DYNAMIC CAPABILITIES OF ICT COMPANY IN THE SMART CITY FIELD

by

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Dedication

To my dear parents, my lovely wife Marwa, and my wonderful children Farida, Mohamed, and Nariman, who have been my constant source of inspiration.

Acknowledgements

I would like to express my deepest gratitude to Dr. Francesco Derchi for his invaluable support, mentorship, and insightful guidance throughout my research journey. His expertise, constructive feedback, and encouragement have played a significant role in shaping my academic work.

Dr. Derchi's dedication to excellence and his ability to inspire innovative thinking have been instrumental in refining my research direction. His constructive criticism and continuous support have challenged me to strive for academic rigor and clarity in my work. I am truly grateful for his time, patience, and unwavering commitment to my academic and professional growth. His mentorship has been a driving force in my research, and I sincerely appreciate his contributions to my intellectual development.

Thank you, Dr. Derchi, for your guidance and support.

ABSTRACT

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2025

Dissertation Chair: Dr. Meskina Olesya
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The dynamic capabilities of Information and Communication Technology (ICT) companies play a pivotal role in the development of smart cities. This research investigates how ICT firms can effectively sense, seize, and transform in response to the volatile, uncertain, complex, and ambiguous (VUCA) environment of smart city initiatives. The study develops a comprehensive framework for measuring these dynamic capabilities and applies analytical models, including the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA), to evaluate decision-making processes. By integrating concepts from dynamic capability theory and smart city frameworks, this research provides a novel approach to assessing the strategic adaptability of ICT companies. The findings highlight the importance of critical success factors (CSFs) in fostering innovation and sustaining competitive advantages for ICT firms engaged in smart city projects. Key insights emphasize the significance of collaborative decision-making, platform integration, and the adoption of disruptive technologies. This study offers practical recommendations for ICT companies and policymakers, advocating for a balanced approach to technological innovation, resource allocation, and stakeholder engagement. The research contributes to academic discourse by bridging the gap between dynamic capability theory and smart city development, providing a foundation for future empirical and theoretical advancements.

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CHAPTER I:

INTRODUCTION

1.1 Introduction

The rapid urbanization of the 21st century has introduced unprecedented challenges in resource management, infrastructure development, and urban sustainability. As cities worldwide strive to enhance the life quality of inhabitants, the smart cities concept has emerged as a transformative paradigm, leveraging advanced technologies to optimize urban functionality and efficiency. However, amidst the volatile, uncertain, complex, and ambiguous (VUCA) environment of modern cities, the role of Information and Communication Technology (ICT) companies in driving this transformation has become increasingly significant.

Smart cities are not merely an assemblage of intelligent systems but a dynamic ecosystem that necessitates continuous adaptation and innovation. The ability to sense opportunities, seize them effectively, and transform organizational capabilities accordingly defines the essence of dynamic capabilities, a concept that has gained traction in strategic management and urban planning. For ICT companies, these dynamic capabilities are pivotal in navigating the complexities of smart city development, enabling them to integrate disruptive technologies, optimize decision-making, and foster long-term urban resilience.

This study explores the intersection of dynamic capabilities and smart city development, focusing on how ICT companies can strategically position themselves within this evolving landscape. By assessing the ability of ICT firms to anticipate emerging trends, allocate resources efficiently, and reconfigure their technological assets, this research aims to construct a comprehensive framework for evaluating the role of ICT in smart city initiatives. Furthermore, by incorporating analytical methodologies such as the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA), this study provides an empirical foundation for measuring and benchmarking the dynamic capabilities of ICT firms.

The potential of this research lies in its momentum to link the gap of academic theory and practical implementation. While the discourse on smart cities has predominantly centered around technological advancements and policy frameworks, there remains a crucial need to understand the strategic mechanisms that underpin sustainable urban transformation. By addressing this gap, this study not only supports to the current state of knowledge , however it offers actionable insights for industry practitioners, officials, and urban planners trying to enhance the efficiriveness for smart city projects.

In an era where urban environments are becoming increasingly interconnected and technology-driven, the ability to adapt and innovate is no longer optional—it is imperative. This study, therefore, serves as a guiding blueprint for ICT companies seeking to thrive in the smart city domain, providing a structured approach to harnessing dynamic capabilities for sustainable and intelligent urban growth.

1.2 Research Problem

In today's rapidly evolving technological landscape, Information and Communication Technology (ICT) companies play a pivotal role in the development of smart cities. These companies are essential for integrating innovative solutions that drive urban efficiency, sustainability, and improved quality of life. However, a critical challenge facing these companies is their dynamic capabilities, which are crucial for adapting to and thriving in the smart city sector. Dynamic capabilities defined as the ability of a corporate to integrate, build, and reconfigure internal and external competences to address fast changing environments.

The problem lies in the insufficient understanding and implementation of these capabilities, which includes sensing opportunities and threats, seizing opportunities, and maintaining competitiveness through transformation. For ICT companies eager to engage in smart city projects, the lack of robust dynamic capabilities can lead to missed opportunities, inefficient responses to technological advancements, and a failure to innovate sustainably.

Furthermore, the absence of a standardized framework for assessing and enhancing these capabilities hinders ICT companies from effectively aligning their strategic objectives with the demands of smart city initiatives. This misalignment can result in suboptimal contributions to smart city projects and may even cause these projects to falter, affecting broader urban development goals.

Thus, this problem necessitates a thorough investigation and development of strategic frameworks that support ICT companies in enhancing their dynamic capabilities, ensuring they can successfully contribute to and benefit from the burgeoning smart city industry.

