are all discussed as part of the Smart City Strategy (Ministry of Higher Education and Scientific Research Egypt, 2019).

Lastly, the Ministry of Communications and Information Technology introduced the **Regulatory Framework for IoT Service Provision** that includes the concept of smart cities from the Fourth Industrial Revolution. Based on the framework, cities should rely on ICT pillars like digital services and intelligent transportation with the help of technology and communication (NTRA, 2022). Egyptian policy documents concerning smart cities examine smart cities in many ways and with many aims. These objectives included promoting new urban development, utilizing information and communications technology, and establishing fourth-generation universities. Due to this, it is apparent that no national strategy for smart cities has been developed in Egypt that addresses the multidimensional idea and establishes the criteria and requirements for such an approach. Meanwhile, efforts are being made to develop a framework for smart cities called "Smart Cities Code" which would outline the fundamentals, requirements, management, operation, and sustainability of smart cities. The study is currently underway.

As far as implementation opinions based on the scientific literature are concerned, the systematic literature review (chapter 2) noted a lack of studies dealing with the concept of an Egyptian smart city (Janik et al., 2020; Mora et al., 2019; Tan & Taeihagh, 2020) , on the other hand, little information can be gleaned from the available studies.

According to Hamza (2016), the author discusses the barriers to smart city development in Egypt and the smart city strategy as a megaproject. The author concluded that smart cities are necessary in countries like Egypt to ensure sustainable development and take advantage of the technology, which will increase job opportunities and investment, as well as increase efficiency and reduce costs. Moreover, he reiterated that one of Egypt's main challenges in achieving its sustainable development goals involves the integration of smart cities into a strategic framework. Hamza developed a strategic proposal for smart cities in the Egyptian context in three parts: first, a structure for smart cities, then factors for smart cities, and finally, the strategy for smart cities. Hamza stressed the need for private investment and foreign investment in smart cities as a matter of structure. Based on these factors, the Egyptian government should focus on building a smart citizenry – an essential component of a smart city, as described earlier in the literature – by providing equal opportunities to all students in education and by eliminating poverty by meeting basic needs. Through the city assessments, city goals, city indicators, stakeholders, and strategic city planning, he explained the key elements of smart city strategies in an Egyptian context. Hamza (2016) argues that Egypt should adopt three strategies: develop existing cities; build smart cities; and integrate smart cities by integrating multiple cities.

In a second study by Hussein and Pollock (2019), the NAC is one of several mega-projects in Egypt aiming at sustainable development (Hussein & Pollock, 2019). Researchers looked at the concept of smart cities from the perspective of sustainable development approaches and specifically concentrated on the energy sector, so that the establishment of new fourth-generation cities enables the use of clean, renewable energies. In their discussion of the NAC – which is a pioneering model for smart cities – revealed that the model faces a number of challenges. First, given the lack of smart city experience within Egypt, implementing these technologies for the first time in the country presents numerous challenges. They recommend contracting an international company that specializes in smart cities to run, manage, and transfer knowledge of smart cities over a five-to-ten-year period within Egypt. There is also the issue of high infrastructure costs and how they should be financed.

During the literature review analysis, I found other studies that evaluated smart cities in the Egyptian context, but they focused mostly on communication and information aspects, which were not relevant to my research question. In the Egyptian context, an academic review shows that smart cities have not been clearly defined or are defined by sectoral dimensions of policy.

In summary, **the smart city concept in Egypt** aims to build new urban communities that incorporate sustainability, innovation, and knowledge for seamless integration with the proposed fourth generation of universities in those cities. Furthermore, the model will create a new intellectual and economic environment compatible with Egypt's current development paths. A smart city model in Egypt should consider infrastructure, services, smart transportation, and a sustainable, smart economy. The following section discusses the implementation of such a policy.

3.3.2 Components of The Smart City Concept

In Egypt, 14 new fourth-generation cities are planned, including the New Administrative Capital (NAC), New Al Galala City, New Alamein City, and New Mansoura City, as well as several others spread throughout the country, not just around Greater Cairo, as in Figure 16. These cities absorb the planned urban and economic activities of the governorates of Egypt. These cities are also designed to attract knowledge- and innovation-based economic activities, including urban solutions based on information technology. In order to achieve urban balance in Egypt, cities were spatially distributed across different governorates.

In the introduction to this chapter I mentioned that executive officials were interviewed as part of the narrative analysis in order to gather data and information about the smart city program. Interviews were centered around three key axes: (1) the concept of the proposed smart city policy, (2) the vision for smart city program, and (3) components of the model applied in the new administrative capital.

During *the first interview*, we talked about the following: what is the proposed smart city policy?; Where does the city model come from?; To what extent do smart cities represent the vision of decision-makers and stakeholders?

During the *second interview*, the following questions were asked: What are the main components of the Egyptian smart city model that is applied in the NAC? How does the The

Administrative Capital for Urban Development (ACUD)[3] company contribute to city administration?

Data and information gathered from interviews can be summarized as follows:

- Administrative and governmental procedures for formulating the model in Egypt.
- The policy tools proposed for smart cities.
- The proposed urban intelligence components for smart cities.
- Key pillars of the smart city model in Egypt.
- Land uses and activities proposed for the NAC.
- Administrative and service models that are used in the NAC.
- Objectives of the NAC model.

Furthermore, the following is a summary of the data set collected from strategies and working papers developed by government agencies:

- Suggestions for smart city locations.
- Innovation components within cities (fourth-generation universities, e-government, financial and business centers, and high-tech industries).
- Estimated populations, cities' size.
- Goals and visions for the proposed cities.

Based on the interviews with the two officials, the policy sought to enter the smart city / urban intelligence era with these new cities as the first step, then transfer the knowledge and apply the model for the existing cities in the second phase. On the basis of a presidential decree, the government formed a national committee to oversee the smart city proposal. The committee is composed of representatives from the ministries of Defense, Interior Affairs, Communications and Information Systems, Housing, Utilities and Urban Development, and Administrative Capital Company for Urban Development (Khalil & Mousa, 2021). The primary task was to formulate, mold, and compose an "Egyptian smart city model", taking into account the Egyptian context's spatial characteristics and challenges, while avoiding the mistakes of other smart city initiatives. Meanwhile, the NAC is the guide to make use of this policy. According to national strategic plans, these cities will concentrate on developing their capabilities: fourth-generation universities, smart infrastructure, research and development centers, and business hubs, as well as moving the governmental institutions from Cairo to the NAC to become the new governance and administration center. Under the current

[3] A company established in 2016, it is the owner and main developer of the new administrative capital. https://www.linkedin.com/company/administrative-capital-for-urban-development/

government in Egypt, smart city approaches are receiving strong political support, particularly in the NAC and the new city of Alamein, within the context of transferring all government ministries, the parliament, and national governmental institutions to the new government district in the NAC, which is currently undergoing transition and trial operations.

In order to create the 14 smart cities, decision-makers and stakeholders (including private sector companies, real estate developers, international and private universities) are using different configuration of components of urban intelligence (see Table 13). Within the proposed cities, **urban intelligence** 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).

Several features of the proposed smart city programs in Cairo, Alexandria, and Dakahlia demonstrate majority the urban intelligence components, whereas these features are absent from the rest of the proposed city models. The NAC's innovative features 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.

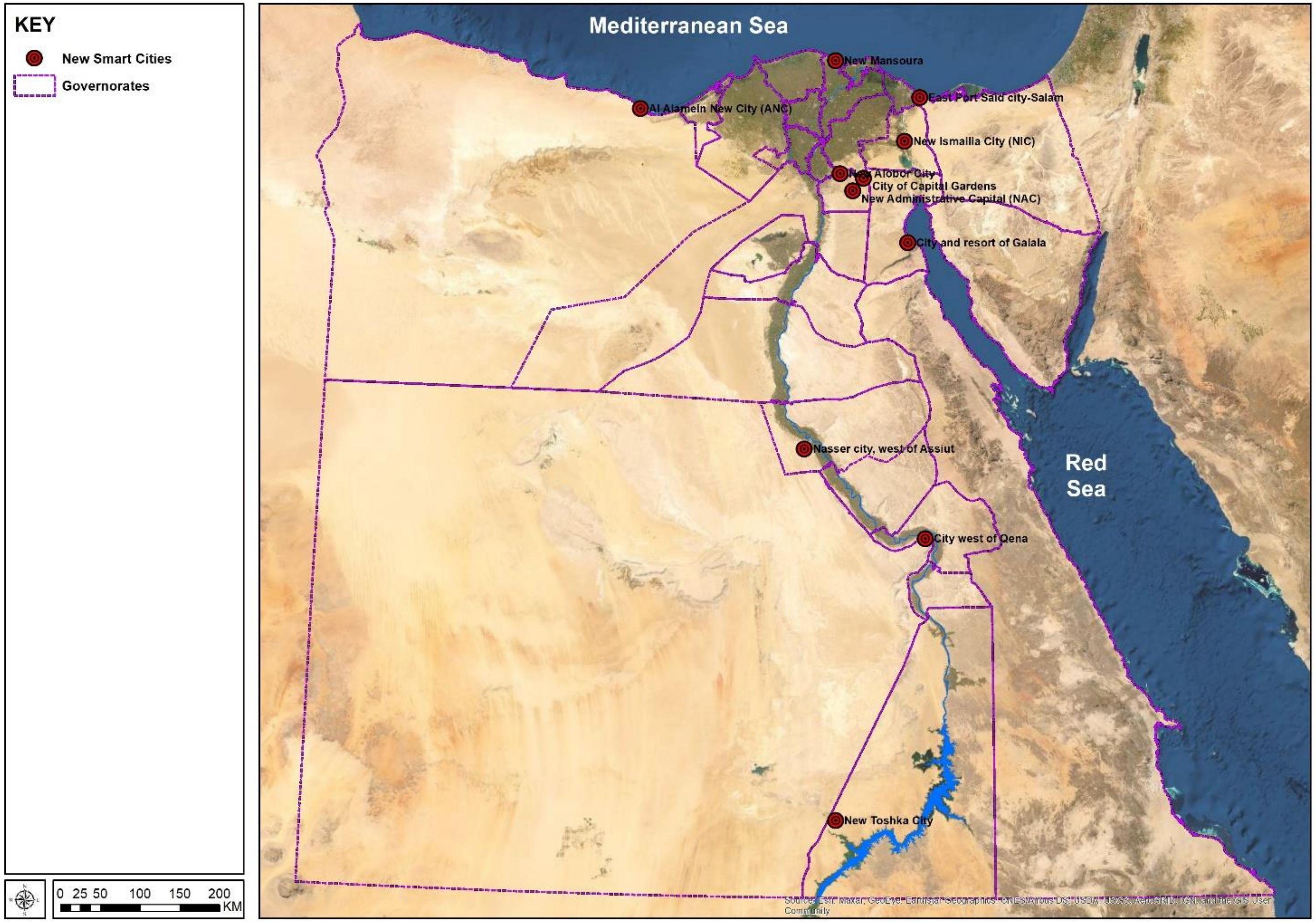
The NAC and El Alamein prefer localizing those components, including smart infrastructure, smart transportation, smart governance, smart services, smart competitive economy, smart environment, and smart people. In both the NAC and El Alamein, **smart infrastructure**, technologies, and technology supporting 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. Development of smart transportation systems for the Middle East and North Africa, such as the monorail network (for the first time in the region), rapid electric trains (to connect smart cities with major capitals), and large transportation stations, is also an element which can be found in the NAC.

The Egyptian government's move to the new government headquarters in the NAC is an example of **smart governance**, a move that is centered 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). These new financial and commercial centers rely on the concept of a "one-stop shop" for establishing companies and dealing with multinationals, which facilitates localization. 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 can be applied to the new administrative capital - 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 through the use of high technology, alternative and renewable energy sources, and re-exploitation of water (due to a limited supply of water in Egypt) as well as analyzing data usage to achieve sustainability in urban environments.

Hence, it becomes obvious that the proposals for smart cities or those currently under implementation, their infrastructure elements, their smart mobility, and their smart services constitute the common components of Egyptian smart city programs, with NAC standing out for its smart governance, its smart economics, and its environmentally sustainable initiatives. Therefore, the Egyptian government seeks to apply this model to other smart cities in the context of smart city policy in Egypt (see the interview report in Appendix 4). Therefore, in the next chapter, we present the NAC as a model for Egyptian smart cities since it is considered the pioneer model when it comes to implementation stages and data availability.

Figure 16 Egyptian smart cities locations



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

Table 13 Smartness and Innovation components for Egyptian new smart cities

Economic Region	Governorate	New Smart cities**	Innovation components			Intelligence 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	Centeral Business District	Smart Infrastructure – Mobility – Governance – Services– Economy – People – Environment	6.5	170	35
	Cairo	City of Capital Gardens				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	Centeral 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: own representation, based on Ministry of Housing, Utilities and Urban Development data for the master plans and strategic plans for the cities, which is available online at http://www.mhuc.gov.eg
** The number of proposed Smart cities in Egypt is 14 cities, but the table shows cities with online-available data

3.4 The New Administrative Capital (NAC) pioneer model

The construction of the New Administrative Capital (NAC) began in 2015 and is expected to usher in an era of smart cities and become the Middle East and North Africa's region's foremost political, cultural, and business platform (Abdeen, 2020). The NAC is located 35 kilometers east of Cairo on 170000 acres, which is the equivalent of Singapore (ACUD, 2017). Figure 17 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 i almost four times the size of Disneyland (Khalil & Mousa, 2021). The target population is about 6.5 million people (ACUD, 2020). 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. The new administrative capital was designed to enhance its innovation ecosystem by presenting and implementing a set of components. This model is composed of the following components:

- Establishing eight fourth-generation universities,
- City of knowledge,
- Central business district and entrepreneurs,
- Egypt Informatics University,
- Startup incubators,
- Science and Technology Parks.

Egyptian universities and regional innovation potential are being integrated into the NAC model using the smart city policy for fourth-generation cities (MoHUUC, 2020). According to Table 12, 40% of the 20 universities in the NAC belong to the fourth generation. They are working on building the city of knowledge on 200 acres, which will house international and emerging companies, Misr Informatics University, the Digital Creativity Center, as well as incubators for startups (ACUD, 2017). As a result of these knowledge potentials, the NAC might become the regional innovation regime not only for the Greater Cairo Region (GCR), but also on the national level. 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 to the NAC, there are various science and technology parks, which are regarded as innovation environments. The NAC is considered Egypt's national innovation center thanks to its smart governmental districts, universities, research centers, high-technology industries, and international companies. The current sub-chapter examines the model of the NAC from a number of perspectives, including its components, the administrative model, and the proposed service strategy. Data and information from interviews with executives are also used for this section. It is divided into two sections: the development components for the proposed NAC model and the proposed smart services model.

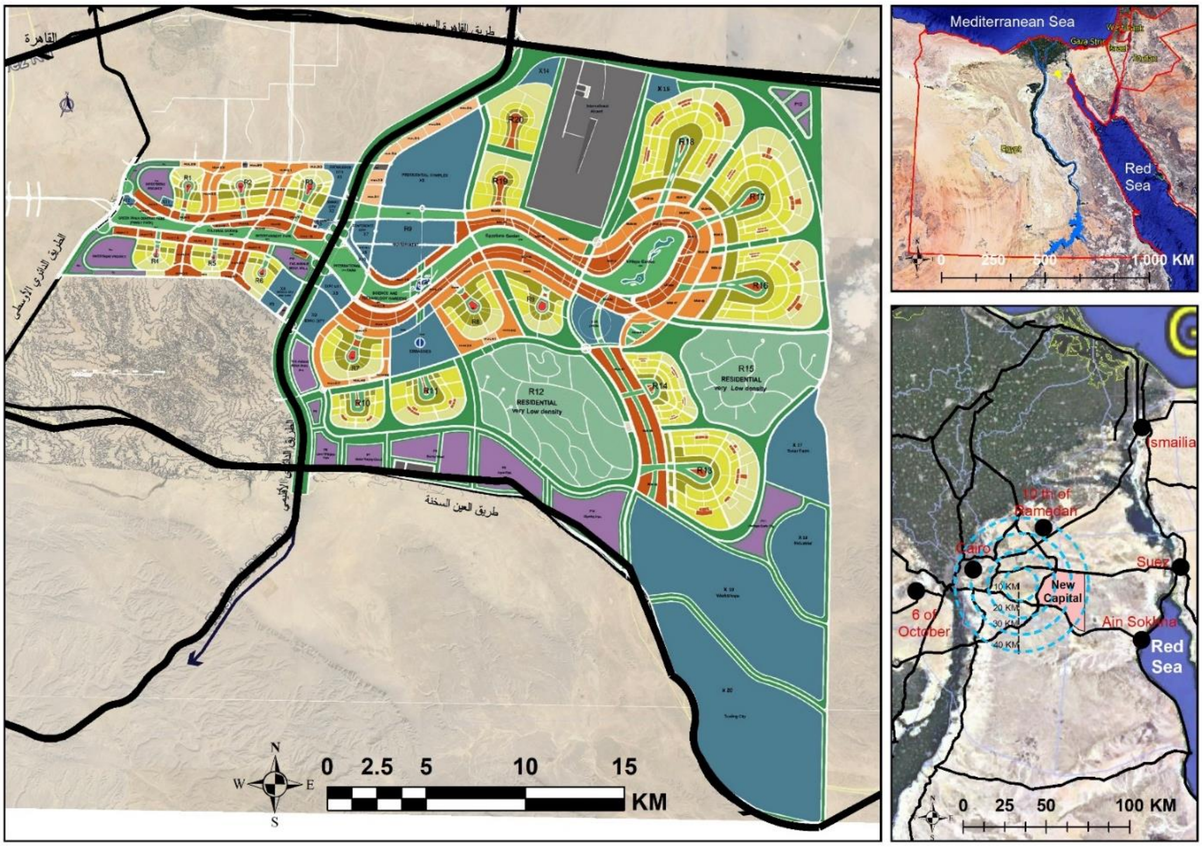
3.4.1 Development components and proposed model

The NAC is a megaproject intended to absorb urban and demographic pressures from the Greater Cairo region and establish a new development hub for future generations. 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. In the central business and financial district (CBD), which is being implemented by the China State Construction Engineering Corporation (CSCEC[4]), there are 18 towers, including administrative companies, entertainment facilities, resorts, and the tallest tower in Africa (Hussein & Pollock, 2019; Report, 2020). Figure 17 shows the different districts of the NAC, 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. **The Financial and business districts** serve as the economic and financial centers of the NAC due to their high investment volume, which was 3.4 billion dollars. Besides the Central Bank, it contains all local and international banks, multinational companies, and multinational companies' headquarters. Many of the world's most famous commercial centers and projects are located within the 195-acre financial and business district. 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

[4] 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/

infrastructure and facilities for those neighborhoods). Additionally, the NAC first phase includes a number of mega projects investments financed by government ministries. One of these projects is **Knowledge City**, which aims to increase NAC's competitiveness in higher education and scientific research. through the development of research and innovation in the fields of energy, health, environment, and communication technology. Besides establishing partnerships with the city's industrial and business sectors. About $1 billion was invested in the creation of the city of knowledge, which covers an area of 396 acres. **The Information City** is another mega project being implemented in the first phase on an area of 200 acres with a total investment of one billion dollars. With this city, 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).