1.3 Purpose of Research

The purpose of this research is to assess the dynamic capabilities of ICT companies in the implementation of smart city projects. By applying Dynamic Capabilities Theory, the study aims to evaluate how well companies can sense, seize, and transform opportunities within the rapidly evolving smart city ecosystem. The research seeks to develop an analytical framework utilizing methods such as Exploratory Factor Analysis (EFA) and Analytic Hierarchy Process (AHP) to systematically measure and benchmark these capabilities. Understanding these dynamic capabilities will provide actionable insights for improving strategic decision-making in smart city projects, identify critical success factors necessary for sustainable smart city implementations, and contribute to the academic discourse on dynamic capabilities in ICT firms operating in volatile, uncertain, complex, and ambiguous (VUCA) environments.

1.4 Significance of the Study

Saudi Arabia is at the forefront of the global smart city revolution, spearheading transformative projects such as NEOM, The Line Smart City, and the New Murabba. The market is valued at approximately 800 billion USD , and NEOM is $500 Billion USD. These ambitious initiatives embody the Kingdom’s commitment to innovation, sustainability, and digital transformation under Vision 2030. By utilizing the new technologies, artificial intelligence, and IoT-driven technology.

As a professional working in one of the major ICT companies in the country, my role places me at the heart of this transformation. The complexity and scale of these projects necessitate a robust understanding to measure and evaluate the dynamic capabilities required to successfully implement and sustain smart cities. Dynamic capabilities—such as sensing technological trends, seizing opportunities, and transforming business operations—are critical for ensuring the delivery of high-quality, innovative, and future-proof smart city projects.

This study is significant as it aims to develop a systematic approach to assessing these dynamic capabilities within the ICT sector, providing insights into how organizations can enhance their strategic agility, innovation capacity, and execution excellence. By identifying the key enablers and barriers within smart city projects, the research will contribute to improving project efficiency, optimizing resource allocation, and ensuring the sustainability of smart city developments.

Furthermore, the findings of this study will offer practical recommendations for policymakers, technology leaders, and urban planners in Saudi Arabia, helping them refine strategies that align with the Kingdom's long-term objectives. Ultimately, this research will play a pivotal role in ensuring that the next generation of smart cities in Saudi Arabia is built on a foundation of technological excellence, strategic foresight, and sustainable innovation structure, Saudi Arabia is redefining the urban landscape, positioning itself as a global leader in smart city development.

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1.5 Research Questions

How can the dynamic capabilities of ICT comapny be evaluated to determine their effectiveness and areas for improvement in smart cities projects implementation?

1.6 Limitations, and Assumptions

One key limitation of this study is that it focuses on measuring the dynamic capabilities of a single ICT company, which, while being a major player in its country, may not fully represent the broader ICT industry or other companies operating in the smart city sector. However, this study operates under several assumptions to ensure its validity. It is assumed that the Dynamic Capabilities Theory is applicable to this company's operations and strategic decision-making. Additionally, the study assumes that analyzing this one major ICT company can provide insights into broader industry trends at the national level. The research also relies on the assumption that the data collected—whether from internal reports, employee surveys, or external sources—is accurate and sufficient for evaluating the company's sensing, seizing, and transforming capabilities. Furthermore, it is assumed that the company's leadership actively engages in dynamic capabilities to enhance its role in smart city development rather than merely reacting to external market forces. Finally, the study assumes that there are no significant external shocks (such as economic crises or regulatory changes) during the research period that could drastically alter the company's capabilities beyond normal business fluctuations.

1.7 Definition of terms

Analytical Hierarchy Process (AHP)

A structured decision-making process that uses pairwise comparisons to determine the relative importance of multiple criteria. It is commonly applied in multi-criteria decision-making (MCDM) scenarios.

Confirmatory Factor Analysis (CFA)

A statistical method used to verify the factor structure of a set of observed variables, commonly used in social sciences and psychometric research.

Critical Success Factor (CSF)

Key areas that must be performed well for an organization or project to achieve its mission and objectives successfully.

Exploratory Factor Analysis (EFA)

A statistical technique used to identify underlying relationships between measured variables and to uncover the latent constructs that influence observed data.

System Dynamics (SD)

A modeling approach used to understand and simulate complex systems by analyzing feedback loops, delays, and interdependencies.

1.8 Overview of Smart Cities and Dynamic Capabilities

Smart cities are more prevalent as metropolitan regions globally seek to enhance the superiority of individuals' lives and improve resource use. A smart city is characterized as a metropolitan region that incorporates its physical, information technology, social, and business infrastructures in order to take advantage of the collective knowledge and insights within the community. Mohanty, et al. (2016). technological intelligence framework indicates impulsive computation principles such as automatic configuration, autonomous recovery, self-defense, and continuous optimization Nam , et al. (2011).

Smart city urban dwellers are the essential component. According to the World Health Organization (WHO), 55% of people worldwide resides in urban environments, underscoring the necessity for substantial initiatives to incorporate citizens into the smart city paradigm. These residents are key contributors to the creation of the intelligent city, as the systems ultimately need to cater to their needs.

Smart city platforms are increasingly becoming an essential part of modern cities, i.e., they are a crucial enabler of this transformation, providing a common infrastructure for integrating and managing a wide range of sensors, actuators, and data sources. Moreover, these platforms leverage data and technology to improve citizens' quality of life and maximize the efficiency of resource utilization. However, adopting such platforms can be challenging due to the disruptive nature of the technologies involved and the volatile, uncertain, complex, and ambiguous (VUCA) environment in which cities operate. As a result, decision-makers need to grasp the advantages and potential risks associated with different smart city platforms and how they can leverage dynamic capabilities to use smart city big data to make effective decisions on managing the city.

Several smart city platforms are available, each with strengths and weaknesses. Furthermore, the choice of platform can have a significant impact on decision-making. Some platforms are used for specific applications; others may prioritize data collection and analysis, traffic management, or water management. In comparison, others may focus on citizen engagement and participation. Others are more general-purpose and can use for a variety of applications. Decision-makers needs to have evaluation for platform's strengths and weaknesses, which helps decision-makers ability to adopt new disruptive technologies. A well-designed and easy-to-use platform will make it easier for decision-makers to experiment with new technologies, find solutions that work for their city, and consider their specific needs and priorities.

1.8.1 Smart City Generations

The smart city advancement has made significant progress through various stages of innovation, with each phase building upon its predecessor. In the first generation of Smart Cities, known as Smart City 1.0, digital technologies are utilized to enhance and automate urban systems and services, including traffic management, public safety, and waste collection. The primary objectives are efficiency and cost savings, and decision-making tends to be centralized and top-down.

In contrast, Smart City 2.0 adopts a citizen-centric approach by integrating open data, participatory platforms, and feedback mechanisms to empower residents to co-create and co-manage their urban environment, fostering a sense of ownership and accountability. This stage acknowledges the crucial role of citizen involvement and participation in the evolution of urban settings.

Smart City 3.0 expands the scope of Smart Cities by encompassing more intricate and interconnected systems such as energy, water, and food. It adopts a more comprehensive and integrated approach, acknowledging the interdependence and trade-offs between different urban functions.

The latest iteration of Smart Cities, Smart City 4.0, surpasses the optimization and management of urban systems by addressing broader societal challenges, such as inequality, climate change, and social cohesion. This stage harnesses emerging technologies like AI, blockchain, and the IoT to create more intelligent and adaptive urban systems that can gain insights and responses based on these data. The focus of Smart City 4.0 is to create a regenerative and resilient urban ecosystem that benefits all residents.

1.8.2 VUCA and Dynamic Capabilities Environment

The VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) has been widely used to describe the unpredictable and fast-growing nature of the modern business environment. As the speed of modern technological innovation continues to accelerate, decision-makers across different sectors encounter numerous challenges when implementing new technologies. and trends. Smart cities are no exception to this trend and are increasingly subject to the VUCA phenomenon.

Urban planners and decision-makers in smart cities face complex challenges in adapting to the constantly changing technological landscape. In particular, new technologies like the well-known IoT (Internet of Things), AI (artificial intelligence), and big data analytics have created new opportunities and challenges.

These technologies can provide new insights into urban planning, improve service delivery for public people, and enhance citizens' quality of life. However, their implementation can also be complex, costly, and fraught with uncertainty.

- **Smart City Volatility**

Volatility describes the rapidity changes and its intensity within the business ecosystem. Within the framework of smart cities, this means that urban planners must be ready to adjust to rapidly changing technologies and react swiftly to new trends.

- **Smart City Uncertainty**

Uncertainty is about the absence of predictability in the business environment. For smart cities, this means that decision-makers must be ready to navigate an environment where the outcomes of implementing new technologies are uncertain.

- **Smart City Complexity**

Complexity pertains to the interdependence and interconnectedness of different elements in the business environment. Within the framework of smart cities, this means that decision-makers must be able to understand and manage the complex interrelationships between different technologies, public services, and stakeholders.

- **Smart City Ambiguity**

Ambiguity pertains to the absence of clarity or comprehension of a business's ecosystem. In smart cities, this means that decision-makers must be able to make effective decisions in an environment where information is incomplete or ambiguous.

1.8.3 Smart City Dynamic Capabilities

To effectively navigate the VUCA environment, decision-makers in smart cities require dynamic capabilities. Dynamic capabilities are considered an organization's ability to adapt to changing circumstances and seize new opportunities. Dynamic capabilities encompass core strategic and organizational activities through Which supervisors Modify their resources, obtain and release resources, combine them, and reconfigure them to formulate innovative strategies that generate value (Eisenhardt and Martin, 2000). Within the framework of smart cities, dynamic capabilities are vital for decision-makers to stay ahead of the curve regarding innovation and efficiency. For example, decision-makers must be able to quickly identify new technologies that can improve the public provision of services, experiment with different implementation strategies, and learn from their successes and failures.

Smart city platforms can be important in supporting decision makers' dynamic capabilities. These platforms provide a common infrastructure for managing data and enable decision-makers to experiment with new technologies more easily. By providing decision-makers with access to real-time data and analytics, smart city platforms can also help them make more informed decisions. For example, a smart city platform might enable urban planners to collect data on traffic flows, air quality, and public transport usage and use this data to optimize the public provision for the services.

In addition, decision-makers can use a range of other strategies to build their dynamic capabilities. One strategy is to cultivate an innovative culture and experimentation. This might involve encouraging employees to generate new ideas with trend technologies and learn from their successes and failures. Another strategy is to collaborate with other organizations and stakeholders. By partnering with other organizations, decision-makers can leverage their expertise and resources to build new capabilities and respond to emerging trends.

Urban planners and decision-makers in smart cities Should be ready to navigate a rapidly changing and unpredictable business environment. In order to do this, decision-makers flexible abilities that allow them to modify changing situations, seize new opportunities, and stay updated in terms of innovation and efficiency.