Figure 17 The location and the Master Plan of the New Administrative Capital - Egypt.

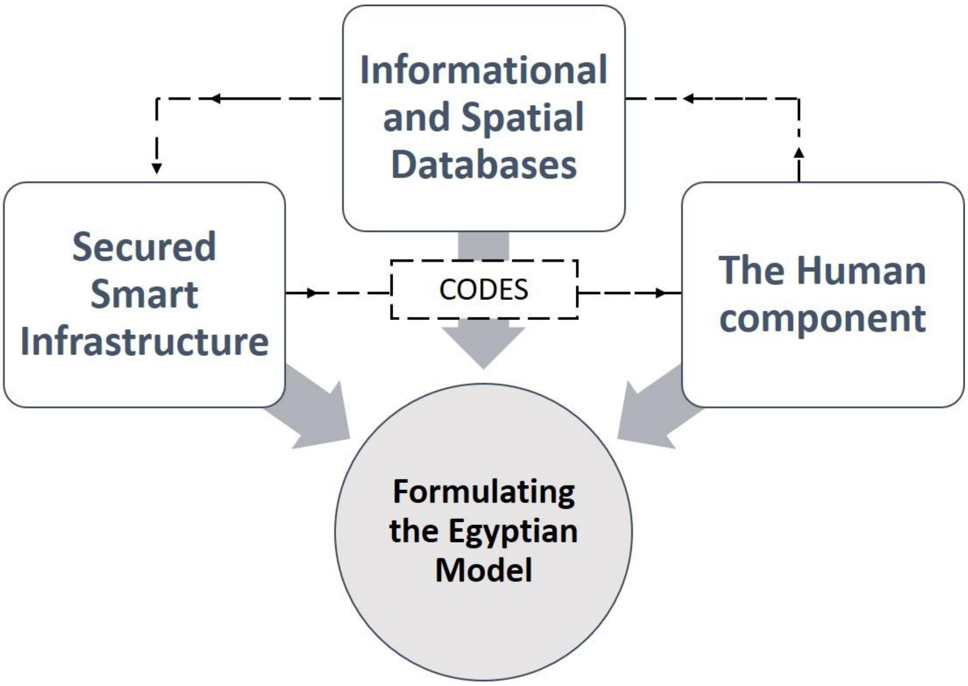


Source: Own representation, based on the data from Administrative Capital for Urban Development Company, using ArcGIS software to compile the map (Ali, 2021b).

IoT has been adopted by the NAC as part of the fourth generation of cities. In the first era of cities, steampower 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). As for the Egyptian case, most of cities are second-generation cities. The main challenge for the smart city policy of the NAC since 2015 was figuring out the best policy or strategy to make the NAC a sustainable smart city based on international standards.

Moreover, the literature mentioned that management and governance are considered to be one of the primary challenges to smart city development in developing countries. The city administration has been transferred to ACUD, a government-owned company owned directly by the Egyptian Sovereign Fund for Investments, to manage and develop the NAC. Along with other private developers, it is considered the main owner and developer within the NAC. 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, n.d.; Khalil & Mousa, 2021). The NAC's urban intelligence model consists of three main pillars, as shown in Figure 18. 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 and controlling the administration of 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. Secondly, the **spatial and informational databases** provide unified rules at the city level that include geographic data. In Figure 19, the Security Control Center and City Administration Center rely on these databases for their administration. Thirdly, administration and society depend on **human componet**. Through smart applications for city services, the model integrates the human factor in collecting data from citizens. Furthermore, smart and skilled people (human capital) 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). Development of the NAC was not funded by government funds, but by land sales by the ACUD copmany (Abdeen, 2020).

Figure 18 Pillars of the Egyptian smart city Model



Source: Own representation, based on the interview with the official of the technology and systems sector at the Administrative Capital for Urban Development Company, and one of the committee members responsible for the smart city model for The New Administrative Capital.

3.4.2 The Smart Services model

In order to build the new smart city, the State set technological solutions to provide sustainable services. A set of mechanisms was identified by the committee for implementing smart services within the NAC. According to Khalil (one of the interviewees), the NAC’s smart services strategy is distinguished by a set of characteristics, including: achieving a competitive advantage by classifying the NAC as a smart sustainable city; achieving optimal strategies to maintain the capital life cycle; high security for data and its processors to get the right decision at the right time; high efficiency in controlling and managing resources and facilities; intelligent distribution of assets, services, and energy sources; instant monitoring of networks, services, and utilities rate performance; and rationalizing expenses while achieving profitability in return for providing services characterized by quality and speed (ACUD, 2021). According to Table 14, the NAC's services aim at rationalizing expenses, maximizing profitability, and gaining a competitive advantage. The NAC model is noted for its adoption of ambitious smart services (such as smart building management and waste management) that seek to ensure a competitive advantage. The other services mentioned (IPTV, smart cards, smart parking, electronic communication with citizens, internet in public areas, and transportation management) are aimed at achieving profitability and a competitive edge. Another group of smart services seeks profitability and rationalization of expenses together, such as smart meters/Multi-use smart lighting columns. A final group of smart services aims to rationalize expenses such as smart Infrastructure Networks, asset Management, Building Management, and Waste Management. Smart services like these are capable of providing a sustainable city for the NAC. As mentioned in the literature, financing and appropriate budget issues are considered one of the main challenges for developing smart cities (Hamza, 2016). Therefore, the smart services model embraced diverse methods to face financing issues and achieve the sustainability concept pertaining to the city (ACUD, 2021).

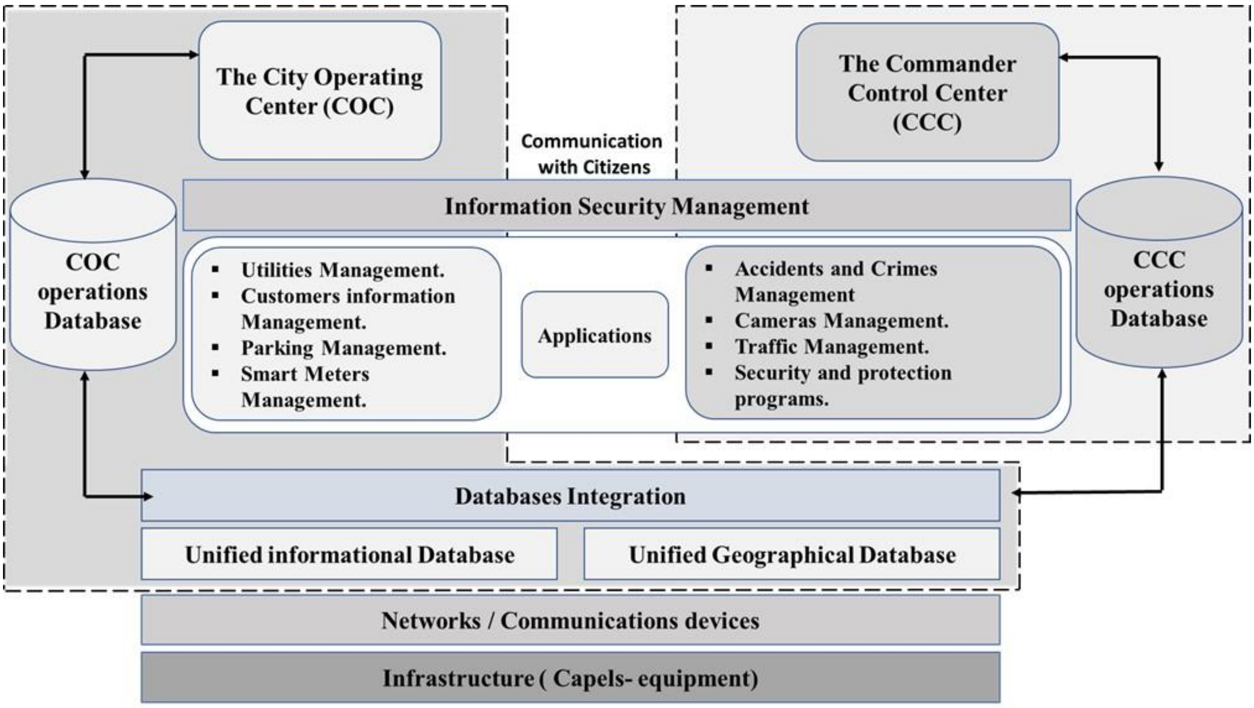
Accordingly, the NAC smart city model is based on an application model for smart services. In this model, technology, information-based decision-making, and process management are used to provide smart services. The model shown in Figure 19 is built on a high-tech infrastructure and networks integrated with the infrastructure. In addition to the database integration, the Commander Control Center (CCC) and the City Operation Center (COC) manage the smart services for the city through data analysis. A key difference between the NAC and other existing cities is that the ACUD Company functions as a mediator for the provision of services via applications that act as a communication tool for citizens, thus reducing administrative and bureaucratic obstacles.

Table 14 Aims of the Smart Services for NAC Model.

<table>
<tr><th>Competitive Advantage</th><th>Profitability</th><th>Rationalizing Expenses</th></tr>
<tr><td></td><td></td><td>Smart Infrastructure Networks</td></tr>
<tr><td></td><td colspan="2">Smart meters</td></tr>
<tr><td></td><td colspan="2">Smart lights columns</td></tr>
<tr><td></td><td>Internet and Communications</td><td>Asset Management</td></tr>
<tr><td>Building Management</td><td></td><td>Building Management</td></tr>
<tr><td>Waste Management</td><td></td><td>Waste Management</td></tr>
<tr><td></td><td>IPTV</td><td></td></tr>
<tr><td colspan="2">Smart cards</td><td></td></tr>
<tr><td colspan="2">Smart parking</td><td></td></tr>
<tr><td colspan="2">Electronic communication services with citizens</td><td></td></tr>
<tr><td colspan="2">Internet services (Wi-Fi) in public areas</td><td></td></tr>
<tr><td colspan="2">Transportation management</td><td></td></tr>
</table>

Source: the author, based on the data from the technology and systems sector at the Administrative Capital for Urban Development Company.

Figure 19 Smart Services application model for the New Administrative Capital.



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

3.5 Evaluation of the policy concept

The smart city policy in Egypt introduced a set of points through which the model can be evaluated. Depending on the data and information available, different perspectives can be taken on policy:

1. In order to activate the smart cities policy in the Egyptian context, the Egyptian state adopted an approach to the **new smart city strategy**, one of the spatial strategies of smart cities (Angelidou, 2014). In my view, this strategy is appropriate for Egypt, a country with challenges associated with urban agglomeration and regional imbalance. Through the establishment of new cities that rely on urban intelligence for planning, management, and development, it facilitates the implementation of fourth-generation cities. Therefore, the implementation of smart city policies, which incorporate information technology and innovation, it may be possible to build an ecosystem that facilitates knowledge and innovation. Moreover, the Egyptian state is planning to implement the policy in existing cities in the near future. According to the objectives of the strategy set forth in the introduction and third chapter, it is intended to achieve sustainable comprehensive economic development. New fourth-generation cities can implement regional development based on smart cities and innovation due to current urban development issues and limited resources. **According to the results of the interviews, Egypt will use the model of the NAC to apply to all other smart city programs**. However, the author is concerned about the possibility of using the same model without accounting for the spatial and geographical dimensions of the governorates. In the previous RIS evaluation, the same model could not be applied because innovation systems differ significantly between regions, and many are unprepared. Consequently, I conduct a further quantitative analysis to investigate this issue in the next chapter. Moreover, if other cities do not receive the same financial and political support, they may not achieve their policy objectives.
2. The NAC model suggests using technology and information systems to operate and manage the system. Furthermore, process management is used to manage and resolve issues on the network. On the other hand, the proposed smart city model for NAC based on three main pillars raises concerns for the researcher regarding the city's ability to integrate the human component (one of the three pillars) as well as provide a sufficient number of qualified professionals to operate the smart city, which will be evaluated later during the smart city's operation. As part of its efforts to address this issue through the human

component pillar, the Egyptian government trained 50,000 highly skilled government employees to work within the NAC.

3. Through the establishment of the ACUD Company, a multi-ownership non-governmental organization, NAC smart governance will serve as a model for other planned smart cities. By organizing, operating, and developing assets, achieving profitability, and ensuring sustainability, this entity is responsible for operating and managing the city. ACUD has, therefore, combined its role as a city manager to oversee a smart city that supports smart decisions and to plan, operate, form, and implement smart projects (Anthopoulos, 2017). However, if the smart governance model is applied to other smart cities, it must take into account the spatial characteristics and administrative components of the governorates. Capitals of governorates and other smart cities must be managed differently based on their unique characteristics.

4. This smart city model of NAC can achieve a variety of objectives, including rationalizing expenses, striving for sustainability, and achieving profitability in order to achieve sustainability, which is seen as an obstacle to smart city development in the developing world (Hamza, 2016). Moreover, it seeks to establish the capital as a competitive center in the MENA region and at a national level.

5. Furthermore, the NAC’s regional innovation components include fourth-generation universities, academic institutions, knowledge cities, science and technology parks, all of which are considered R&D centers. Therefore, the NAC’s innovative components are viewed as a catalyst for revitalizing the spatial sphere's innovation process. As a result, if the operating procedure does not include a clear innovation policy, some failures will occur after the first phase.

In summary, according to policy narrative and case study analyses for the Egyptian smart city policy, the NAC model represents a pioneering approach for smart city policy in Egypt, and the state has ambitious plans to implement the policy in many other cities throughout Egypt. Smart cities are innovated through research, development, innovation, information technology, and the Internet of Things. Regional factors of innovation, as mentioned previously, are unevenly distributed in the Egyptian governorates. Therefore, a number of questions arise: (1) to what extent are all proposed projects in the different Egyptian regions and governorates likely to meet their goals through the components and factors of innovation?, (2) which are the governorates that are ready to implement smart cities policies?, (3) what are the factors that most influence the innovation system in Egypt?, and do there exist spatial connections among these governorates that affect the implementation of smart city policies? In this light, an empirical analysis is needed to identify the factors contributing most to the innovation and knowledge system and the ability of Egyptian governorates to adopt innovation policies and smart cities based on innovations, technology, and knowledge. In the following chapter, we will analyze empirically the innovation factors in Egyptian governorates and the readiness degree of the governorates to determine whether innovation and smart cities are feasible within the Egyptian context as an innovation policy in line with Egypt's 2030 strategy.

4. EMPIRICAL ANALYSIS OF REGIONAL INNOVATION FACTORS

Innovation is the engine of smart cities, as has been discussed in previous chapters. Nevertheless, innovation depends on a variety of factors and components within a local context. Regarding the Egyptian context, noted that the Egypt Strategy 2030 and the Egyptian National Urban Development Plan 2052 are targeted at creating and developing fourth-generation cities based on urban intelligence. Governorates in Egypt have ambitious plans to implement a smart city approach. According to the narrative analysis of the regional innovation policies within Egypt's governorates in Chapter 3, differences exist among the constituent components (4^{th} generation universities, government, and industry/central business districts), as well as differences among smart city programs based on the components of the innovation system and urban intelligence. Based on the findings of chapter 3, the case study, and interviews, **Egypt can implement smart city concept in part based on the performance of RIS**, therefore I selected methods that examined RIS in governorates.

Accordingly, in the current chapter, I will **examine the governorates that are spatially autocorrelated to the knowledge production outputs**. A smart city's success depends on these outputs which enable innovation and development. Taking advantage of the knowledge and innovation factors generated locally within the region is essential for successful smart city programs, as suggested in the theoretical framework and case studies of developing countries. According to Caragliu and Del Bo (2020), smart city policies in regions are associated with urban economic growth. Thus, through local knowledge outputs, urban intelligence can be developed through the application of information technology and innovation in smart cities. In addition, the study examines which factors are associated to regional knowledge outputs within the Egyptian governorates, as well as whether all governorates are autocorrelated with innovation outputs in order to implement the smart cities policy. The analysis helps us determine which regions and governorates are best prepared to embrace innovation policy, like smart cities. Thus, policy recommendations can be tailored to highlight the strengths and weaknesses of the policy system to help guide policymakers and stakeholders in implementing smart city policies that will enhance regional development.

Using empirical analysis, this chapter explores **regional innovation outputs in Egypt's governorates and determines what are the most relevant innovation factors**. In particular, this chapter attempts to answer the following questions:

RQ 4: *Which Egyptian governorates have the conditions to adopt the political concept of the smart city?*

RQ 5: *Which Egyptian governorates's RIS is the readiest for the implementation of the SC concept*?

In order to address these questions, this chapter is organized as follows: introducing the empirical methodology, presenting the concept of analyzing Exploratory Spatial Data Analysis (ESDA) through Local Indicators of Spatial Association (LISA) and introducing the Knowledge Production Function (KPF) approach. In the second section, I describe the model and variables that were used to build it, and also the data that were used. In the third part, I summarize the empirical analysis of the factors promoting innovation and knowledge production in Egyptian governorates. In order to develop the results, there are two parts: (1) the spatial autocorrelation of innovation and knowledge in Egyptian governorates, which identifies the spatial correlations of innovation and knowledge factors; (2) regional innovation modeling to identify factors most associated to knowledge and innovation outputs in Egyptian governorates. The final sub-chapter concludes with an analysis of the regional readiness of Egyptian governorates in implementing smart city policies and innovation utilizing the findings of the narrative analysis and case study presented in the third chapter as well as the findings of the empirical analysis presented in the fourth chapter.