1.8.4 Dynamic Capabilities of ICT Companies

Dynamic capabilities, specifically the starting point of dynamic capabilities sensing, then the middle process of seizing, and finally transforming, contribute significantly to the success of ICT companies. Sensing is the capability of an enterprise to acknowledge and evaluate alterations to the outside world, including market trends and technological advancements. This capability is critical for ICT companies to maintain a lead over competitors by recognizing new opportunities early. For example, proactive sensing involves systematic environmental scanning to notice initial signs of new ideas or trends, enabling timely Reactions to new opportunities.

Seizing is putting resources into action to seize opportunities that have been recognized. This capability allows companies to improve and implement strategies that capitalize on new market possibilities. Effective seizing requires firms to be agile and responsive, making informed decisions based on a thorough evaluation of possible advantages and drawbacks.

Transformation, or reconfiguring capabilities, involves the ability to perpetually adjust and reorganize organizational assets to address evolving market dynamics and technological advancements. This process ensures that firms remain competitive by aligning their assets and competencies with the industry's evolving demands Sajib, (2018) .

ICT plays a crucial role in smart city development by serving as the backbone for various urban functions, enabling efficient resource management, and supporting sustainable development. It offers a strategic framework for decision-makers and urban planners. to avoid pitfalls like inefficient investments and short-term solutions. With the use of technologies like data analytics, cloud computing, and the Internet of Things, Real-time data collecting is made easier by ICT, enhances connectivity, and supports intelligent decision-making across multiple domains, such as energy, transportation, healthcare, and governance. This integration promotes enhanced service delivery and a higher quality of life, as well as innovation and growth within urban environments. Furthermore, ICT enables the automation of city operations, the creation of intelligent infrastructure, and the creation of smart governance practices, ensuring cities are adaptable and resilient. By empowering citizens and businesses with the availability of digital services, ICT contributes to smart cities' overall economic and social vitality, making them more inclusive and sustainable El Hendy ,et al. (2015).

The link between smart cities, ICT, and dynamic capabilities is crucial to contemporary urban development. Smart cities utilize ICT to develop interconnected and responsive urban systems where real-time data collection and advanced analytics enhance resource management and service delivery. This technological infrastructure supports city operations and enables the essential dynamic capabilities for continuous adaptation and innovation. With ICT integration, smart cities can quickly respond to changing conditions, optimize processes, and encourage a culture of ongoing improvement and resilience. This synergy between ICT and dynamic capabilities ensures that smart cities remain adaptable, sustainable, and capable of addressing the evolving needs of their residents.

1.8.5 Decision-Making Methods

Decision-making methods are classified into multi-criteria decision-making, mathematical programming, artificial intelligence, and integrated methods Tran Thi Hoang et al., (2019). By examining these methods on smart city platforms, stakeholders can better understand decision-making, which reflects on prioritizing projects and allocating resources more effectively, ultimately leading to more resilient, eco-friendly, and prosperous urban environments.

When analyzing the possible future trends in smart cities, a key aspect is the necessity for a well-defined governance model and frameworks to support the decision-making and use of technologies in local governments, especially regarding the role of each actor in governing smart cities Pereira, et al. (2020).

CHAPTER II:

REVIEW OF LITERATURE

2.1 Introduction

A smart city is a place characterized by the use of advanced, integrated materials, sensors, electronics, and networks that are interfaced with computerized systems comprised of databases, tracking, and decision-making algorithms Teli, et al. (2015). The idea of smart cities has garnered considerable attention in recent years due to the growing challenges faced by city governments Zhao, et al. (2021). These challenges include rapid urbanization, increasing population density, resource constraints, and the necessity for sustainable development.

The literature review conducted on the dynamic capabilities of ICT companies working in the smart cities building field reveals several key themes that are crucial to understanding the concept and its implications.

According to the European Commission, a smart city is “A place where existing networks and services are enhanced using digital and telecommunication technologies to serve its residents and businesses better.” (European Commission, p. 6) Israilidis, et al. (2021).

The smart city combines smart people, smart technology, and smart collaboration Timeus, et al.(2020). Ismagilova, et al.(2019) Highlight the importance of strong leadership and collaboration among different stakeholders in smart city decision-making. An important theme is the role of decision-makers in shaping and executing smart city initiatives. Decision-makers, such as city governments, urban planners, and policymakers, play a critical role in driving the expansion and execution of smart city solutions.

The concept of dynamic capabilities is a key factor for successful smart city development. It's mention to the ability of organizations and cities to continuously learn, adapt, and innovate in a way to act in a changing environment. Despite considerable research on dynamic capabilities, especially of public sector mangers, there have been no studies based on empirical data for smart city managers' dynamic managerial capabilities. This is alarming because smart city managers' positions and tasks help in smart city transformation, this is requires from them to get a deep understanding for the dynamics of a metropolis where the surroundings are always shifting then they needs to integrate , and create, then doing the required reconfigure to the resources to cope with rapid changes.

Fernandez-Anez et al. Zhao, et al. (2021) explore the concept of dynamic capabilities in the outline of smart city governance and argue that cities need to develop dynamic capabilities to effectively navigate the complexities and uncertainties of the smart city landscape.

Smart cities not only rely on a city's hard infrastructure , but also on the exitance and quality of information and communication of social infrastructure Israilidis, et al. (2021). Smart cities also operate in a VUCA environment. This means that smart cities must be able to adapt and respond to rapidly changing conditions and challenges. Ismagilova, et al. (2019) highlight the requirement for creativity and agility in smart city systems to navigate the uncertainties and complexities of the urban environment.

The development of smart cities is increasingly recognized as a pivotal strategy for addressing urban challenges, with decision-makers playing an important role in this transformation. Disruptive technologies like the IoT, artificial intelligence, analytics of the big data, cloud computing, and blockchain are key to this evolution. These innovations offer remarkable opportunities to revolutionize urban infrastructure, enhance service delivery, and improve residents' quality of life. The notion of dynamic capabilities emerges as vital, emphasizing the need for continuous learning, adaptation, and innovation in response to changing urban environments. This is particularly relevant for smart city managers who swiftly integrate and reconfigure resources.

2.2 The Inclusion Criteria

The initial phase of our literature review involved crafting the research queries, which served to delineate the study's scope and steer the review procedure. The systematic review sought to explore the present status of smart cities by scrutinizing decision-makers, dynamic capabilities, VUCA disruptive technologies, smart city platforms, business models of the smart city, and smart city framework. In this literature review, we tried to answer the following questions:

- How do dynamic capabilities help organizations adapt and thrive in smart city projects?
- What defines a smart city, and what factors drive its success?
- How can multi-criteria decision making guide smart city initiatives?
- Are there identifiable dynamic capabilities associated with smart cities?
- Which critical success factors are most important for smart city development?

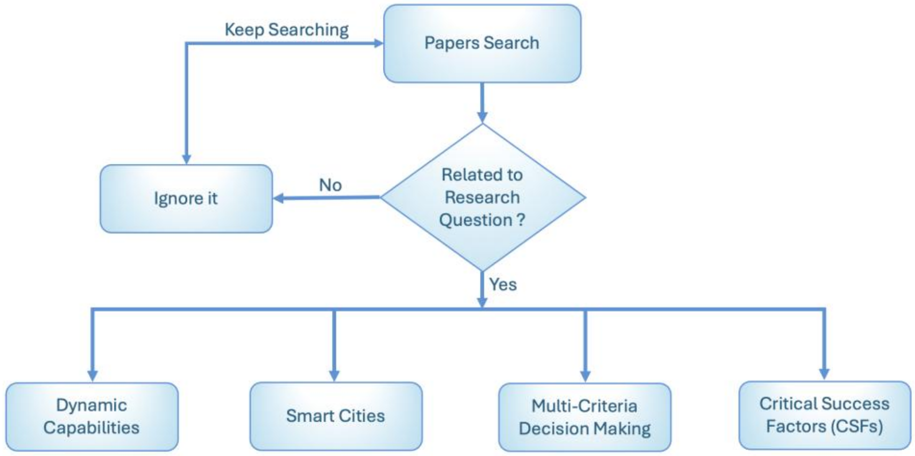

Figure 1 The Search Process

Figure 1 shows the search process while the table 1 shows the literature review reference list.

Table 1 The Literature Review References List

The Topic	The References List
Dynamic Capabilities	Abro et al. (2011); Adner & Helfat (2003); Eisenhardt & Martin (2000); Teece, Pisano & Shuen (1997); Teece (2007, 2016, 2018a, 2018b, 2023); Teece & Linden (2017); Parida et al. (2016); Ellström et al. (2021); Konlechner et al. (2018) ; Laaksonen & Peltoniemi (2018); Kump et al. (2019); Chirumalla (2021)
Smart Cities	Achmad et al. (2018); Anindra et al. (2018); Attaran et al. (2022); Batty (2016); Bolivar & Meijer (2016); Chamoso et al. (2015, 2018); Choudhary et al. (2018); Daim (2017); Diaz-Diaz et al. (2017); El Hendy et al. (2015, 2022); Giang et al. (2017); Giourka et al. (2019); Gracias et al. (2023); Ghades et al. (2021) ; Ismagilova et al. (2019); Israilidis et al. (2021); Kogan & Lee (2014); Mohanty et al. (2016); Nam & Pardo (2011); Pereira et al. (2020); Radu (2020); Rana et al. (2019); Saric et al. (2021); Szpilko (2020); Teli et al. (2015); Timeus et al. (2020)
Multi-Criteria Decision Making	Aruldoss et al. (2013); Chai et al. (2013); Das et al. (2020); Gaisser et al. (2006); Ishizaka & Labib (2011); Langemeyer et al. (2016); Mishra et al. (2018); Rondini et al. (2018); Vaidya & Kumar (2006); Zapolskytė et al. (2020)
Critical Success Factors (CSFs)	Hasanali (2002); Joshi et al. (2015); Martins (2024); Paroutis et al. (2014); Ram & Corkindale (2014); Trkman (2010)

2.3 Theoretical Framework

This dissertation is based on the Dynamic Capabilities Theory, which serves as a fundamental theoretical framework for understanding how companies adapt to dynamic and complex environments, such as smart cities. This theory posits that companies with strong dynamic capabilities can effectively sense opportunities and challenges (Sensing), seize them (Seizing), and transform/adapt (Transforming) to enhance their innovation and sustainability in rapidly changing conditions.

In this research, the Dynamic Capabilities Theory is employed as a foundation to examine how Information and Communication Technology (ICT) companies respond to smart city requirements by assessing their ability to develop sustainable strategies and make effective decisions within a volatile, uncertain, complex, and ambiguous (VUCA) environment. By analyzing the factors influencing these companies' dynamic capabilities, this study contributes to the development of an innovative measurement framework that helps both companies and decision-makers evaluate their readiness to navigate digital transformations and smart city demands.

Based on this theory, the research hypotheses will be tested using analytical and statistical methods such as Exploratory Factor Analysis (EFA). This approach enables the study to derive evidence-based findings that enhance our understanding of how companies can improve their performance within the smart city landscape. Thus, this theory is not merely an analytical framework but serves as the key to solving the research problem, providing practical recommendations for businesses and policymakers on how to build more effective dynamic capabilities to keep pace with smart city advancements.