4.1 The empirical methodology

In order to analyze the shape of the regional innovation system within the Egyptian governorates, I apply a two-pronged methodology: (1) Exploratory Spatial Data Analysis (ESDA) and (2) the Regional Knowledge Production Function Approach (RKPF). On the basis of their goals, tools, and results, Figure 20 summarizes the two empirical approaches.

Data are in general explored by researchers before being used for a variety of reasons. Researchers can explore trends, pinpoint data characteristics, or develop and test hypotheses. In a traditional exploratory data analysis, variables are simply analyzed in terms of how they influence one another. In the meantime, Exploratory Spatial Data Analysis (ESDA) examines the values of a variable in the neighboring areas to tie variables to locations. This method is known as *spatial autocorrelation*, which is defined *as the positive or negative* *correlation of a variable with itself due to the spatial location of the observations* (Bouayad & de Bellefon, 2018). Spatial autocorrelation describes systematic patterns in spatial distribution. The autocorrelation typically appears in the form of positive and/or negative spatial autocorrelation, or there is no spatial autocorrelation among variables in the spatial distribution. The two main methods of ESDA are:

(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. Thus, the local spatial autocorrelations within local clusters can also be run as the second type of analysis.

(2) *Local Spatial Autocorrelation Analysis* helps the researcher to study the spatial association between independent and dependent variables. The spatial autocorrelation values of Moran's I are positive or negative (Huallachain & Leslie, 2007). In addition, significant local spatial association leads to a study of geographical patterns associated with RIS among Egyptian governorates (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 association of subregions within a given geographical area. In addition to identifying local clusters, they can also identify spatial outliers (Anselin, 1995). These statistics are particularly useful when trying to identify spatial clusters. There are clusters of spatial autocorrelation values that indicate clusters of autocorrelation values that are high or low. Graphs in GeoDa (discussed later in sub-chapter 4.3) illustrate the differences between ++, –+, +–, and – – 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). In this chapter, I examine the association among patents, as knowledge outputs, in 2018 in Egyptian governorates and innovation factors as lagged independent variables. The analysis is cross-sectional since data for earlier periods are not regularly available (Ali, 2021a).

By combining the statistical data with the Egyptian map, the analysis focuses on the spatial autocorrelation in innovation output across the number of patents in the spatial units. This ESDA utilizes 'first-order queen' contiguity. There are 27 cases in the database that refer to the Egyptian governorates.

ESDA analyzes the spatial autocorrelation in spatial units using 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. Additionally, the contiguity weight matrix has been run. 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 analyze 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. These are crucial when specifying spatial variables in a model, such as spatially lagged dependent variables and spatially lagged explanatory variables for the spatial lag and spatial error models. A cross-sectional analysis of spatial dependence also requires *spatial weights*. It enables the creation of spatially explicit variables, such as spatially lagged variables and spatially smoothed rates, which are essential for constructing spatial autocorrelation statistics (Anselin & Rey, 2014). There are two types of spatial weights: contiguity and distance.

It is analogous to the moves that the pieces can make in a chessboard that we can distinguish between a queen and a rook criterion of contiguity. Rook's criterion affirms that two spatial units can be neighbors if they share a common edge. According to the Queen criterion, neighbor refers to a unit that shares a common vertex or an edge with another unit. Thus, the queen criterion's number of neighbors will always be at least as large as the rook criterion's number of neighbors (Anselin & Rey, 2014). Spatial distance weights consist of inverse distance weighting and K-nearest neighbor weights. In the first case, a distributed set of points in space is used to incorporate multivariate features. The weighted average of the values at the known points is used to calculate the selected unknown values. The second type of distance weight is the K-nearest neighbor weight, which is useful for avoiding the problem of isolation. Selecting the K-nearest neighbors will prevent the problem of isolation. In accordance with Egyptian governorates' characteristics, the concept of 'first-order queen' contiguity has been employed. There have been 27 observations. There has been a substantial variation in the number of neighbors between the minimum recorded (2 neighbors), and the maximum (10 neighbors). The variance can be attributed to the different geographical conditions found in Egypt: on the periphery, in the coastal regions, and in the core.

For the second prong of empirical methodology, OLS regression was used to model the Regional Knowledge Production Function (RKPF) and determine the associations between patents and and regional innovation factors of the Egyptian governorates. According to Ács et al. (2002), I decided whether variables were dependent or independent.

In the last three decades, regional innovation analysis has been more popular. In the late 1990s, the regional knowledge production function (RKPF) became the focus of empirical research in this stream (Varga & Horváth, 2015). Researchers have presented four different empirical techniques in the literature for assessing the localized nature of knowledge flows. First, Jaffe (1989) identified evidence of localized knowledge spillovers by studying academic research's impact on the industry. This was done using the *regional knowledge production function* (Jaffe, 1989). Secondly, Glaeser et al. (1992) developed *a city-level growth equation* that measures the extent of spillovers of knowledge between firms of similar industries and those of different industries. The study sought to determine which of the two variables has a greater impact on metropolitan growth (Glaeser et al., 1992). In a third research study, Jaffe et al. (1993) developed *a methodology using patent citation data* to examine whether knowledge spillovers are indeed localized or should equally be tracked over large geographical distances to identify knowledge flow trails explicitly (Jaffe et al., 1993). Lastly, Cooke (1992) developed *a survey-based research methodology* of data collection that could be used to study the way knowledge flowed in a regional innovation system that developed in the second half of the 1990s (Cooke, 1992).

Based on the spread of application of RKPF in comparison to those of the other three approaches, Varga and Horváth (2015) believe it is the most widely used method when it comes to the analysis of regional innovation. RKPF has gained widespread use for a number of reasons, one of which is its straightforward approach to *relating outputs to inputs*. It is also relatively easy to handle data at *various spatial scales* due to this benefit. Flexibility is another factor that makes it so popular. In addition to incorporating the analytical techniques used in the three alternatives, it has *successfully responded to critiques* over time (Varga & Horváth, 2015).

Varga and Horváth (2015) refer to the KPF components as a functional relationship between the inputs and outputs of knowledge production, which affects economic growth. In addition to measuring spatial extent and influence, RKPF is also concerned with measuring knowledge flows. The RKPF methodology has been applied to a variety of purposes. According to Jaffe (1989), the *basic structure of the regional knowledge production function* (RKPF) methodology evolved as a result of three major waves of research beginning in 1989 (Jaffe, 1989). In addition to the research inputs covered by Jaffe (1989), Feldman (1994) and Feldman & Florida (1994) contributed to a subsequent wave that included *regional sources of innovation* as well (Feldman, 1994; Feldman & Florida, 1994). Late 1990s researchers, such as Anselin et al. (1997) and Varga (1998), who used a *finer dataset and spatial econometrics methodologies*, were able to quantify *the geographical extent of knowledge flows* more precisely (Anselin et al., 1997; Varga, 1998).

A turning point in the history of the RKPF was reached at the beginning of the new millennium based on research contributions. Approximately 250 studies using RKPF approach (including refereed articles and working papers) were published until 2015 (Varga & Horváth, 2015). According to Varga and Horváth (2015), researchers focused on the following aspects in the RKPF studies: spatial extent; exploratory factors (*regional factors in innovation*); *university* and *public research*; *small firms*' *role in innovation*; *specific industries and technologies*, methodology; *intra-regional knowledge flow mechanisms*; and *extra-regional knowledge flow mechanisms*, and *policy implications.* The method of regional knowledge production was also extensively used in recent research. Using the keywords "knowledge production function", "regional" and "regression", I searched Google Scholar on February 26, 2022. According to Google Scholar, the time period for the search (2016-2022) covered works done after Varga and Horváth (2015). According to Google Scholar search, researchers used the knowledge production function approach in a variety of ways. In some Google Scholar results, the RKPF method was mentioned only when referring to another method. The other papers were indirectly related to the function of knowledge production as well. However, the results suggested that regional knowledge production methodologies can still be used to analyze regional innovation, where most of the research papers the keywords related to the purpose of the RKPF.

Analysis of papers grouped by relevance shows that some focus on creating regional knowledge across US metropolitan counties through interregional knowledge (Kekezi et al., 2021). According to a study published in 2019, Russian regions have been reevaluated for their knowledge production function (Perret, 2019). According to Bernard (2019), the knowledge production function consists of heterogeneous coefficients (Autant-Bernard & Lesage, 2018). Finally, Ali (2021) modeled regional innovation at the regional level in Egypt using the regional knowledge production function approach. According to its prevalence in the literature, RKPF is relevant and appropriate to answer this research question because it is flexible, can be applied at different spatial levels, and is robust. This sub-question explores *whether smart city policies and innovation can assist regional development in Egypt, and what factors encourage knowledge production there*.

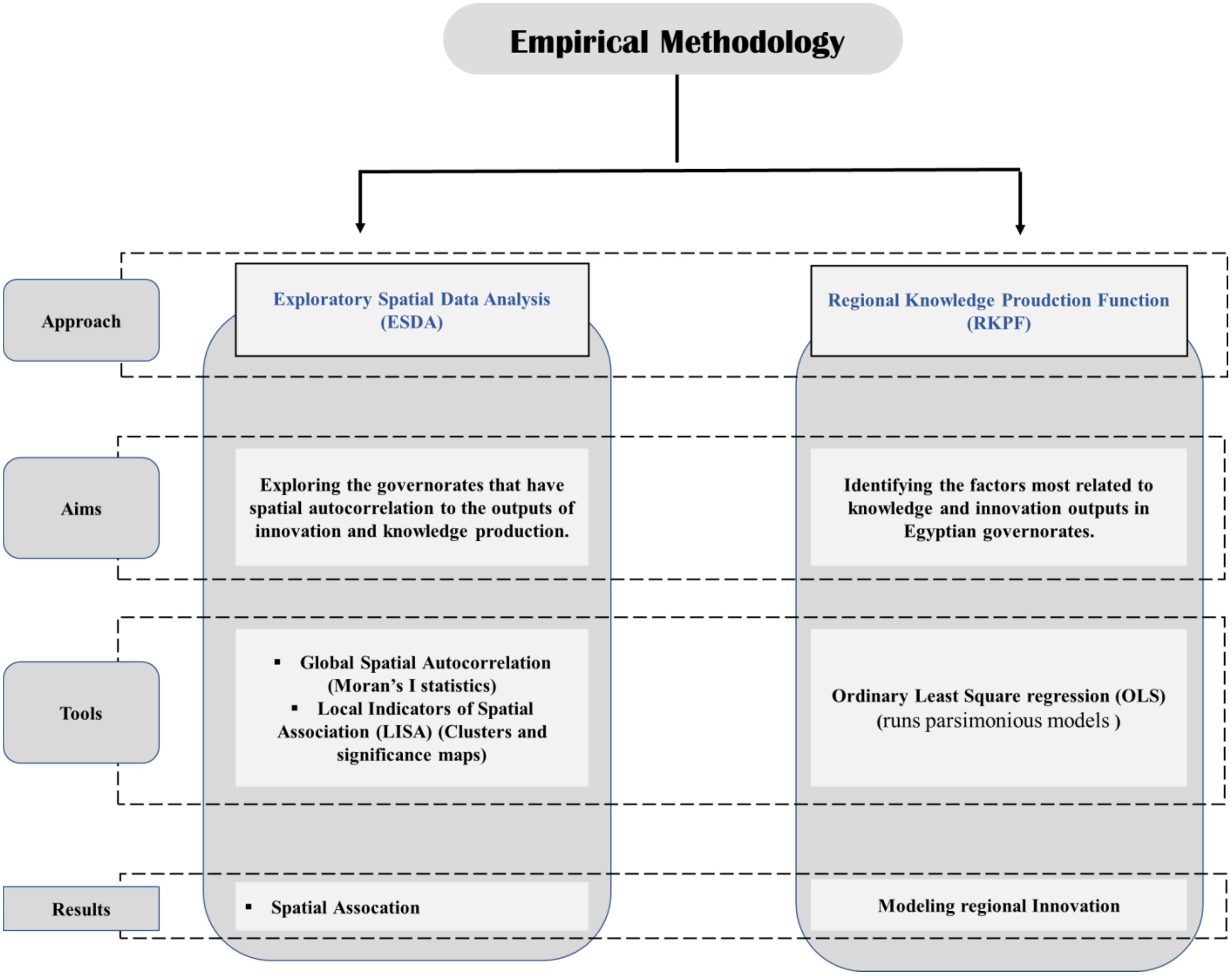
Regional innovation systems function when multiple factors and actors are integrated, such as the education system, research institutions, and knowledge spillover, that differ from one region to another (Kaufmann & Tödtling, 2000b; Varga & Schalk, 2004a). There are certain factors that give some regions an edge over others. Accordingly, researchers have noted that *learning*, *finance*, and *production* institutions influence RIS's ability to innovate (Cooke & Uranga, 1997). It is also important to note the role of *institutions* in a regional innovation system (Aidis, 2017; Brown, 2016; Muller & Zenker, 2001). Thus, the regional innovation system was transformed into a production process that included inputs and outputs. Innovation can be measured in three main ways: (1) by measuring inputs, such as research and development expenditures; (2) by measuring an intermediate output, such as patents granted; and (3) by measuring the innovative output directly (Ács et al., 2002). To capture economic knowledge output, patents data has used an intermediate measure for economic activities.

Consequently, the spatial proximity of actors in innovation systems could promote knowledge flow among them (Ács et al., 2002; B. T. Asheim & Gertler, 2009; Juhász & Lengyel, 2018; B. Lengyel et al., 2015). As a result, researchers studied knowledge flows within regional innovation systems while combining the innovation system context and the regional dimension. Patents provide a reliable measure of innovation, a view that Acs et al. (2002) offer as a basis for their methodological approach. According to their research, patent counts are an effective method to measure capability, technological change, and innovation in the regional context. They also mentioned that there is some confirmation that patents support a fairly decent amount of innovation at the industry level through regional activity. Furthermore, as mentioned by Varga and Horváth (2015), proxies of *innovation activity* *outputs* can be measured through *R&D expenditures, scientific publications, patent applications, products or processes for innovations,* and *total factor productivity*, as well as *regional technological startups, technological efficiency, regional knowledge spillover* (outward knowledge stock), *innovative output* in a region, and the *startup rate of either high-tech or technology firms* (Varga & Horváth, 2015). The regional knowledge production function (KPF) analysis was constructed based on the thorough examination of the innovation literature and the use of *patent data* provided by the Egyptian Patent Office (EPO) to estimate innovation outputs of the 27 governorates of Egypt.

There are several major inputs to the basic RKPF model pertaining to the *innovation inputs*. In a variable titled Research and Development in *the Business Sector* (BRD), the private sector is measured in terms of its ability to contribute to research and development. Academics are assessed on how they contribute to the research and development process via the *university research and development variable* (URD). Model input variables include the *agglomeration of industrial activities* (relevant industries and business service sectors) within the studied area (Varga & Horváth, 2015). Varga and Horváth (2015) mention a group of studies that use the research and development variables together in one research variable (RD).

To summarize, KPF components are used as a functional connection between inputs and outputs of a knowledge production process. Studies show patents can be used to measure innovation outputs as proxies. Knowledge outputs are also derived from innovation inputs, which include commercial and academic research and development, as well as industrial activities associated with research and development. As a result of this robust method, *I am able to identify which inputs directly contribute to knowledge production and innovation in the Egyptian governorates*, which is the purpose of this chapter. Second, by examining spatial autocorrelations between innovation inputs and outputs across Egyptian governorates, I can identify the second aspect of the methodology: exploratory spatial data analysis. By doing so, *I am able to determine which the governorates of Egypt can benefit from smart city and innovation policies*.

Figure 20 Empirical Methodology



Source: Own construction.

4.2 The model and data

4.2.1 The model

Due to the crucial role that regional context plays in development, it has been argued that regional innovation policies should be mostly location-specific in the literature discussing Regional Innovation Systems (RIS). Regional considerations should be made when it comes to innovation, according to these studies. Several factors play an important role in innovation, including endogenous factors (Uyarra, 2007; Varga, 2017; Varga & Schalk, 2004b). There are a number of factors that make up the innovation system, including economic, institutional, social, and organizational ones (Muller & Zenker, 2001; Navarro et al., 2009). As such, Ács et al. (2002) suggest that the knowledge production function (KPF) illustrates the relationship between inputs and outputs within the knowledge production process. Therefore, the KPF is used to determine region performance (Ács et al., 2002). Empirical studies have been conducted on regional innovation across the US and Europe using this approach (Varga & Horváth, 2015). It was pointed out by Varga and Horváth (2015) that the Regional Knowledge Production Function (RKPF) is flexible and can be applied at different spatial scales. Using the RKPF model, which has been used by Ács et al. (2002), I apply it for the first time to the Egyptian regional level, with some minor modifications to make it more appropriate for measuring innovation outputs there. To account for limited data availability, few variables, and small sample size in the Egyptian case, the current analysis uses a *parsimonious model* (Daganzo et al., 2012; Neath & Cavanaugh, 2012):

$$ln(\widehat{K}) = \beta_0 + \beta_1 \cdot ln(R) \quad (1)$$

$$ln(\widehat{K}) = \beta_0 + \beta_1 \cdot ln(U) \quad (2)$$

$$ln(\widehat{K}) = \beta_0 + \beta_1 \cdot ln(R) + \beta_1 \cdot ln(U) \quad (3)$$

$$ln(\widehat{K}) = \beta_0 + \beta_1 \cdot ln(R) + \beta_1 \cdot ln(LQ) \quad (4)$$

$$ln(\widehat{K}) = \beta_0 + \beta_1 \cdot ln(R) + \beta_1 \cdot ln(B) \quad (5)$$

(K) is a proxy for innovation output (patents). (*R*) is a proxy for research and development in the private sector. (*U)* is a proxy for research and development for the academic sector. (*B*) is a proxy for business services activities. Lastly, (*LQ*) is a proxy for the concentration of high technology industries. The value of coefficients that is significant

and positive indicates the positive influence of regional knowledge sources on the Egyptian governorates. Two model selection tools are calculated in the analysis: (1) Schwarz's Bayesian Information Criterion (BIC) and (2) Akaike Information Criterion (AIC). Simpler models are preferred by BIC over AIC, where a lower BIC score indicates the best model (Akaike, 1973; Bishop, 1995; Cover & Thomas, 1991; Neath & Cavanaugh, 2012; Ripley, 1996; SCHWARZ, 1978). The formula of BIC is given as:

$$BIC = -2 * \text{loglikelihood} + \text{d} * \log(\text{N}).$$

, whereas the formula for AIC is:

$$AIC = -2 * \text{loglikelihood} + 2 * \text{d}.$$

N represents the sample size of the data set, while d represents the total number of parameters in the model. The model with a lower BIC score is the best.