2.3 Smart City Domain Structure

Smart city preparation and governance, as in Zhao, et al. (2021), is the most researched area in smart city studies and plays a central part in decision-making processes that shape the success and sustainability of smart urban environments. This involves strategic decisions on integrating technology, formulating, and implementing policies, managing resources, and engaging with various stakeholders, including residents, businesses, and government entities. The emphasis on this area in research reflects the complexity of balancing technological integration with commercial, community, and ecological objectives. Decisions made in this domain impact everything from urban development strategies to the arrangement of smart technologies and the effective management of resources. Furthermore, these decisions address critical social and ethical concerns such as confidentiality, information security, and ensuring equitable benefits of smart cities. Thus, the extensive research in smart city development and governance highlights its significance as the nexus of strategic decision-making, crucial for creating efficient, sustainable, and inclusive smart cities.

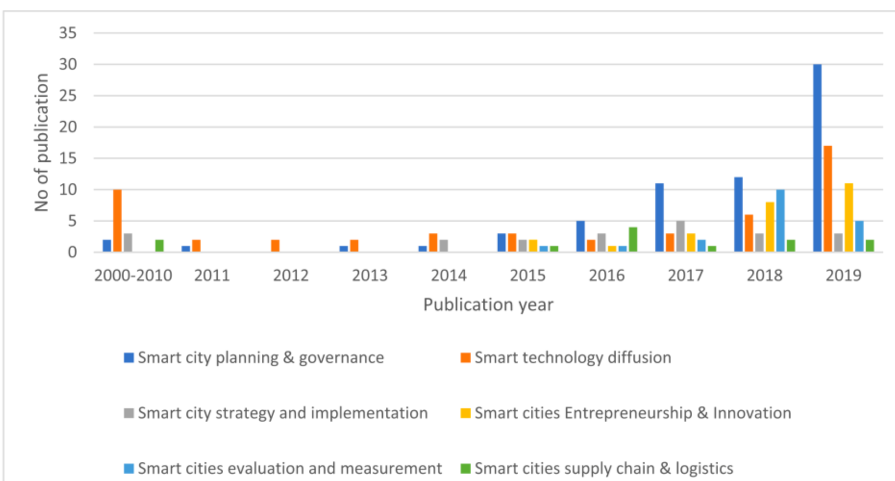

Figure 2 Growth of smart city investigate by focus area Zhao, et al. (2021)

The bar chart in Figure 2 appears to show the number of papers per year across various research areas of smart cities. The blue bars represent the area of "Smart city planning & governance." From the visible trend, there is a clear growing in the number of published papers in this area, especially noticeable in the years leading up to 2019, where there is a significant peak. This suggests a heightened focus and increases scholarly output in the field of smart city forecasting and governance during these years, indicating it as a topic of rising importance and interest within the academic community.

The increase in publications likely corresponds to the evolving complexity of urban environments and the corresponding need to better understand how to effectively plan, govern, and manage smart city initiatives. As cities convert into more organized form and dependent on technology, the challenges associated with planning and governance become more complex, thus driving research efforts in this area. This trend may also reflect the increasing investments in smart city technologies, the evolution of policy frameworks, and the expanding global interest in creating more workable, effective, and technologically integrated urban spaces.

2.3.1 Smart City Structure

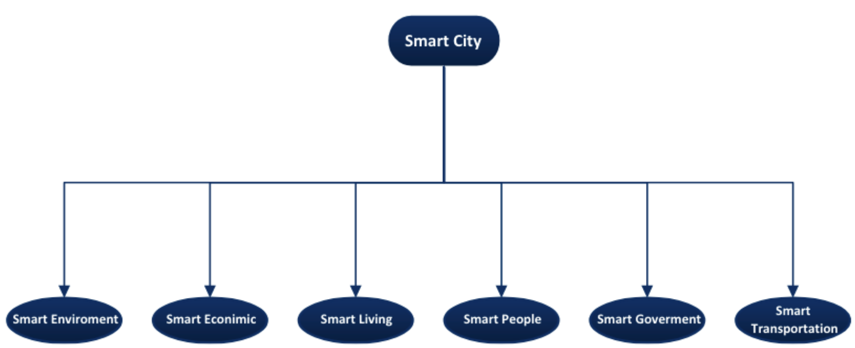

Figure 3 The General six dimensions model of smart city Attaran, et al. (2022)

The structure of a smart city, as in Attaran, et al. (2022), is characterized by its integration of various technological and organizational components to enhance urban life. This structure typically includes the core gears: smart people, smart government, smart environment, smart transportation, smart economy, and smart life.

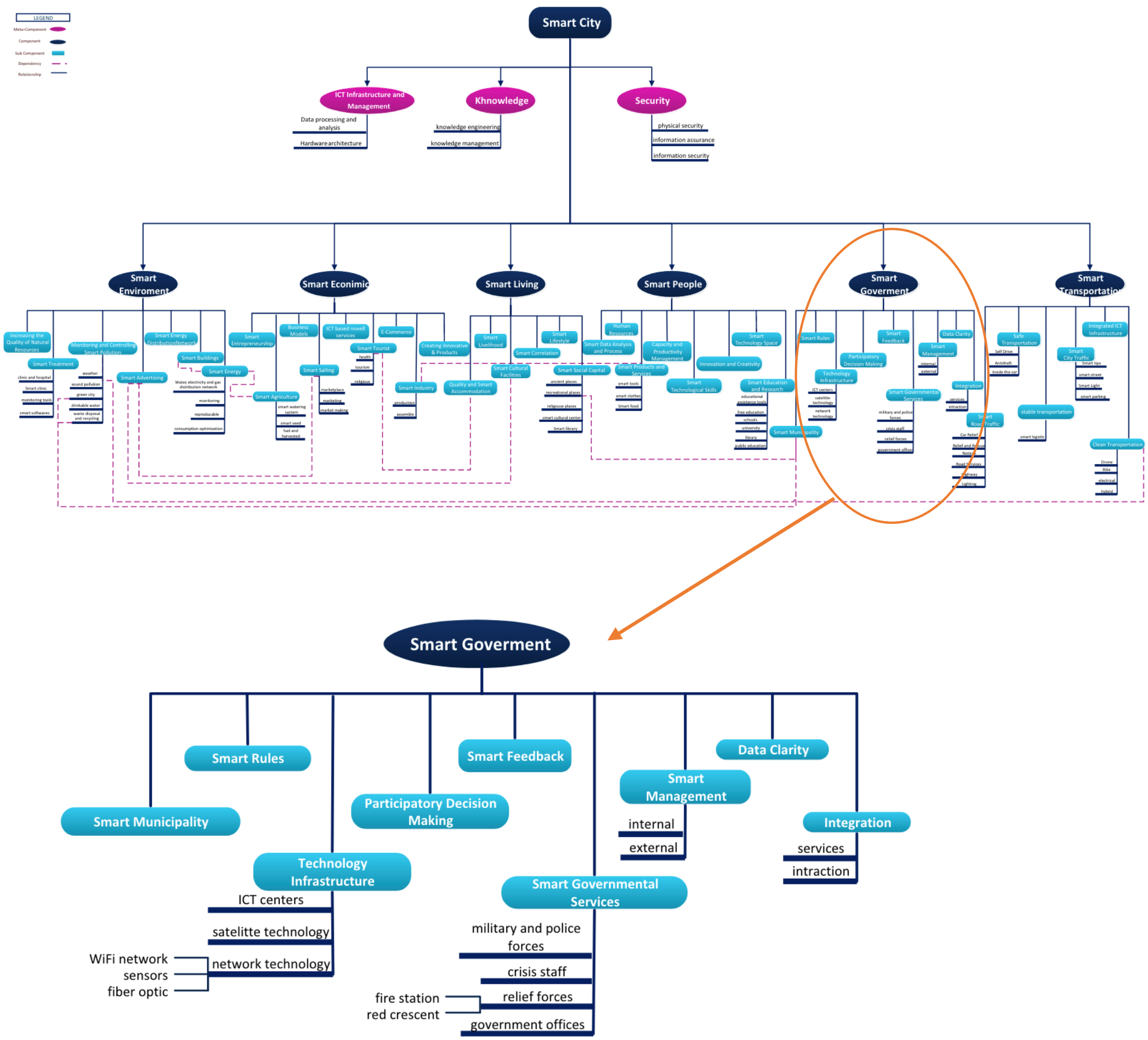

Figure 4 Decision Making of Smart City Structure Attaran, et al. (2022)

These elements work in concert to create a cohesive and efficient urban ecosystem. Smart governance plays a pivotal role, utilizing ICT (information and communication technologies) to improve services and interactions among private, public, and civil organizations. This allows the city to function effectively, leveraging technology infrastructure like IoT, sensors, and data analytics. The model stresses on the status of participatory decision-making, enabling citizens to engage actively with their city's management and contribute to its development. This integrated approach aims to improve resource use, improve the life quality, and ensure sustainable urban development.

2.3.2 Smart City Resources

Achmad, et al. (2018) made a categorization of smart city resources into three key structures: Suprastructure, Infrastructure, and Infostructure.

- **Suprastructure (Brainware):** Encompasses non-physical elements like leadership, policy, and governance, that are vital for strategic planning and resource management.
- **Infrastructure (Hardware):** Includes physical and technological resources like network infrastructure and data centers, which are vital for operational efficiency and service support.
- **Infostructure (Software):** Involves the management of information systems, data, and applications, which are crucial for data-driven decision-making and enhancing city services.

Together, these structures form a comprehensive framework for effectively managing and evolving smart cities, aiming to improve urban living.

The relationship between Smart City Resources and the six key structures of smart cities (economy, mobility, environment, people, living, and governance) is established through a framework where resources are managed to enhance these dimensions effectively.

- **Economy:** Suprastructure resources involving leadership, policy, and governance offers a central part in shaping the economic dimension by framing economic policies and strategies, while infrastructure and infostructure resources support the technological and physical characteristics of economic improvement.

- **Mobility:** Infrastructure resources, including transportation systems and network infrastructure, are vital for developing the mobility dimension. Infostructure assists in managing data and information systems that enhance mobility services.

- **Environment:** Managing environmental aspects requires a synergy of all three resources. Infrastructure resources contribute to sustainable urban planning, green buildings, and waste management. Infostructure is key in environmental data analysis and monitoring.

- **People:** The people dimension is supported by suprastructure through policies focusing on social inclusion and education and by infostructure through systems that facilitate civic engagement and community development.

- **Living:** This dimension involves features the level of life quality such as health, housing, and cultural facilities. Infrastructure resources provide the necessary physical facilities, while infostructure enhances service delivery through information management.

- **Governance:** Governance is largely influenced by suprastructure, which includes policy-making and regulatory frameworks. Infostructure resources like e-governance platforms aid in transparent and efficient governance.

These six smart city structures are interconnected and dependent on the effective management of smart city resources suprastructure, infrastructure, and infostructure. Together, they form a comprehensive model for smart city development, where each resource contributes to the expansion for these key structures or dimensions.