There are two knowledge sources included in Table 15, which presents descriptive statistics. We measure both academic research expenditures (GERD) and private research and development expenditures (RDIND). Academic research accounts for 96% of all research and development activities according to Egyptian Science and Technology Indicators (ESTIO, 2019). The private sector, on the other hand, accounts for about 3.8% of total R&D. Accordingly, R&D activities are not equally contributed by these two sources (ESTIO, 2019, p. 53). There may be different associations between these two sources of knowledge and patent numbers in the regression model. Furthermore, a location quotient for high technology employment (LQ) and business services activities (BUS) measures how local economic characteristics impact innovation.

The number of patents is positively correlated with all variables according to correlation statistics. There is a strong correlation between patent counts and academic research activities, business services activities, and private research activities. The concentration of high-tech industries is weakly correlated with patent counts. Table 15 indicates that private research activities are of concern based on the variance inflation factor (VIF).

4.2.2 The data

Various Egyptian sources were used to compile the data for the empirical analysis in this chapter, including cross-sectional data. Because time-series data were not available at the governorate level and census data had been available for many years (Egypt conducts a comprehensive census every 10 years, the most recent in 2017), cross-sectional data were used to build the model. In this dissertation, I analyze data on *patents* (innovation output) for 2018, which is based on data from the Egyptian Patent Office, which categorizes applicants into individuals, companies, research centers, and universities. The innovation input variables were constructed using official census data for the 2017 census (gross expenditure on R&D, private sector employment in R&D, high tech employment, and business services activities).

According to the Egyptian Science and Technology Indicators Report (2018), patent applications by companies scored 54%, followed by those by individuals at 36%, and those by research centers at 10%. It is divided into patent applications and patent grants according to the definition of patent applications provided by the Egyptian Patent Office (EPO), which states that a patent application is "a request pending at a patent office until the patent for the invention described is granted" (ESTIO, 2019, p. vii). Consequently, not all patent applications are approved by the Egyptian Office, where accuracy and reliability are thoroughly reviewed.

In 2018, the EPO received 2321 patent applications, of which 787 were granted, or 34 percent. Previously, empirical literature has used patent applications or patents granted as proxies for innovation. Studies have indicated that it is an accurate measure of innovation performance (Ács et al., 2002; Choi, Lee, & Williams, 2011; Hong & Su, 2013; Jaffe et al., 1993; Wang & Lin, 2013). New knowledge facilitates innovation, leading to economic growth and regional development (Ács et al., 2002). Patent applications were used as a proxy in the current study for more accurate statistical analysis. While some studies suggest patent data are less reliable, there is no other way to measure innovation outputs in Egypt. Despite its limitations, the indicator is widely used in the research literature and accepted as well. Egyptian Science and Technology Indicators 2019 based on 2017[5] data provide data about

[5] It is measured annually by The Egyptian Science, Technology and Innovation Observatory (ESTIO) at the Academy of Scientific Research and Technology (ASRT). Also, the data for high technology industries have been built from the official Census 2017 by the Central Agency for Public Mobilization and Statistics (CAMPUS).

research and development for academic sector employment. There are four levels[6] of regional spatial structure in Egypt. The Regional Knowledge Production Function (RKPF) was modeled by running OLS regressions with parsimonious models on 27 cases. Consequently, we are interested in the properties that interact among the actors of an innovation system, such as high-tech manufacturing and business services.

The dataset consists of *one dependent variable*, which serves as a proxy for innovation, and *four independent variables*. The dependent variable for governorates is the number of patent applications from the Egyptian Patent Office in 2018. In Figure 21, the patents are broken down by governorate, illustrating how patents are distributed geographically. According to this spatial distribution of patent applications, urban areas and lower Egypt governorates have the highest concentration of patent applications. According to the *independent variables*, based on Ács et al. (2002), the current study chose two variables of knowledge flows inside governorates for the dataset, reflecting the research and development aspect of the innovation system. Research and Development spending in the academic sector was measured by *Gross Expenditures on Research and Development (GERD)*. It includes expenses such as labor costs, which are further broken down into annual wages and salaries and all associated costs of researchers, technicians, and support staff. The cost of materials, supplies, and R&D are included in addition to capital expenditures, which include expenditures on land and buildings, instruments and equipment, and computer software.

Second, we looked at *professional employment* in R&D in the *private sector*, which includes both R&D activities in the private sector and specialized technical and scientific activities. In order to determine which factors are more closely associated with innovation output, whether they come from academia or industry, two R&D sectors and different factors were selected.

[6] The first level is the country level (national level). The second level is economic regions, their number is seven. The third level is the governorates level, which counted 27 governorates. The lowest regional Egyptian level is Administrative City Regions (ACR) which scored around 185.

Table 15 Descriptive and correlations statistics

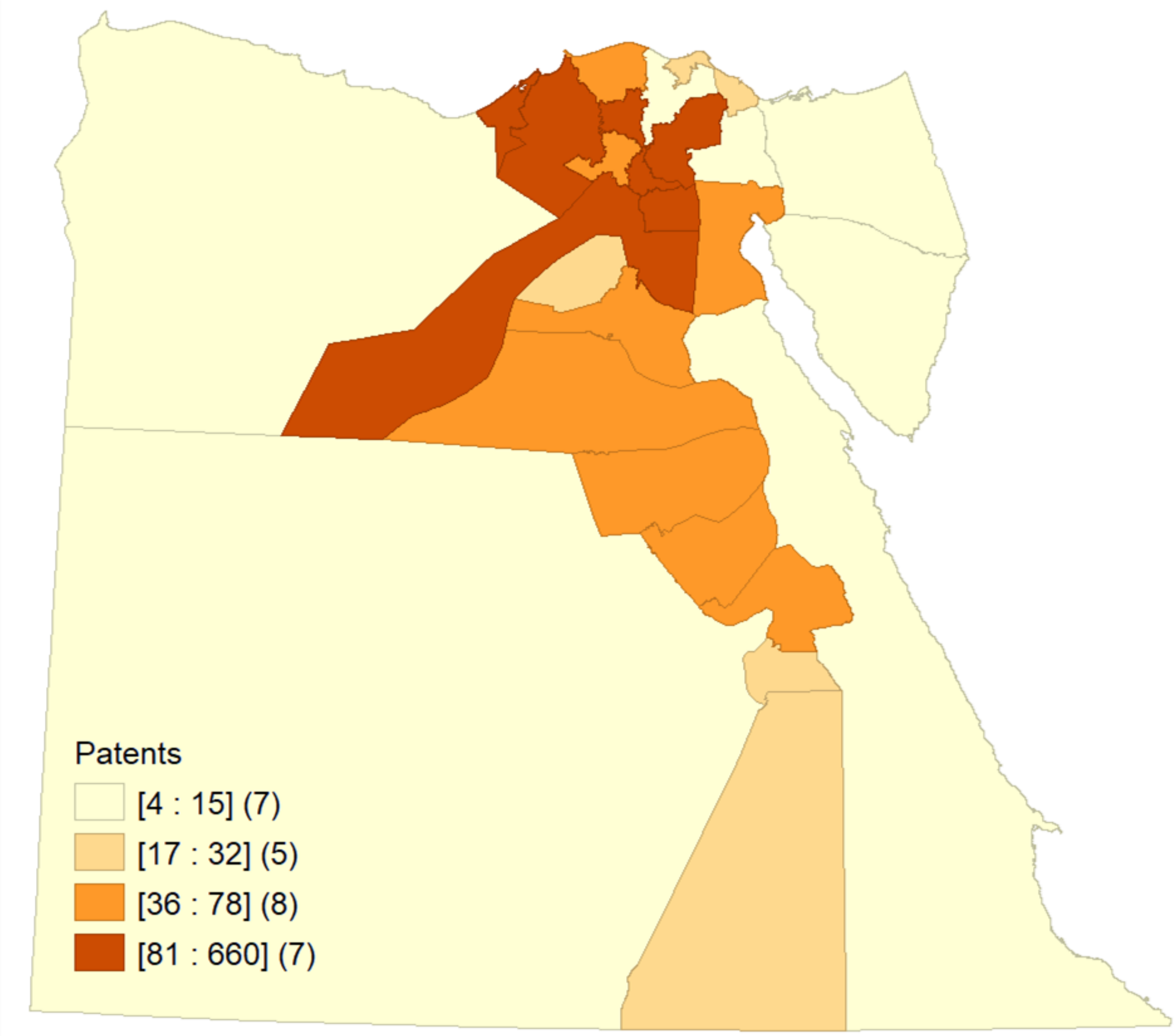
	Min.	*Max.*	*Mean*	*S.D*	PAT	GERD	RDIND	LQ	BUS	VIF
PAT	4	660	85.96	148.77	1					
GERD	41.44	10,600	843.5	2,274.7	.970**	1				3.565
RDIND	2	9,009	953.59	2,264.5	.629**	.593**	1			6.353
LQ	0.007	3.794	0.507	0.8177	.414*	.406*	.892**	1		3.538
BUS	11	34175	5,314.6	7,232.2	.874**	.805**	.700**	.415*	1	3.107

Notes: PAT is counts of patent applications inside governorates; GERD is academic research expenditure in Millions of Egyptian pounds L.E.; RDIND is professional employment for research and development in the private sector; LQ is location quotient for high technology employment for every governorate. BUS is the employment of business services activities

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level.

Figure 21 Spatial distribution of patent counts for the Egyptian governorates, 2018



Source: the author, derived using GeoDa software version 1.2

High technology manufacturing is also a component of the regional innovation system. According to Anselin et al. (1997), high technology industries rely on innovation research and development for their survival. This definition of high technology employment includes employment in the chemicals, industrial machinery, and electronics industries (Ács et al., 2002). The localization of innovation activities within the governorates is therefore indicated by two variables. One of them is the concentration of *high-tech employment* within the governorates. Among the high-tech industries are electronics and optical products, electronics components and boards, communication equipment, irradiation, testing, electromedical and electrotherapeutic equipment.

Location Quotients (LQs)[7] are used to measure high technology industries, which refers to high tech industries' contribution to total industry output. Second, the number of workers employed in *business support services* (BUS) is used to measure business services activities (BUS). Local expertise in financial, legal, marketing, or technical knowledge has been utilized to provide business services. The legal knowledge (M691, M70) covers the activities of the legal department and head office, as well as consulting (CAPMAS, 2017).

Following is a summary of the variables used in the regional knowledge production function model:

- **Dependent variable (output)**: *patent data.*
- **Independent variables (inputs)**:

1. *Gross Expenditure on Research and Development (GERD).*
2. *Professional employment in R&D in the private sector (RDIND).*
3. *High technology employment concentration (Location Quotient) (LQ).*
4. *Business services activities (BUS).*

[7] 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.

4.3 Results

4.3.1 Spatial association for innovation and knowledge

Figure 22 shows the logarithm of the patent count at the Moran scatter plot and its spatially lagged counterpart on the vertical axis. The patent values have been standardized and are expressed as standard deviations. The slope of this line corresponds to Moran's I and its value (0.282). In the scatterplot shown, there are some outliers at the high endpoints in Cairo and Giza. The number of patents was 469 and 660 (compared to the mean patent, which is 85.96) at these points. The standard deviation was 2.228 and 2.258, respectively. Further, Moran's I significance was determined using 999 permutations of randomization, which is typically sufficient for reliable inference. According to this evidence, *patent numbers in Egyptian governorates are spatially autocorrelated*.

Table 16 shows significant positive spatial associations for some variables according to Moran's I statistics. Moran's I for patents is 0.282, which is significant at the 0.009 level. In this case, a pseudo-significant level is derived through a random permutation procedure (Anselin, 2005) at 999 permutations. The significant spatial association was evident in one of the knowledge sources for research and development activities in the private sector, the concentration of high-tech industries (LQ), and business services activities (BUS). Conversely, Academic Research and Development Expenditure (GERD) does not exhibit spatial dependence.

There is, however, an inconsistent pattern of spatial autocorrelation. Due to this, the second type of spatial autocorrelation analysis is conducted in the study. The Local Indicators of Spatial Association (LISA) can be used to identify local clusters and spatial outliers. It can be interpreted as an indicator of hotspots or pockets of non-stationarity (Anselin, 1995). Thus, local spatial autocorrelation significance allows cluster statistics to be provided for the locations with significant and local spatial autocorrelation. Figure 23 shows the Local Spatial Association significance map (LISA) for patents. The map shows not all governorates of significance for the given number of permutations, however, there are some governorates that are significant at $p = 0.05$ and higher. Five observations are significant at $P = 0.05$,meanwhile, two observations are significant at $P = 0.01$. Figure 24 presents the cluster map as a classification of the scattered plot in quadrants. Based on Moran's I graph, these categories are called high-high, low-low, low-high, and high-low, relative to the mean (Anselin, 2014). These patterns were identified using LISA cluster maps based on the Local Moran's I statistic.

Figure 22 Moran's I scatter plot for patents

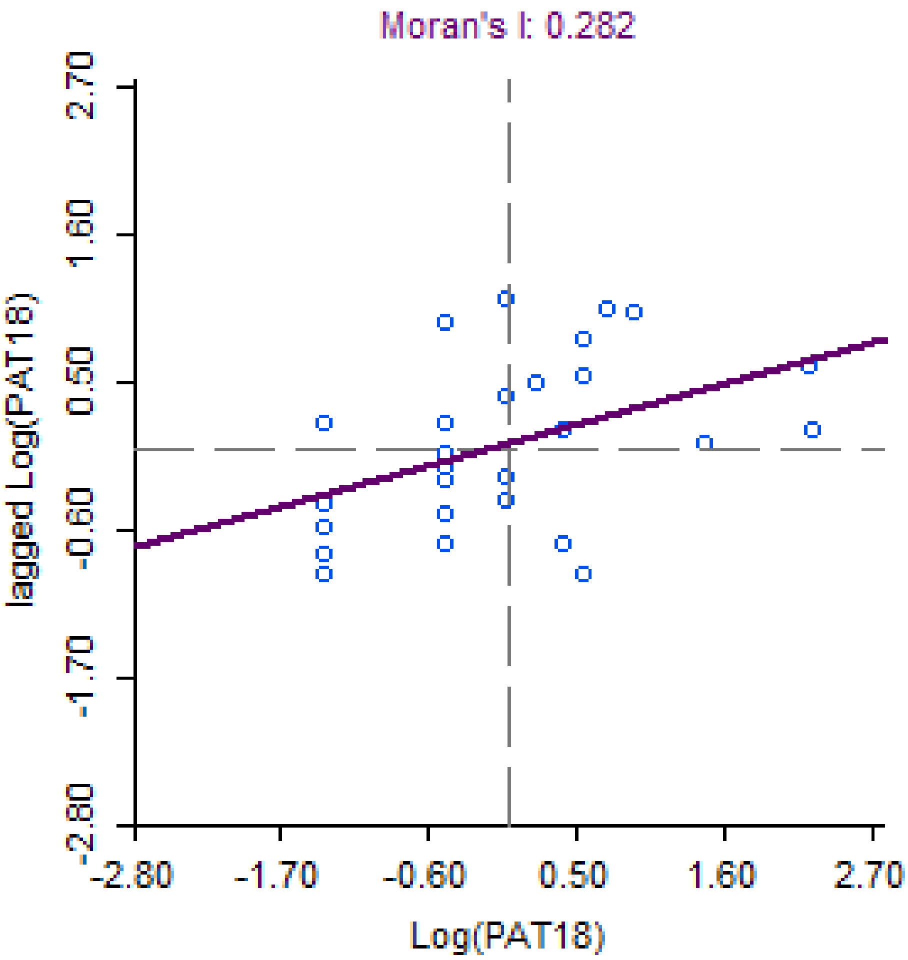


Table 16 Results of Moran's I statistic for dependent and independent variables

Variables	Moran's I value	Significance level
PAT	0.282	0.009
GERD	0.084	0.128
RDIND	0.219	0.016
LQ	0.112	0.060
BUS	0.299	0.005

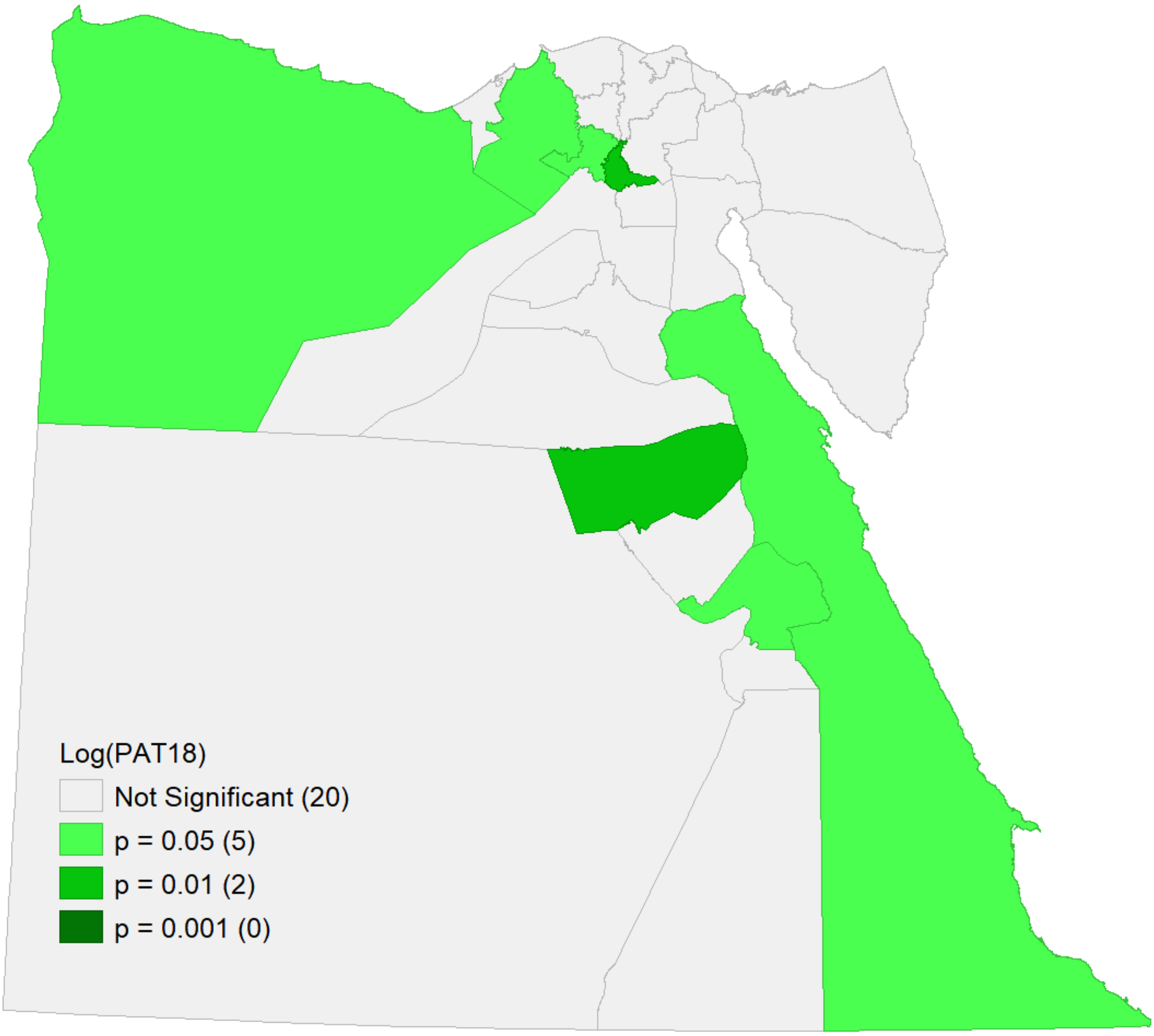
LISA cluster maps show four possible spatial association patterns in individual variables: (1) high-high—a high rate with surrounding neighboring states that have a high weighted average rate; (2) low-low—a low rate with surrounding neighboring states that have a low weighted average rate; (3) high-low—a high rate with surrounding neighboring states that have a low weighted average rate; and (4) low-high—a low patenting rate with surrounding governorates that have a high weighted average rate (Anselin, 1995). The cluster map for patent shows that there are three governorates (Kalyoubia, Menoufia, Beheira) with a positive significant spatial autocorrelation for patents High-High.

In contrast, the Red Sea governorate has reported a significant positive autocorrelation for the Low-Low of the granted patent. On the other hand, three governorates have reported a negative significant spatial autocorrelation. Nonetheless, Matrouh governorate has reported Low-High patent numbers, while two governorates (Assiut and Qena) have reported High-Low patents.

Appendix 5 shows patterns of spatial association among governorates for independent variables. Statistical significance was set at 0.05 and the results were shown for variables with prominent governorates clusters. In determining effectiveness, cluster membership is sensitive to significance level and the number of randomized permutations, but the results presented here are stable above a large number of latter at (999). Appendix 5a shows that there are significant clusters of Gross Expenditure on Research and Development activities in the academic sector (GERD). In the northern region, Cairo and Qalyoubia are the core governorates of innovative governorates. South Sinai and southern governorates formed a broad Low-Low governorates cluster as a result of low patenting application rates in the eastern and southern regions. The high patenting rate of Alexandria and its proximity to the northern and western governorates resulted in a High–Low pattern.

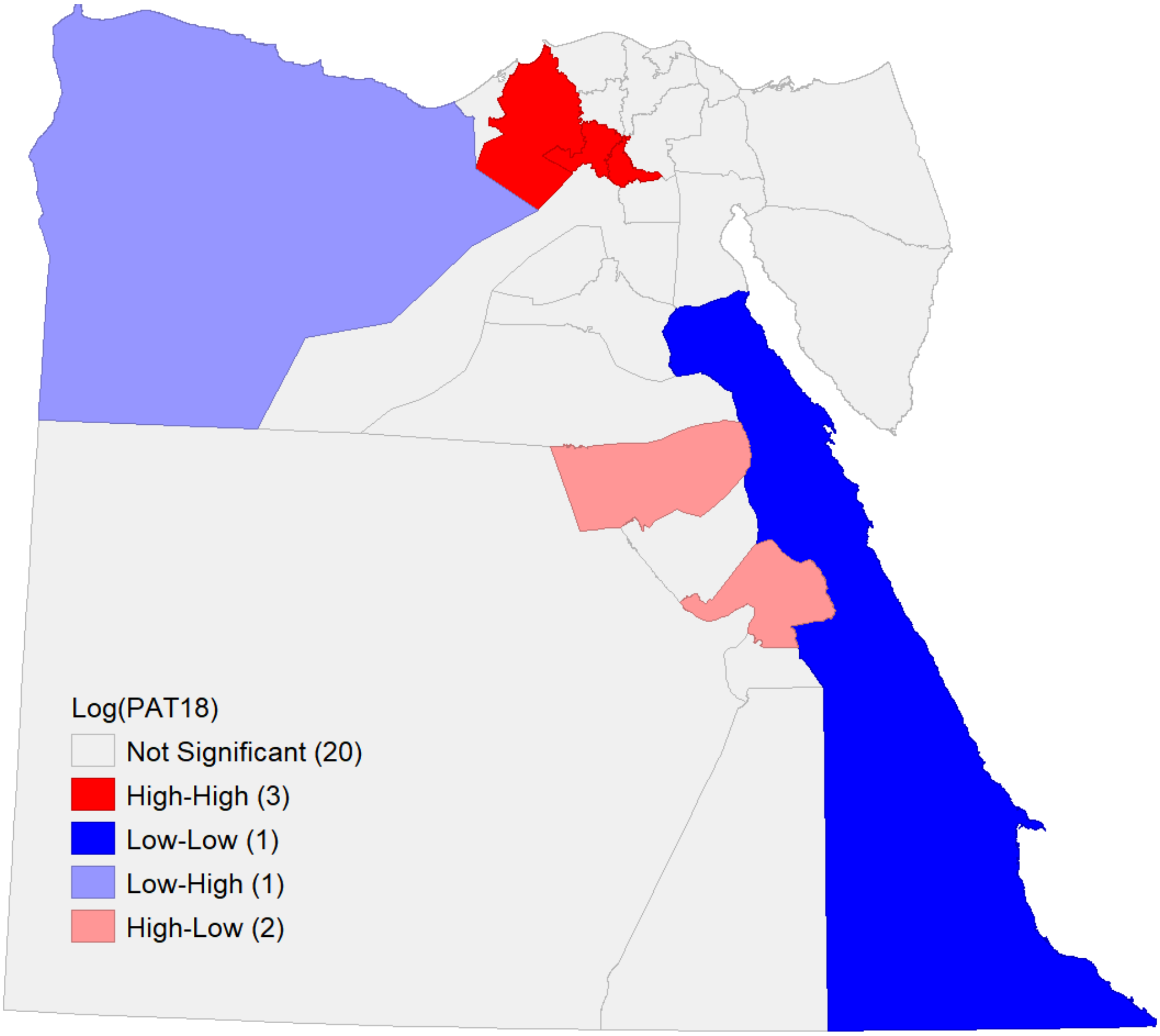
Fayoum had a Low-High patenting pattern, generating fewer patent applications than its more innovative neighbors in the Greater Cairo Region. Appendix 5b shows the LISA clusters of R&D employment in the private sector. There is again a significant cluster of High-High governorates in the Cairo region. High–High patterns are found in Cairo, Kalyoubia, and Menoufia in the core governorates. Combined with neighboring Sohag and Luxor, the Red Sea and Asyout governorates make up a Low-Low governorate cluster. According to appendix 5c, patent business services activities (BUS) have two clusters of high-to-high inequality. There are two governorates in the core, Cairo, and Kalyoubia. There are Low-Low clusters in North Sinai and South Sinai governorates, as well as in Aswan in the south. The high-tech industry's employment concentration (LQ) is shown as a local spatial association by the LISA clusters of Appendix 5d.

Figure 23 Significance map for the granted patents



Source: The author, by using a digitalized map for Egypt with data set, using GeoDa software version 1.2

Figure 24 LISA cluster for patents



Source: The author, by using a digitalized map for Egypt with data set, using GeoDa software version 1.2

There is once again a High-High cluster in Cairo, Kalyoubia, and Behera governorates. Conversely, Menoufia governorate has Low–High patterns. According to the above-mentioned results of the exploratory analysis, innovation outputs are concentrated mainly in the northern governorates and their surrounding areas.

4.3.2 Modeling regional innovation

Egypt's governorates are associated with the spatial distribution of knowledge production. In the Greater Cairo Region governorate and its surroundings, development factors are concentrated. Thus, there are regional variances in knowledge production among governorates in different locations. My goal was to examine the factors most correlated with innovation outputs in the Egyptian governorates using the regional knowledge production function approach. The OLS regression is run using the current version of GeoDa Space 1.2 software. Table 17 reports the regression results for the number of patent logarithms and all other independent variables lagged by one year.

The OLS model (1) is run with the first source of knowledge: the Gross Expenditure of Academic Research (GERD) activities, where the GERD coefficient for the interpretation of patent applications in the Egyptian governorates is 0.722 while R^2 is 0.608, and the F-test is highly significant. Academic research activities confirm the intense significance associated with patent applications in Egyptian governorates. According to the second source of knowledge, R&D in the private sector reported R^2 is 0.425, and the F-test is highly significant, as shown in Model (2) where the RDIND coefficient is 0.330. In contrast, as in Model (3), R&D in the private sector report is not significant for patent applications, while Gross Expenditure of Academic Research (GERD) activities confirm the intense significance associated with patent applications in Egyptian governorates with an R^2 value of 0.611, and a highly F-test.

Regarding Model (4), the model is run with academic research activities (GERD) and high-tech industries concentration (LQ) with an R^2 value of 0.611, and a highly significant F-test. Academic research activities indicated a highly significant association for patent applications with a coefficient of 0.755; meanwhile, LQ has a non-significant association with patent applications. Lastly, academic research (GERD) activities and Business (BUS) activities are run in Model (5). Academic research and development activities confirm again the high significance associated with patent applications in the Egyptian governorates, with the R^2 of 0.637, and the highly significant F-test, while Business (BUS) activities show a non-significant association with patent applications. The multicollinearity is not present for all models, except the last model that might report some concerns at 15.772.

The best model was determined by calculating a pair of model selection tools based on a parsimonious model. As shown in Table 17, Model (1) has the lowest BIC of all models at 69.576, and has a highly significant association with academic research (GERD). In the Egyptian governorates, the GERD coefficient is 0.722, R^2 is 0.608, and the F-test is highly significant. Considering the type of data set variables, the sample size, the value of the model selection tools, and the significance level, model (1) is deemed the best model for modeling regional innovation.

Table 17 OLS regression models for patent applications for 2018

Dependent variable: logarithm of patent					
Regressor (log)	***(1)***	***(2)***	***(3)***	***(4)***	***(5)***
Constant	-0.240 (0.638)	2.212*** (0.376)	-0.076 (0.745)	-0.509 (0.863)	-0.881 (0.779)
Academic Research and Development Expenditure (GERD)	0.722*** (0.116)		0.654*** (0.193)	0.755*** (0.137)	0.554*** (0.167)
R&D professional employment in the private sector (RDIND)		0.330*** (0.077)	0.047 (0.105)		
High-tech industries concentration (LQ)				0.051 (0.109)	
Business activities (BUS)					0.198 (0.143)
Multicollinearity condition number	8.066	3.719	14.115	11.61	15.772
R^2	0.608	0.425	0.611	0.611	0.637
F-statistic	38.744 (0.0000)	18.441 (0.0002)	18.852 (0.0000)	18.881 (0.0000)	21.043 (0.0000)
Log-likelihood	-31.567	-36.744	-31.455	-31.442	-30.529
Number of observations	27	27	27	27	27
Number of parameters	2	2	3	3	3
BIC	69.726	80.080	72.798	72.772	70.946
AIC	67.134	77.488	68.91	68.884	67.058

Source: calculated by the author in the statistical package GeodaSpace software version 1.2. OLS Regression results for Log Patent 2018, numbers in parentheses are estimated standard errors. Significance level: *** (P < 0.01).

4.4 Conclusion and regional readiness

In the Egypt case, RKPF was used to analyze the relationship between innovation output and innovation inputs. Empirical evidence suggests that, in Egypt, academic R&D is associated with innovation output differently than private R&D. There is a significant association between academic research activities and patent applications, compared with private research activities. Geographically, innovation output has been centered around the Northern governorates and their surrounding areas based on Exploratory Spatial Data Analysis.

There are some drawbacks and features to regional innovation systems in Egypt, according to these current findings. Academic research contributes to regional innovation, as evidenced by its associated innovation output. Further, because R&D activities are concentrated in one sector, policy implications and outputs are lacking. Unless private research activities contribute to innovation output for regional innovation system design, policy implementation is unbalanced (Ali, 2021). In order to move forward, a series of policy interventions is required: namely, the merging of private research activities and academic research activities through the collaboration between academic institutions and private firms. It is necessary to encourage the transformation for the academic institutions from the first and second generation to the fourth generation, which supports merging the localized role for the research activities with the academic sectors. This last one we see is significant for Regional Innovation Policy design at the regional level. Most Egyptian regional universities focus on academic institutions' primary role in education and research and on professionals and scientists as outputs. As a consequence, transformation policy support for academic institutions leads to the integration of private research activities into Egyptian regional innovation systems. As Egypt's higher education system undergoes a transformation, its graduates will not only be professionals and scholars, but will also become entrepreneurs for regional universities. Consequently, entrepreneurs serve as outputs for academic institutions, encouraging private research and enhancing collaboration among educational institutions. As mentioned in the previous section regarding the policy of smart cities for the Egyptian case, these projects attract universities, research institutions, knowledge cities, and fourth-generation universities based on technology and innovation (see Table 13). There is an opportunity for these universities to play an active role in creating and activating the regional innovation system within smart cities through the transfer of innovation outputs and knowledge of the proposed technological industries.

The Exploratory Spatial Data Analysis found that patents (as innovation outputs) cluster spatially among Egyptian governorates. There are significant differences in knowledge production processes across Egyptian governorates, according to the results. Meanwhile, most academic research activities are concentrated in the Greater Cairo Region governorate, containing ranked universities and national research centers. It is believed that the agglomeration of the oldest and most prominent universities offers more collaboration with industry than the others. Cairo University, Ain Shams University, and the national research centers are among these academic institutions. Innovation outputs are associated with knowledge activities in this agglomeration. The findings also indicate that the Cairo Region Governorates (CRG) and the Alexandria region are best prepared for innovation-based development. Because of the agglomeration of research activity and university concentration, it has a high level of knowledge production output. Exploratory Spatial Data Analysis (ESDA) findings indicate that knowledge production is concentrated in northern governorates, but regional divergences can result in knowledge and innovation concentration in some regions and exclusion of others. In order to influence regional innovation policy in Egypt, policy implications must be considered.

Overall, the analysis indicates that innovation outputs and inputs are dramatically different across regions and governorates, affecting the implementation of smart city policies as a result of divergent inputs and outputs. In areas having a premature innovation ecosystem, smart city programs are less likely to succeed since basic requirements are lacking. These regions face a bottleneck, but by removing these obstacles, the innovation economy in the region can be improved in accordance with the needs. It is therefore important to build the components of the missing ecosystem in the first place, and then to apply the smart city concept in places where there is a ready regional innovation system in place.

According to my analysis and conclusions, I am able to answer the RQ5 (Is the entire Egyptian context ready for regional development based on smart cities and innovation?) I can answer that *when it comes to the Egyptian context as a whole, it is not yet ready to implement smart cities and innovation policies*. Nevertheless, *some governorates have the potential, opportunities and readiness for it*. An empirical analysis of the exploratory spatial data and the regional knowledge production model supports this conclusion. Although the governorates that are ready to implement the policy do differ according to their level of readiness, it is still possible to move towards a higher level of readiness by removing some bottlenecks. Consequently, the following section examines the readiness of Egyptian governorates to adopt smart city and innovation policies.

4.4.1 The governorates' proposed regional readiness

Results of the analysis (quantitative and qualitative) indicated that Egyptian governorates do not possess a single model with similar characteristics, but rather have various features, aspects, and readiness to implement the policy. In this regard, a unified regional development policy based on innovation and urban intelligence is becoming a fantasy. In the application and applicability of the policy, regional readiness is embodied in innovative infrastructure, information, and smart urbanization. According to the analysis conducted, I have classified Egyptian governorates according to their readiness for regional development through innovation policies and smart cities.

Table 18 illustrates how governorates in Egypt are categorized in terms of their readiness to implement innovation-based regional development and smart cities. The results of the qualitative analysis presented in Chapter 3 and the empirical analysis presented in Chapter 4 were used to determine the degree of readiness. In determining the level of readiness, five indicators were taken into account: the *outputs of knowledge production* in governorates, the *significance of local spatial associations*, *spatial association clusters*, the *proposals for smart cities* within the Egyptian governorates, and finally, the *classification of governorates' capitals in accordance with development capabilities*[8]. According to the result of the analyses, each governorate was assigned a score (from 1 to 4). By adding up the scores of the five indicators (columns 4-8), I calculated the readiness score (column 9).

- *Knowledge production output indicator* (column 4), where the governorates were divided into 4 groups based on knowledge production outputs (patents), with the lowest getting a score 1 and the highest getting a score 4. According to sub-chapter 4.2.2, the indicator was calculated by analyzing the spatial distribution of patents.
- As in the previous indicator, *the significance of local spatial associations* (column 5) was measured by placing a degree next to each governorate, but only the scores (3 and 4) were

[8] This indicator is based on the results of an analysis of a recent research study published by Bayoumi (2020). A city's development capabilities were used as a basis for classifying Egyptian cities in this study. There were a number of variables in this study that were combined into two pillars. In the first, urban and functional capabilities are measured, while in the second, economic, investment, and competitive capacities are measured. Five variables make up the first pillar: regional population size (population size), ability to absorb population growth, leadership and urban development, "competitiveness of advanced business services" (central), regional role, and connectivity. Additionally, the other pillar involved 7 measurement variables, including the economic size "the size of the resident labor force", the economic agglomeration, employment capacity, economic diversification, level of development of the economic base "economic development stage", the city's contribution to the national economy, and finally, its competitive capabilities "productivity" for Egyptian cities. Bayoumi (2020) categorized Egyptian cities according to their capabilities into six categories. As a result of the study, the governorates' capitals (major urban agglomerations) were categorized into the first four categories of the classification based on their abilities.

used. For the Egyptian governorates, the significance map for granted patents (sub-chapter 4.3) only had two categories. Therefore, the indicator degree was weighted between the two highest degrees (3 and 4), so that a score of 4 indicates a higher level of readiness, and a score of 3 indicates a lower level of readiness. As the scale of scores (from 1 to 4) indicates that the lowest score is 1 and the highest score is 4, I used the two highest scores (3 and 4) in the two categories of significance for the spatial association.

- For the indicator of *spatial association clusters* (column 6), the results of the map of the analysis of LISA clusters for patents were considered (sub-chapter 4.3.1). As in the previous indicator, scores of 4 and 3 determine which governorates are positively autocorrelated in space (High High), while a score of 3 represents governorates that are positively autocorrelated in space, but their neighbors have low knowledge outputs (High Low). A score of 2 and 1 has been assigned to governorates with a negative spatial autocorrelation with knowledge outputs. Score (1) for the governorates where they and their neighbors have Low knowledge outputs (Low Low), and (2) for those where they are Low, but their neighbors have High knowledge outputs (Low High). There is a possibility that the neighboring governorates may have an impact by removing the bottleneck and raising their readiness level, and as a result, a higher level has been set for them, which is 2.
- The *classification of governorate capitals* (places of economic activity agglomeration) (column 7) was based on the Bayoumi (2020) study, which classifies Egyptian cities by their capabilities. The indicator was graded (from 1 to 4) based on the classification of the study, where (4) was for the capital of the governorate with the highest level of development capabilities, and (1) for the capital of the governorate with the lowest level of development capabilities. A high development capabilities score indicates a high readiness level, and a low score indicates a low readiness level.
- Last but not least, *the smart cities (proposed or currently underway)* indicator (column 8). Scores for this indicator were determined by the case study analysis and narrative analysis of smart city policy in sub-chapters (3.3 and 3.4). The indicator seeks to identify governorates with smart city policy proposals; those with more than one smart city proposal are scored as (4) and those with one smart city proposal as (3). In the same way, the higher two scores (3 and 4) were utilized to weigh the indicator and maximize the governorates that have proposed smart city programs or are implementing them.

Based on the sum of all indicators, *a readiness score* was calculated for each governorate (column 9). The readiness score provides a total assessment of the factors that influence the suggested level of readiness. The governorates were divided into four readiness categories based on the readiness score. Governorates in the first category (no readiness) are not included in the policy readiness assessment because they lack innovative elements, do not represent the spatial significance of innovation outputs, and do not have smart city programs proposed within them. They are rural and desert governorates. In the second category (8-13), also governorates have not demonstrated significant components of innovation activities, but they have proposals for smart cities within the Egyptian smart city policy. Those in (13-18) and (over-18) categories were divided into two stages of readiness to implement the policy in the capitals of these governorates according to their level of readiness. Listed in (column 10), there are five stages priority of readiness, as well as a category of no readiness for governorates that lack the capacity and are not ready to implement smart city and innovation-based regional development. The first and second priorities (dark and light green) are for the planned and ongoing smart cities that have been proposed for implementation of the policy, taking into account the overall readiness score of the governorate (column 9) in which the smart city is situated. Depending on their overall readiness score, the third and fourth priorities (dark and light yellow) also differ for the governorates' capitals (existing cities). This fifth priority (light red) pertains to proposed new smart cities within governorates that failed to have any ingredients and possibilities for innovation, and their capitals were not put within the category of readiness to implement the policy (and these were governorates in the category (8-13) in readiness score).

Thus, only 13 governorates out of 27 (those in column 10 were colored shades of yellow, green, and light red) are prepared or are capable of preparing for regional development based on innovation policies and smart cities, depending on their readiness and ability to remove bottlenecks. Therefore, the policy should not be applied to the remaining governorates and cities in Egypt. In these marginal and rural governorates (the governorates not colored in column 10), there is no evidence of spatial autocorrelation of knowledge production. Further, innovation and smart city policies are difficult to implement in those governorates due to their economic base and rural characteristics.

In conclusion, regional development in Egypt requires different approaches based on components, capabilities, and readiness. The policy should be applied in five phases in Egypt to ensure regional readiness. The level of readiness varies across the proposed new smart cities and the capitals of the existing governorates. In addition, the analysis shows that in 14 governorates in Egypt, implementing a regional development strategy through innovation and smart cities does not make sense. There was no spatial autocorrelation among the capitals of these governorates and regional innovation outputs. Additionally, they lack a regional innovation system comprised of key factors and components, as well as limited knowledge and innovation capabilities. Conversely, if this policy were implemented in governorates with high development capabilities, less capable governorates might have more opportunities in the future.

Table 18 The governorates' proposed regional readiness for applying innovation and smart city policy

			Factors that explain the suggested degree of readiness						
			4	5	6	7	8	9	10
N	Economic Regions	Governorates	Knowledge production output	Local Spatial Association significance	Spatial association clusters	Classification of governorates capitals according to development capabilities*	Smart Cities (proposed or currently underway)	Readiness Score	Readiness priority degrees
1	Greater Cairo	Cairo	4	4	3	4	4	19	New Administrative Capita City of Capital Gardens governorate's capital
2		Kalyoubia	4	4	4	2	–	14	New Alobor City governorate's capital
3		Giza	4	–	–	3	3	10	New October City governorate's capital
4	Alexandria	Alexandria	4	4	3	3	3	17	Al Alamein New City (ANC) governorate's capital
5		Behera	4	3	4	2	3	16	governorate's capital
6		Matrouh	1	–	2	2	–	5	No readiness
7	Suez Canal	Port-said	2	–	_	2	3	7	East Port Said city-SALAM
8		Suez	3	–	_	2	3	8	City and resort of Galala
9		Sharkia	4	–	_	2	–	6	No readiness
10		Ismailia	1	–	_	2	3	6	New Ismailia City (NIC)
11		North sinai	1	–	_	2	–	3	No readiness
12		South Sinai	1	–	_	2	–	3	No readiness
13	Delta	Damietta	2	–	_	2	–	4	No readiness
14		Dakahlia	1	–	_	2	3	6	New Mansoura
15		Kafr- El -Sheikh	3	–	_	2	–	5	No readiness
16		Gharbia	4	–	_	2	–	6	No readiness
17		Menoufia	3	3	4	1	–	11	governorate's capital
18	North Upper	Beni- Suef	3	–	_	1	3	7	No readiness
19		Fayoum	2	–	_	2	–	4	No readiness
20		Menia	3	–	_	1	3	7	No readiness
21	Middle upper	Asyout	3	4	3	2	3	15	Nasser city, west of Assiut governorate's capital
22		New valley	1	3	_	2	3	9	New Toshka City
23	South upper	Suhag	3	–	_	2	–	5	No readiness
24		Qena	3	3	3	2	3	14	City west of Qena governorate's capital
25		Luxor	1	–	_	2	–	3	No readiness
26		Aswan	1	–	_	2	–	3	No readiness
27		Red sea	1	3	1	2	–	7	No readiness

New smart cities
- Priority 1 of Readiness
- Priority 2 of Readiness

Existing cities
- Priority 3 of Readiness
- Priority 4 of Readiness
- Priority 5 of Readiness

Other governorates
- No readiness

Source: The author, based on the results from policy narrative, LISA, and empirical analysis.

(*) This factor was based on classifying the Egyptian cities according to the development capabilities approach from another source: (Bayoumi, 2020).

5. THESES AND PROPOSED POLICY IMPLEMENTATION FRAMEWORK

Summary of dissertation findings

Egypt has introduced a new regional innovation policy. It has decided that Egypt will develop smart cities, fourth-generation cities that rely on knowledge, data technology, and innovation. In this thesis, I tried to answer the following question: *In order to ease regional differences, can innovation policies, such as the smart cities concept originally developed by advanced economies, be adapted efficiently to developing countries such as Egypt*? To address this question, first, I examined literature on innovation and the development of smart city concept in developing countries. The review of the regional innovation literature conducted that the "one-size-fits-all" policies are ineffective. Consequently, to develop effective strategies and policy concepts, regions must identify their own strengths and weaknesses, and choose strategies and policy concepts based on their regional assets. Second, I analyzed the regional innovation policies of three developing countries: China, India, and Saudi Arabia. There were a set of criteria for choosing these countries. First, the systematic literature review of relevant research studies should include case studies on the selected country. Secondly, the selected countries should share some of the same attributes as Egypt (e.g. smart city programs, national strategic development plans, and top-down regional planning design). Countries with large populations (such as Egypt), where high population density poses similar challenges to development. Furthermore, at least one case study from the Middle East should reflect the region’s features. In this review, I looked at the features and components of the three countries' regional innovation systems (RIS) as well as the challenges they confront. My research indicates that developing countries rely on two kinds of knowledge for innovation, local knowledge and the other is knowledge derived from developed countries. The research has also shown that the effectiveness of the RIS of these three countries varies depending on whether they emphasize the role of universities, government, businesses, or the private sector.

In addition, I analyzed the smart city programs of China, India, and Indonesia. There are a number of reasons why these countries were selected. First, smart city policy is part of a national strategic plan in Egypt as well. Second, some of these countries have developed national plans to establish new smart cities, as is the case in Egypt. In addition, the selected countries should have a model that applies urban intelligence to existing cities (such as in Indonesia), as the Egyptian government also intends to implement the smart city policy on a group of existing cities at a later stage of the policy. While the smart city programs of these developing countries share some common characteristics (e.g. ICT usage, smart infrastructure, developing a sustainable concept), the tools used to implement policies vary based on local circumstances and development goals. I did not aim to determine whether the examined smart city programs will be successfully adapted in these developing countries. Smart city approach is still a relatively new idea, and its applicability poses many questions, particularly for developing countries. Since the programs have just been rolled out in these countries, so it may be too early to evaluate their effectiveness. Such an analysis would be misleading and could give the wrong impression. Hence, my study focused on the concept of smart cities in each country, as well as the development goals, components, implementation approaches, and spatial development strategies (in terms of implementing new smart cities and/or transforming existing cities in order to adopt the urban intelligence approaches), while highlighting some concerns regarding the implementation of the policy. Consequently, the analysis of developing countries' cases reveals that each country has its own way of addressing the policy based on its goals, tools, and issues.

As a next step toward responding to the second part of the above-mentioned question in the context of the Egyptian case, interviews have been conducted and policy documents have been analyzed as well to identify three main themes: (1) the objectives and concept of smart city policy in the Egyptian context, (2) identifying smart city proposals and their components in Egyptian governorates, and (3) the components of the pioneering model (NAC). The interviews and the thorough review of policy documents highlighted that through smart cities, Egypt aims is to develop new urban communities that integrate sustainability, innovation, and knowledge-creation with the support of fourth-generation universities in those cities. Also, the model aims to build a new knowledge-based economy that is compatible with the changes and development paths in Egypt.

Moreover, in the third chapter, a case study approach was used, while in the fourth chapter, the spatial autocorrelation approach was applied to model knowledge production and regional innovation to determine which Egyptian regions (governorates) have a high potential for implementing smart city policies. The results of the analyses show that not all regions are prepared for these policies, because their RIS is not ready for that. The following results emerged from the analysis of the Egyptian policy on smart cities: the Greater Cairo Area (GCA), especially Cairo and Giza governorates, as well as the Alexandria governorate, have the innovative and knowledge components. As these governorates have a number of characteristics associated with innovation, they are providing opportunities for the development of knowledge, technology, innovation, and information technology.

Still, a question arose in this context: *does it make sense to allocate development resources for knowledge, innovation, and urban intelligence to Cairo, Giza, and Alexandria governorates alone, or should they be distributed to the other governorates as well?* As stated in the Egyptian case's narrative analysis of its smart city policy (in subchapter 3.3), the state plans on implementing an ambitious program for 14 smart cities distributed around the country. According to a national strategy based on urban intelligence and information technology, new urban development aims at providing urban areas for population growth and strengthening urban intelligence components. Toward answering the above-mentioned question, the empirical analysis (spatial autocorrelation and regional innovation modeling) in the 4th chapter presents the findings. First, knowledge and innovation outputs are spatially correlated in Cairo, Giza, Qalyubia, and Alexandria governorates. Second, the other governorates do not show a concentration or localization of innovation, knowledge, and technology factors. Third, universities and educational institutions show a highly significant association with the outputs of knowledge production in the Egyptian regional innovation system.

In light of these results, *I believe that regional innovation development policies applying smart city approach should be prioritized only in governorates with a high level of innovation potential.* Such high level of innovation potential to implement a smart city program is available only in Cairo and Alexandria governorates, the two largest urban agglomerations of Egypt. Moreover, only thirteen governorates out of 27 are prepared or potentially capable of preparing for regional development based on innovative policies and smart cities, depending on their capacity to remove bottlenecks. Accordingly, the policy should not be applied to the remaining governorates and cities in Egypt. It is not apparent that knowledge production is spatially correlated in these marginal and rural governorates. Additionally, the economic base and rural characteristics of those governorates make it difficult for them to implement smart city policies. On the other hand, my research confirmed that smart city development is a reasonable policy approach for the development of the Egyptian state within the framework of the new urban development axis of Egypt 2030.

In the next section, I present the theses of my doctoral dissertation. Its purpose is to demonstrate my answers to the research questions posed in the dissertation in an accurate and clear manner. The argument behind my theses is primarily bolstered by qualitative and quantitative analyses presented in chapters three and four, a literary analysis of innovation policies and smart cities, and an examination of the experiences of developing countries in chapter two. Finally, the chapter outlines policy implementation framework for demonstrating how smart city and innovation policies can be implemented well and effectively within the Egyptian context.

5.1 Theses

Here I summarize the main conclusions of my research. My theses are based on the a literary analysis of innovation policies and smart cities, and an examination of the experiences of developing countries, the case study of Egypt, and the conducted empirical analyses. My main objective was to understand *whether it makes sense for developing country like Egypt to support the implementation of smart city innovation policies*, or that such policies cannot be applied for developing countries.

Each of my thesis is organized in the following way to be as precise, accurate, and detailed as possible: (1) the thesis statement (T1,T2, etc), (2) research question(s) answering the given thesis (RQ1, RQ2, etc.), (3) chapters of the dissertation providing evidence(s) for the statement, and (4) argumentation for the statement and conclusions.

Thesis 1 (T1): The innovation-driven and technology-centric concept of smart cities (SCs) represents a place-based tailored policy approach, which means that each region must adopt the concept to its own regional characteristics to promote regional development. Consequently, I assert that the concept of smart cities can be applied to developing countries as long as they *adapt* it to their *own spacial context,* and do not fall into the trap of copying the successful solutions – but relevant only in their context –of developed economies. Appropriate adaptation can enable the SC concept to be successfully implemented in developing countries.

The first thesis provides answer to the first and second sub-questions:

- *RQ1*: How does innovation policy support *regional development*?
- *RQ2*: Can smart city policy be applied *in general to any developing country*?

Evidences from *subchapters 2.2, 2.3, and 2.4* supports T1. *Subchapter 2.2* discusses the theoretical underpinnings of regional innovation policies. In addition, *subchapter 2.3* introduces smart city concept as a novel innovation policy. In s*ubchapter 2.4,* I present examples of smart city innovation programs in developing countries (China, India, and Indonesia). In these chapters, I used systematic literature review (SLR) method to examine the related research questions.

T1 is supported by a number of research findings. First, the literature review on innovation and its role in regional development in subchapter 2.2 revealed why *innovation is a place-based phenomenon*, which means that internal capabilities of the regions, as well as localization and regional distribution of knowledge factors are important to promote regional competitiveness. Innovation and new knowledge occurs through the activities and interactions of the localised network of actors and institutions, which is called the regional innovation system (RIS). In the sub-chapters 2.3.2 and 2.3.3, it is explained that innovation is the engine for regional development, and it is supported by the RIS. There are various innovation policies that aim to increase innovation through the development of RIS. Smart city is a complex innovation policy as it relies mainly on technology, IT, digitalization, etc. To generate innovation via smart cities, RIS is a prerequisite, since the given RIS must be able to create, adapt, accept, and utilize smart city policy. A number of studies have shown that, as a result of spatial differences and development objectives, the performance of the RIS and knowledge diffusion in developing countries such as China, India, and Saudi Arabia are regionally uneven. Consequently, the study concluded that place heavily influences regional innovation policies. Smart city as a novel policy notion of innovation that can be utilized to enhance innovation. My research on smart city concepts (subchapter 2.3) revealed that *the term does not have a commonly accepted standard definition*, and *tailor-made nature* is its primary characteristic. Confirmed by the literature review as well, it appears that developing countries such as China and India *place emphasis on local factors in the design of their newest regional innovation policies* that support the development of smart cities.

This fact was also confirmed in sub-chapter 2.4 by the analysis of the smart city experiences of China, India, and Indonesia. The findings indicate that *the examined developing country adapted the* SC *concept to its own circumstances*. The establishment of smart cities in India is a response to increasing population and subsequent issues related to urban development. On the other hand, China developed smart cities to replace "eco-cities" in order to improve city services and infrastructure by using ICT. With regards to the Indonesian smart city approach, it is based on the development of existing cities to address challenges by utilizing urban intelligence and information and communication technologies. As part of an effort to improve the urban environment, a number of sectoral initiatives are being introduced in collaboration with the private sector to deal with urban and environmental problems. Therefore, it is evident that some characteristics are similar (e.g. dealing with urban challenges or implementing sustainable policies), but there are *significant differences in the tools used to implement those policies*. Furthermore, my examination of developing country experiences shows that localizing technology infrastructure, economic structure, enhancing local knowledge, and engaging the private sector is critical. In order for smart city policy to be effectively implemented at the local level, all of these factors need to be considered.

In the light of the above, I believe that developing countries may have a greater chance for success with smart city policies if they know the characteristics of their regions and build their strategies on their revealed assets.

Thesis 2 (T2): According to my findings, *certain preconditions* need to be met in order to facilitate the implementation of smart cities in Egypt's governorates.

The second thesis provides answer to the third sub-question:

- RQ3: *Are there any preconditions that need to be met before Egyptian governorates can adopt the smart city concept?*

Evidences from *sub-chapters 3.1 to 3.4, and 4.3* support T2. In *subchapter 3.1*, I discuss the Egyptian state economic readiness for innovation. In *subchapter 3.2,* the Egyptian Regional Innovation System (RIS) is introduced by using a narrative analysis. While in *subchapters 3.3 and 3.4*, case study analysis and interviews provide a comprehensive overview of the Egyptian smart city program and present a thorough description of the New Administrative Capital (NAC) pioneer model. In *subchapter 4.3*, I investigate the spatial autocorrelation of innovation and knowledge for the governorates in Egypt. In order to clarify the rationale for this thesis, the following points can be mentioned. First, in *sub-chapter 3.1*, I examined whether the Egyptian state is ready for innovation policy based on long-term analyses of well-known economic indicators. According to the investigation, Egypt's situation has changed significantly and it seems ready in general. In *sub-chapter 3.2,* the analysis of the Egyptian case study clearly indicates that certain factors and components of RIS leading to high regional innovation performance are more prevalent in the northern governorates compared to the southern governorates of Upper Egypt. The narrative analysis of policy in *sub-chapter 3.2* identified the following preconditions and components that contribute to strengthening the regional innovation system in the governorates:

- *The concentration of the population* is accompanied by *the concentration of employers* in the industrial sector in the northern governorates of Egypt (Cairo, Giza, Qalyubia, and Alexandria), which represents 25% of the country's total population.
- In the northern governorates, *high-tech industries* (such as electronics, software, communication, programming and computer activities, data processing and analysis) comprise 80% of the total innovative industries at the national level.
- *Research activities and universities*, where 44 % of universities are located, 43 % of research centers are, and 24 % of workers are engaged in scientific research, development, and patents.
- The governorates of the north encompass 50% of the total number of *business incubators.*

Therefore, it is clear that some components of the RIS can be found relatively well in some governorates, whereas they are scarce in others. Nevertheless, the Egyptian state views SC programs as a way to enhance innovation in cities through technology and information. SC programs tend to focus on universities and innovation-based education. Therefore, governorates that provide favorable conditions and promising chances for the construction of regional innovation systems must be utilized. Consequently, a governorate supporting smart cities should *ensure that it has adequate* manpower and employment in *technologically-related industries, R&D activites, business incubators, and universities*.

In *subchapter 3.3*, the narrative analysis of the smart cities program confirms the previous point, which indicates the Egyptian government intends to implement the policy in the new administrative capital in East Cairo, as well as the new city of El Alamein on the north coast west of Alexandria. In addition, the Egyptian government is supporting the setting up of fourth-generation universities and knowledge centers in these cities and within the governorates where they are located in order to facilitate the development of innovation and knowledge in those regions. The state's intention is to implement policies within the governorates that include all of these conditions and components (for example, universities and R&D centers, clusters of technical and technological industries, and business incubators). Accordingly, the narrative analysis of the smart city policy reported in sub-chapter 3.3 confirms the second thesis, namely, that the conditions and requirements listed above must be met in order to support the implementation of the smart city concept within the governorates of Egypt.

In the context of the argument of the second thesis, in *subchapter 3.4* I examined the pioneering model in the new administrative capital that supports the concept of urban intelligence among the fourth generation of cities. According to my analysis of the NAC model, the government is working to provide the following components:

1. Enacting the smart services strategy by providing a multi-objective pattern for the services within the new administrative capital.
2. Setting up the city's data control center to provide the city's information and data infrastructure for the NAC model.
3. Providing the city with an extensive network of smart infrastructure to facilitate research and information activities as well as to activate urban intelligence.
4. Developing a smart multi-mode transportation network connecting the new administrative capital with Cairo Governorate (e.g. monorails, light rail transit (LRT), or bus rapid transit(BRT)).

Thus, the study confirms that the concept of smart cities can be activated only if the conditions for infrastructure, services, transport, and information network are in place. As a result, another argument can be made for the second thesis in light of the discussion in sub-chapter 3.4, that, in order to facilitate the policy in the other proposed fourth-generation cities, there must be an availability of the necessary conditions, components, and structures required to implement the concept of the smart city. This finding lends support to T2 that preconditions and components that are integral to the concept of smart cities can be found in some governorates and absent in others.

In summary, according to my arguments presented above, I believe smart cities programs can be successfully implemented only in Egyptian governorates where certain preconditions are prevalent.

Thesis 3 (T3): In light of the findings, some governorates have the capacity to generate high innovation potential and opportunities because of conditions that are present, while others do not. Although potentials are most lacking in upper Egypt and the Delta regions, it is present in the governorates Cairo, Giza, Qalyubia, Alexandria, Beheira, Assiut, and Qena.

T3 provides answer to the fourth research question:

- *RQ4*: *Which Egyptian governorates have the conditions to adopt the political concept of the smart city?*

In this instance, chapter 4 of the thesis (most of all *sub-chapter 4.3)* provides supporting evidence. In this chapter, Exploratory Spatial Data Analysis (ESDA) and the regional knowledge production function approach were used.

Based on the empirical analyses for modeling knowledge production in *sub-chapter 4.3*, opportunities are related to both innovation and knowledge in Egyptian governorates. As a result of the analysis, and based on the empirical evidence provided, R&D in the academic sector has a different impact on innovation output compared to R&D in the private sector. Comparatively to private research activities, academic research activities are significantly associated with innovation outputs. Taking into account that regional knowledge production and the academic community have a high correlation, *fourth-generation universities can significantly contribute t*o the achievement of a successful regional innovation system within smart cities through the transfer of innovation outputs and knowledge of the proposed technological industries.

The Exploratory Spatial Data Analysis in *subchapter 4.3* revealed that, based on high innovation potential, innovation outputs are geographically related across Egyptian governorates. The findings show that *the outputs of knowledge creation differ among Egyptian governorates*. Despite the lack of in upper Egypt and the Delta, Cairo, Giza, Qalyubia, Alexandria, Beheira, Assiut, and Qena all have potential. Furthermore, according to these findings, Egypt has 14 governorates, making a regional development program based on innovation and smart cities impossible to implement. According to the findings of subchapter 4.3, there was no evidence of spatial autocorrelation for regional innovation outputs in these governorates. They also lacked knowledge and innovative capabilities, as well as elements and resources. Currently, most of the country’s academic research activity takes place in the Greater Cairo Region governorate, which includes ranked universities and national research centers. Universities in mega cities like Cairo, Asyut, and Alexandria with the longest and most distinguished reputations are expected to collaborate with industry more than regional universities.

Previous point was also confirmed in the analysis of the findings, which indicate that the Cairo Region Governorates (CRG) and the Alexandria governorate are best suited for innovation-based development as a result of the concentration of research activity and universities within them. In spite of the findings of the ESDA analysis, which indicate a concentration of knowledge production in the northern governorates, the southern governorates, and the Delta region governorates lack innovation potential. As a result of these concentrations, there may be regional divergences, which may lead to the concentration of knowledge and innovation in certain governorates but not in others. Thus, *smart city programs dispersed across governorates with preconditions and opportunities might help to reduce regional inequities.*

In conclusion, the analysis supporting the third thesis indicates that there are opportunities for each of the smart city and innovation policies only in certain Egyptian governorates, while other governorates lack some of these necessary elements and conditions. For this reason, it would make sense for Egypt to implement a smart city policy as part of its strategic guidance framework for sustainable development, as stated in Egypt Strategy 2030, only if the preconditions and opportunities are provided within the governorates.

Thesis 4 (T4): Different governorates in Egypt have varying degrees of readiness for smart city policies and innovation-based regional development. It is impossible to activate a smart city policy until the requirements are met, i.e. until the bottlenecks are solved and the preconditions are met, which poses a roadblock for many Egyptian governorates.

T4 answers the fifth research question:

- *RQ5: Which Egyptian governorates's RIS is the readiest for the implementation of the SC concept?*

The sub-chapter 4.4 examines the level of regional readiness of governorates in Egypt for implementing smart city policies and innovation programs. The results of my quantitative and qualitative investigations confirm that Egyptian governorates have RIS with varying characteristics, features, and aspects, and consequently, they have varying levels of readiness for SC policy implementation. Therefore, a uniform, one-size-fits-all regional development policy is not feasible, as regional capacities, reflected in innovative infrastructure, information and smart urbanization, differ from region to region. Based on the outcomes of my research, I developed a *regional readiness measure* for Egyptian governorates for applying regional development through innovation policies and smart cities.

To estimate the degree of readiness, some of the findings from the qualitative analysis reported in chapter 3 and the empirical analysis presented in chapter 4 were employed. The degree of readiness was measured using five indicators: *the outputs of knowledge production in governorates*, *the significance of local spatial associations*, *spatial association clusters*, *smart city proposals within Egyptian governorates*, and finally, the *classification of governorate capitals based on development capabilities*. Each governorate was given a score (ranging from 1 to 4) based on the findings of the analysis, and I generated the readiness score for each governorate by aggregating the scores of the five indicators.

The findings of the readiness analysis supported T4, indicating that there are governorates that are better prepared to implement the policy (leaders), a group of governorates that are less prepared (catchers-up), and a final group of governorates that have no evidence of policy implementation readiness (laggards).

This last group of governorates ("*laggard" regions)*, according to the conclusions of the investigation, lacks inventive features, does not represent the spatial significance of innovation outputs, and has no smart city initiatives suggested inside them. **They are governorates in upper Egypt and some of the Delta governorates** that are primarily rural and arid. In these marginal and rural governorates, there seems to be no indication of spatial autocorrelation of knowledge generation. Furthermore, the governorates' economic basis and rural qualities make it difficult to adopt innovations and smart city plans. As a result, based on their preparedness and capacity to eliminate blockages and satisfy criteria, only *13 governorates out of 27 are prepared or have the potential to prepare for regional development based on innovation and smart cities policies*. As a result, the policy should not be implemented to the remaining governorates and cities in Egypt.

The most ready governorates ("*leader*" *regions*), according to the results of the readiness analysis, are Cairo, Qalyubia, Giza, Alexandria, Assiut, and Qena, where the analysis revealed high levels of readiness to execute the policy within the governorates' capitals. Where the empirical and narrative policy analysis for this group of governorates clearly demonstrates the presence of the components and circumstances required for innovation policies and smart cities. These governorates have high scores in the knowledge production output and a high significance of the local spatial association, in addition to the existence of spatial autocorrelation of these governorates with knowledge production outputs, as measured by the degree of readiness. The capitals of these governorates have a high capability rating, according to an examination of city classifications based on development capacities. In addition, under those governorates' smart city policies, there are proposed seven new smart cities.

In contrast, the analysis revealed that a number of governorates had lower levels of readiness ("*catchers-up*" regions), based on the fact that they did not have a high level of innovative activities components, but they have four smart city plans under the Egyptian smart city strategy. As a result, it is possible to suggest that in order for this group of governorates to catch up to the group of “leaders” governorates, they must first complete the conditions and components, followed by the possibility of implementing urban intelligence programs in the capitals of those governorates based on regional readiness. To overcome the bottleneck, these requirements are fulfilled through supporting innovation activities inside regional universities and the business community within governorates, as well as by integrating the governorates’ spatial autocorrelation with the innovative capacities of the governorates' "leaders."

T4 concludes that smart city policy may be implemented in both proposed smart cities and existing cities - which are the governorates' capital cities - given that the governorates’ readiness to execute the policy is taken into account. Degrees of priority for policy implementation of the smart city program in Egyptian governorates are proposed after a analysis of readiness (see Table 18). The governorates' proposed new smart cities will be the first and second priority for implementing this program, according to requirements and components, and depending on regional readiness. The third and fourth priorities for implementing the urban intelligence policy involve existing cities (governorates capitals) with significant innovation capabilities and components, as well as high levels of readiness (leaders). The fifth priority in terms of implementing the smart city policy is a group of smart cities proposed within the national program for smart cities (East Port Said (Al-Salam), Al-Galalah City and Resort, New Mansoura, and New Toshka City), in which the governorates of these proposed cities lack the conditions and components, as well as demonstrating the lowest degree of regional readiness for implementing the policy. Because of their proximity to the "leading" governorates, these governorates may be able to catch up to them in terms of policy implementation once they achieve the necessary requirements and conditions.

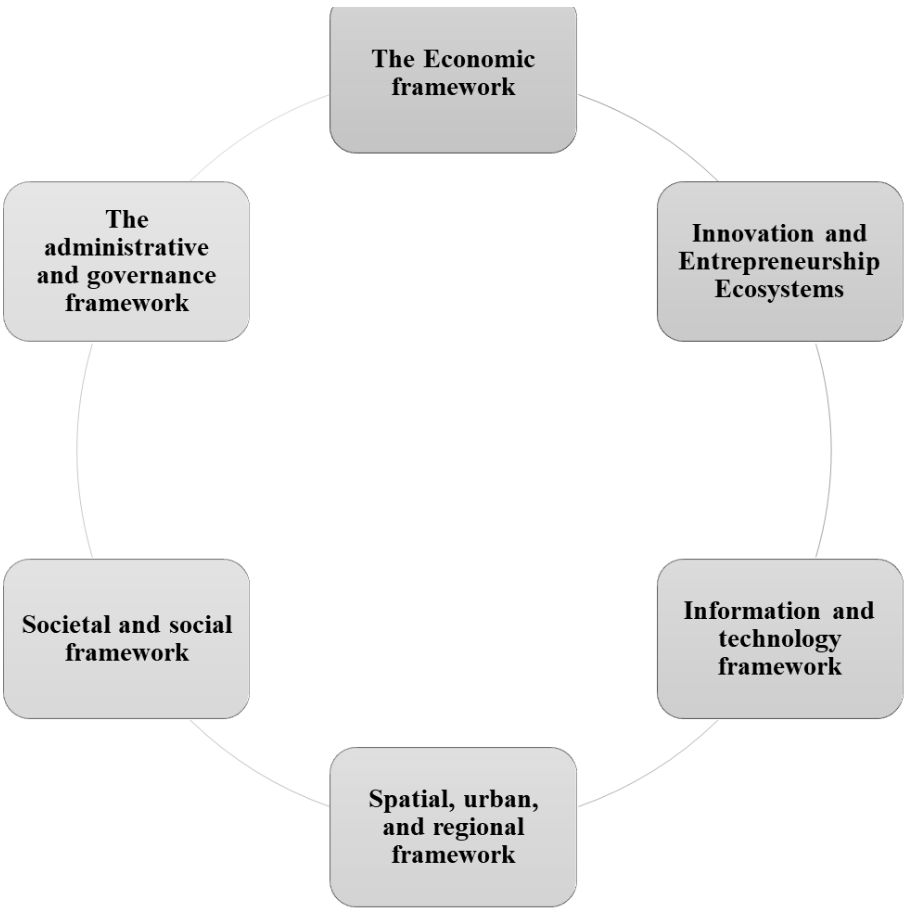
To summarize, the *governorates of Egypt differ in their readiness to execute smart cities and innovation-based regional development*. *Some governorates will be unable to execute policies until the backlog is lifted and the conditions are satisfied*. It might be claimed that smart city development is a suitable method for Egypt, based on the new urban development axis of Egypt Strategy 2030; nevertheless, this depends on the governorates’ preparation level.

In sum, the results of doctoral dissertation support that the Egyptian context can apply a policy model based on innovation and urban intelligence to implement regional development policies, but only if we consider the level of readiness of the regional innovation system of Egyptian governorates and cities in the implementation. Hence, in the next chapter, I propose a comprehensive framework for policy implementation to demonstrate how smart city policy can be implemented effectively and efficiently.

5.2 Proposed policy implementation frameworks (Executive summary)

The regional innovation system, according to the results of the systematic literature review analysis in the second chapter of the thesis, is made up of several components and actors. Furthermore, smart cities are an innovative policy of the twenty-first century that incorporates a wide range of policy objectives, particularly in the context of developing countries. These experiences, which were detailed in subchapter 2.4, revealed that development objectives differed amongst models. Smart city policy can use information technology and the Internet of Things to improve local services, in addition to managing population growth and meeting environmental goals. **My analyses have led me to conclude that a comprehensive, multidimensional framework is essential to facilitate the most effective implementation of the smart city policy**. Smart cities can fulfill their role as technological and information hubs, knowledge and innovation-based economies, as well as development attractions within their region, in addition to their role as centers of urban development. In Figure 25, I present my policy implementation frameworks that consider multiple aspects which facilitate the effective implementation of the policy, namely: (1) the economic framework, (2) the societal and social framework, (3) the spatial, urban, and regional framework, (4) the technology and information framework, and (5) the innovation and entrepreneurship framework. The analysis of interviews and a review of case studies from developing countries and Egyptian case demonstrated that smart city policies are multifaceted, including goals, conditions, and requirements to enable their implementation. In this respect, I submit the following framwork for policy implementation, which is based on my knowledge as a result of my study for this dissertation. I propose specific policy considerations and interventions that policymakers should consider to effectively implement smart city programs in line with the specificities of the Egyptian context and the goals of the Egypt Strategy 2030.

Figure 25 policy implementation frameworks



- **The Economic framework**

Based on the analyses, I offer the following set of essential themes and procedures for consideration within the economic framework:

1. ***Diversification of funding options***: Analyzing the experiences of other developing countries, it appears that one of the challenges associated with implementing smart city policies in developing countries is *a lack of adequate funding*, which is a result of limited resources. Furthermore, smart cities require extremely high funding during the early phases of operations and construction, as it was the case in the NAC model in Egypt as well. Consequently, access to *a multitude of financing* options is the most effective way to finance smart city programs. In order to achieve this type of financing, a variety of smart service patterns can be adopted. Smart city programs provide numerous profitable and competitive smart services that might support multiple funding sources. In the NAC model, for example, this is achieved by partnering with the private sector to operate smart lighting poles, while utilizing them as electronic billboards, thereby achieving profitability and reducing expenses for the services. As well as *strengthening the*

partnership between the public and private sectors, including estate developers and companies offering technology support.

2. ***Consolidate competitiveness in the macro region:*** In the Middle East region, some other countries besides Egypt have developed their own smart city programs. Similar initiatives can be seen in projects such as Saudi Arabia's NEOM (a proposed smart city project) and Dubai, United Arab Emirates. The smart city plans suggested in Egypt, particularly the NAC, might assist to improving the regional competitiveness of the Egyptian experience in the Middle East area by providing competitive advantages. The country gains a competitive advantage by building the NAC as a focus for financial and business operations, multinational corporations, and branches of globally renowned universities. In addition, Egypt's policy model has multiple dimensions and objectives. Among them is targeting FDI through multinational companies and investments in the NAC. In addition, the NAC's proximity to Cairo, Egypt's administrative and commercial hub and the Middle East's largest capital, facilitates the movement of foreign direct investment from Cairo to the NAC. Thus, Egypt's competitiveness in the Middle East region might be improved by utilizing the smart city concept in the NAC. To accomplish so, the NAC can use its competitive advantages to compete with other smart cities in the region.

3. ***Diversifying the targeted economic categories:*** This means that in addition to focusing on a high economic income category, it is also important to embrace economic diversity. In the China model, many failures were caused by the inability to attract the targeted population due to a lack of diversity. As a result of the lack of economic diversification, demand for smart city programs is restricted among social groups, which is the absolute opposite of the intended Egyptian strategy, which aims to establish new societies that can accommodate population growth from all social classes. Therefore, smart city projects should consider the various social classes of the given society residing in these new smart cities. Egypt Strategy 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 too expensive for those in the lower socioeconomic class (working class) may create social tensions, which will make it more difficult to achieve regional development equality and convergence. Policymakers should incorporate diverse socioeconomic groups into smart city plans to overcome this issue.

4. ***Consideration of the economic and development levels of smart city governorates:*** In light of Egypt's plan to establish 14 smart cities from the fourth generation cities

distributed throughout the country, the features and development levels of those governorates must be considered. In order to do this, it is critical that the NAC's economic model not be applied to other proposed cities in Egypt's smart cities plan. The repetitive application of a model without taking into account its specificity or internal regional components usually results in failure, as it is emphazied by my theses as well. In order to ensure the sustainability of the economy, the economic specialization and economic base 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 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 specialization and economic development path(s).*

Finally, I believe that the economic side of policy execution should include a multifinanced economic structure, increased competitiveness, and social class diversity. Furthermore, the suggested smart cities governorates' degree of development and economic basis, as well as the necessity to reduce bottlenecks in those governorates, must be considered.

- **The administrative and governance framework**

Creating an environment of administrative and governance collaboration is critical to successful smart governance in smart cities. *Interaction and collaboration between diverse stakeholders are critical in the context of governance*. Developing countries, such as Egypt, can use two types of smart management. In the first place, there is e-government, which aims to improve services in the urban space by digitizing them. Second, smart governance through the use of information, data science, and analysis, and products for data analysis in decision making. From this point of view, I propose the following set of key points and mechanisms that should be considered within the administrative and governance framework:

1. ***Adoption of the smart city governance model***: Rather than just administering a city that embraces urban intelligence, smart cities are designed, developed, and administered through a governance process. Thus, it is possible to build on this model in the proposed smart cities such the NAC through the establishment of partnerships between the government and the municipalities to manage and operate the city by establishing *a company or administrative entity* that will be responsible for the governance, operation, and follow-up of the city.

2. ***Developing smart city models requires the adoption of different governance and administrative approaches***: Not all governorates have urban intelligence or innovation components, according to policy narrative analysis and empirical analysis. As a result, the idea to establish 14 smart cities in various governorates will necessitate a unique approach to government and management. This proposal suggests the need for *a multi-actor management* structure involving both the city government and other stakeholders (real estate developers, technology companies, etc.), a public-private partnership (PPP). Based on the regional readiness analysis, there are some smart cities in which the governorates lack the knowledge, innovation, and technology components ("catchers-up" and "laggard" governorates). As a result, partnership-based administrative models provide an opportunity for these proposed cities to attract local stakeholders who have investment and development interests to participate in the management of their interests and activities of the city.

Finally, *the suggested smart cities and governorate capitals should be governed and managed differently.* For management, operation, implementation, and analysis of smart city needs, the administrative and governance framework can be applied in three ways: the first is to establish *an independent, stand-alone entity, a company or authority model*. Specifically, this type of model will be applied to the smart cities proposed for the governorates of Cairo and Alexandria, as currently represented in the NAC, and to the implementation of the same administrative style in the new city of Alamein. Second, there is the *multi-actor management model*, which involves the city government as well as other stakeholders (e.g. real estate developers, technology companies), through a public-private partnership (PPP). The partnership is recommended in governorates where knowledge production outputs are not spatially correlated. Finally, *using smart services and smart transportation, the administrative model* may be applied in governorate capital cities (existing cities). It is important that real estate developers and technology companies work together to transfer expertise and implement a successful administrative model in these governorates because the local government of these governorates lacks adequate administrative and governance capabilities to manage the smart city model. The management of the governance model is the responsibility of local governments and city administration. Thus, the governance and management frameworks used for the implementation of the proposed policy are varied. According to the specifics and nature of the smart city to be established, this will be determined taking into account the characteristics and local administrative systems of the smart city.

- **Societal and social framework**

To ensuring that the smart city achieves its objectives, a societal and social framework must be built. In light of this, I propose the following set of critical procedures for consideration:

1. ***It is critical to incorporate the social circumstances of the community into the suggested strategies for smart cities***. People that are creative and qualified are needed for smart city administration and operations. To be effective, several models in the proposed administrative and governance structure rely on creative people. Multi-actor management involves collaboration between the government, the private sector, and real estate developers, as well as the local community and stakeholders. As a result, innovative and competent personnel must be incorporated into the smart city management model.
2. ***The public has to be educated about the role of urban intelligence in the delivery of public services and dissemination.*** Smart cities are a relatively new approach to urban development in Egypt, and the public has to be informed about their influence on public services and public utilities in order to increase the rate of economic growth. This may be useful in government programs that seek to digitize services or increase financial inclusion. Egypt is trying to digitize its payment system to incorporate all commercial, utility, and government services. Also being implemented across all state institutions is the National Program for the Digital Transformation of Public Services by Providing and Following-Up Government Services.

To summarize, it is critical to *integrate skilled individuals* in the planning and administration of cities, as well as to *include community awareness* as part of the smart city initiative. Furthermore, in order to promote employment and population growth, factors and incentives are crucial to attaining the specified goals of smart city policies.

- **Spatial, urban, and regional framework**

Based on the findings of the analysis, the following pillars for the spatial, urban, and regional frameworks for smart cities can be proposed:

1. ***Smart city initiatives (proposed and already implemented) should be incorporated into regional urban development strategies for Egyptian regions*:** Smart city projects should be included into Egypt's urban regional development programs to optimize the influence of these megaprojects on regional development. In the case of the NAC, the projects and services suggested must be integrated with those in the East Cairo region's regional

development strategy. East Cairo's regional development strategy is not synchronized with the NAC project, so the regional strategy should be reformulated in light of NAC developments. By doing so, the NAC development plan will not conflict with the regional development strategy.

2. ***As a priority for urban development within the proposed smart cities, smart services and smart transportation should be emphasized*****:** These new cities depend on being urban clusters based on the use of information technology in infrastructure networks. Thus, the smart city policy model can be applied through services, infrastructure, and smart transportation, as the infrastructure is equipped to localize these projects. As transportation and services are the essential urban attractions for new urban communities, the goal of these new cities is to settle and increase the populated areas. Clean and sustainable transportation networks are required to *increase accessibility between existing cities and new smart cities* in order to achieve the comprehensive smart city concept more efficiently. It is also important to note that old cities may view new cities as potential threats in the future. This potential problem must therefore be addressed by regional policy. In these new circumstances, cities should also figure out what kind of role they can play, how they can connect to these new cities, and what new function they can create in light of these new circumstances.

3. ***The path dependency approach should take into account the fact that existing cities and regions have longstanding economic foundations and that their spatial, urban, and regional specificities should be considered*****:** This framework of policy proposals also suggests that the proposed model is not suitable for all regions. The Egyptian governorates are different from the g overnorates of the Cairo region (the case of the NAC) in terms of their components, capabilities, and needs. Therefore, considering the regional and spatial specificity of smart city regions is extremely important in the Egyptian case, so as to avoid failures of the proposed policy. Interview results indicate that the Egyptian government tends to apply the NAC model to existing cities in the following stages, which raises concerns for the researcher. Due to this, it is important to take into account the spatial, urban, and regional characteristics of existing cities and regions, where an existing economic base has existed for many decades. Consequently, the existing cities will have to be treated in a different manner than the new smart cities in terms of the components, mechanisms, and tools of the proposed model. Therefore, it is necessary to examine the economic base and current economic activity, and then

formulate the priorities for implementing the urban intelligence policy based on the degree of readiness.

To summarize, smart city initiatives (both proposed and implemented) should be *incorporated into urban regional development policies* in order for Egyptian regions to receive the advantages of these megaprojects. Also, because the infrastructure is capable of localizing these projects, the smart city policy model can be applied to *existing cities employing services, infrastructure, and smart transportation*. Urban development goals can be met through growing and developing urban population regions. Furthermore, bottlenecks must be addressed first in existing cities that will eventually embrace the smart city concept. By depending on local characteristics and activating the city's development route in line with its components, features, and competitiveness, as well as avoiding applying the NAC model to existing cities with numerous characteristics and features, the city's growth path may be activated.

- **Information and technology framework**

Because data and information analysis is one of the most significant pillars for building a smart city policy, it becomes clear that the concept of the smart city is an innovation policy based heavily on information, technology, and innovation. Therefore, I propose the following set of key points and mechanisms that should be considered:

1. ***The necessity of establishing an information and data infrastructure within the proposed smart city governorates:*** The secured smart infrastructure considers one of the pillars of managing and operating smart cities, which need further development and infrastructure within the Egyptian governorates. As I indicated in the regional and urban framework, increased interconnectivity between the proposed smart city and the governorate's current cities is essential, and this can only be accomplished through smart infrastructure and the development of information infrastructure.
2. ***Expansion of digital service provision and information integration for government agencies:*** By using data and information, services are made feasible and obstacles are eliminated. In addition, the smart economic framework for smart city policy is based on information technology and data. Furthermore, the New Administrative Capital's technical and information infrastructure was built around the city's operations center (COC) and command center (CCC), which cannot be applied to other cities. This type of command center and data center requires huge investments and intense centralization, which is difficult to implement in other city models. Despite this, these large data centers can be

linked to *smaller sub-centers at the regional level.* In this way, databases can be linked and an information network established at the regional level can be gradually established.

Finally, in the cities recommended by the Egyptian smart city policy, it is critical to *invest in information infrastructure and to apply data analytic sciences and the Internet of Things*. Furthermore, the strategy and information model utilized to deal with the various smart cities differs from those employed by other smart cities and those already in existence.

- **Innovation and Entrepreneurship Ecosystems**

1. ***Smart city sites must be connected to governorate-level regional industrial development programs:*** The Ministry of Industry has devised an economic development strategy centered on industrial competitiveness and growth. According to that by 2025, Egypt will be an industrial country reliant on medium-technology produced goods. By connecting plans for technology-based industries to commercial and industrial sectors in smart cities, informational components and digital infrastructure may be used to fulfill industrial development goals. This linkage between technology-based industry beside research and development in the private sector helps create or develop an environment for high-growth innovation and entrepreneurship.
2. ***Smart cities should be embraced by the Egyptian government as a platform for regional innovation:*** There are knowledge and innovation centers centered on manufacturing and collaboration with the corporate sector through fourth-generation universities. Smart city programs and innovation components within them, can be used to create an ecosystem for the governorates' innovation. Through the technological and informational infrastructure provided inside the proposed smart cities, these components of fourth-generation universities, financial and business hubs, and technology industry centers may engage with one another. As a result, policymakers have the opportunity to use smart components and infrastructure in smart city programs to develop a regional innovation system within Egyptian governorates.

In conclusion, I have discussed the economic framework, the sociocultural and social framework, the spatial, urban, and regional framework, and the innovation and entrepreneurship framework. In sum, to achieve effective policy implementation, I state that *a comprehensive multi-dimensional framework is required*.

6. LIMITATIONS AND FUTURE RESEARCH

- The study had various limitations, which ranged from the small sample size to the number of Egyptian governorates included in the empirical analysis. Furthermore, the data for the variables utilized in the knowledge production periodically to create panel data was unavailable. As a result, resolving these restrictions can lead to more reliable statistical results in the future. As a consequence, further investigation is needed to understand and evaluate the spatial autocorrelation and spatial lag for knowledge production function for Egyptian governorates using a spatial econometrics model using panel data.

- According to interviews with executives, the NAC is a promising model for smart city policy in Egypt because of the data and policy documents accessible, although it does have certain limits. Interviews with citizens, business owners, or urban planners were not conducted as part of the study. One of the study's major limitations is the scarcity of official data on the proposed smart city initiatives, especially since many are still in the planning phases. The NAC model may be able to overcome these constraints in the future.
- The following future research topics should be examined in light of the current study's findings:
  1. Several questions could be answered through more **investigative research based on the stakeholders' reactions** through the initial operating period.
  2. When measuring the economic development of the governorates, how can the **development return of regional innovation systems** be measured?
  3. In the Egyptian case, how does the New Administrative Capital affect the national and regional urban systems?

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APPENDIXES

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 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 , "English")) 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 3 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	(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 strongentrepreneurial 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, businessinnovation, government, communities and sustainability). An SC uses ICTs toimprove economic and political efficiency and enable social and environmentaldevelopment.	(Hollands, 2008)
A Smart City is defined as a city that takes advantage of the opportunities offered byICTs 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 For Cios, 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 throughparticipatory 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	(Kourtit et al., 2012)

force), infrastructural capital (e.g. high-tech communication facilities), socialcapital (e.g. 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 toparticipation); smart human capital (related to people); smart environment (related tonational resources); smart living (related to the quality of life); and smart economy(related to competitiveness)	(Lombardi, Giordano, Farouh, 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 4 Intreview 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.

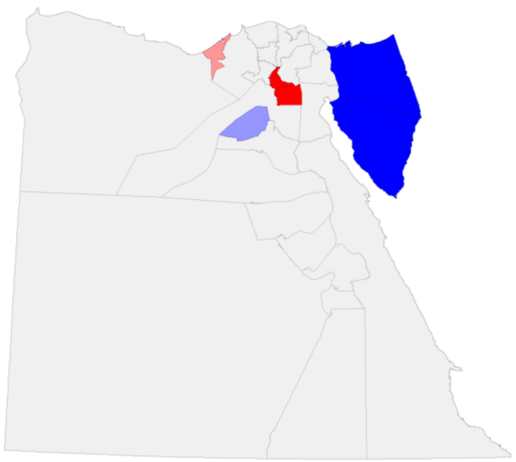
The NAC has adopted the concept of "smart city codes," one of the most important things Khalil stressed when discussing the information system in operating the city and providing facilities and services. Smart infrastructure and smart services (managed by the City Control Center), special services (such 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.

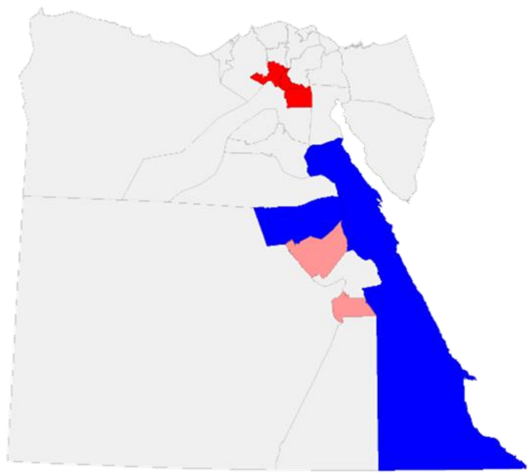
Mohamed Ali 01/03/2021

Appendix 5 LISA clusters for independent variables

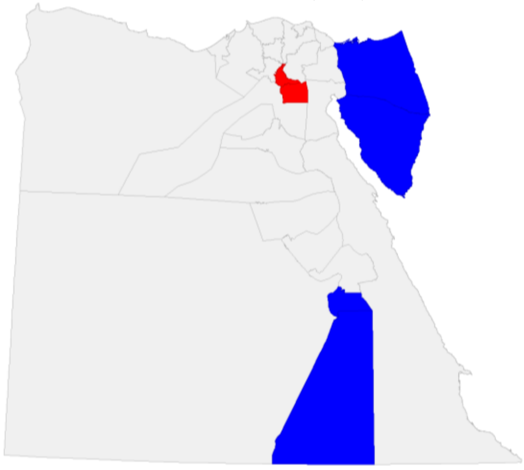
a. Log Gross Expenditure on Research and Development activities in the academic sector (GERD)



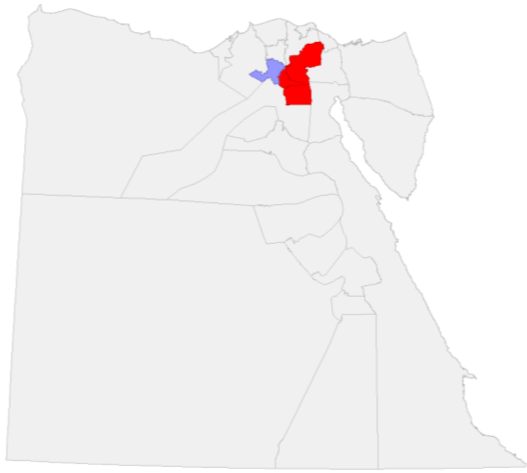
b. Log R&D in the private sector (RDIN)



c. Business services activities (BUS)



d. High-tech industries (LQ)



Source: The author, by using a digitalized map for Egypt with data set, using GeoDa software version 1.2