2.3.3 Smart Governance Model

The model of governance based on smartness as in Bolívar, et al. (2016) is designed to enhance city management by integrating technology and innovation with collaborative governance. It's structured into three main parts:

- Implementation strategies.
    - Implementation strategies focus on a comprehensive vision and concrete actions like policy-making and legal frameworks.

- Governance arrangement.
    - The governance arrangement involves using technology and fostering internal and external collaboration for decision-making and administration.

- Outcomes.
    - The expected outcomes are efficient government operations, improved public services, and overall city development, aiming for economic growth, social inclusion, and ecological sustainability.

This model emphasizes that effective governance for smart cities relies on a blend of technology, collaborative processes, and strategic actions leading to tangible improvements in city life.

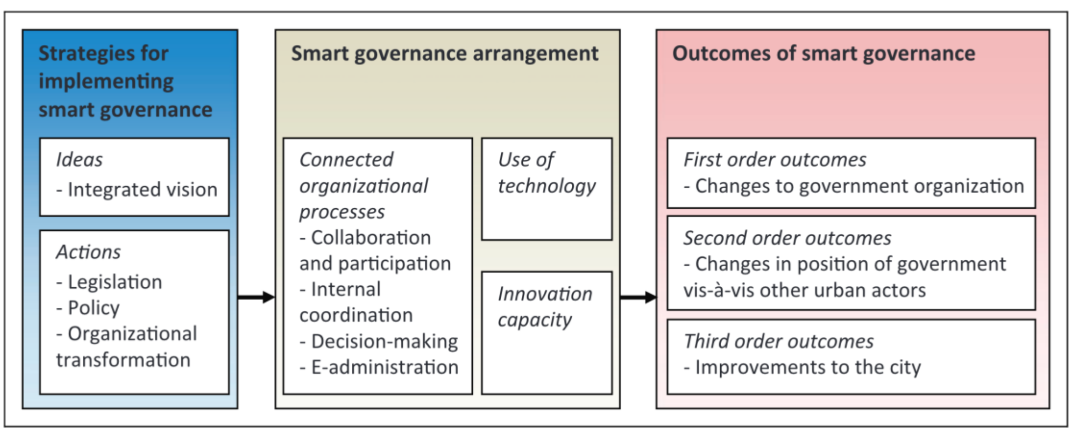

Figure 5 A model of smart governance Bolívar, et al. (2016)

The model of smart governance highlights its application in various types of research. It describes smart governance as a combination of organizational processes, use of technology, and novelty. This model can be utilized for study different forms of smart governance for the cities, mapping variations in approaches and understanding their impacts. The research can analyze the effects of these governance configurations by examining first-, second-, and third-generation outcomes, such as changes in government efficiency, relationships with external actors, and overall city improvements. The model suggests that all dimensions implementation strategies, governance arrangements, and outcomes need to be adequately addressed for effective smart governance. The document also emphasizes the need for upcoming investigations to consider contextual factors like administrative cultures political, demographic, and technological factors.

The following questionnaire should be answered based on your experience according to the current situation of the each one of the topics of the questions displayed in the current public management of your city.

Question 1: General attributes of smart governance This question is about the key elements of smart governance. Six main attributes have been highlighted based on prior research. We ask you to express your perception on the relevance of these domains in a 5-point Likert-type scale. Only one answer for each one of the attributes is allowed.					
Smart governance is governance based on . . .	Level of importance of the attributes				
	Not at all important	Low importance	Neutral	Moderately important	Extremely important
. . . .smart ICT					
. . . .smart external collaboration and participation					
. . . .smart internal coordination.					
. . . .smart decision-making processes					
. . . .smart e-administration					
. . . .based on the smart outcomes					
Question 2: Outcomes of smart governance This question is about the key outcomes of smart governance. Seven main outcomes have been highlighted based on prior research. We ask you to express your perception on the relevance of these domains in a 5-points Likert scale. Only one answer for each one of the outcomes is allowed.					
The main outcome that the smart governance is to achieve is	Level of importance of the outcomes				
	Not at all important	Low importance	Neutral	Moderately important	Extremely important
. . . .economic growth					
. . . .citizen-centric services					
. . . .social inclusion					
. . . .ecological performance					
. . . .interaction with citizens					
. . . .strong city brand					
. . . .more efficient government					
Question 3: Dimensions of smart governance This question is about the dimensions of smart governance. Five dimensions have identified based on prior research. We ask you to express your perception on the relevance of these dimensions in a 5-points Likert scale. Only one answer for each one of the domains is allowed.					
How important are the following strategies for realizing a smart city?	Level of importance of the dimensions				
	Not at all important	Low importance	Neutral	Moderately important	Extremely important
Legislation for stimulating smart city					
Policies for promoting smart city initiatives and projects					
Use of ICTs to strengthen smart cities					
An integral vision for a smart city					
Collaborative governance for a smart city					
Question 4: How would you define smart governance? This question is about the definition of smart governance. It is a free text question.					

Table 2 Smart Governance Questionnaire Bolívar, et al. (2016)

2.3.4 The Smart City Management Model

One key challenge faced by smart city projects, as in Gassmann, et al. (2019), is the absence of a clear frame of reference around which decision-makers can orient themselves. The reference frame should structure the time sequence of projects and should enable individuals to keep track of all relevant topics. Based on our research and our experience with smart city projects, we have developed the Smart City Management Model (SCMM) Figure 6, which provides the needed reference frame for ongoing transformation projects in cities and thus offers valuable assistance to future smart city projects.

As Figure 6 demonstrates, the SCMM combines three essential dimensions of change:

1. The service areas (in the center of the diagram).
2. The transformation process (depicted as a cycle).
3. The fundamental elements (which encompass the other two dimensions).

The SCMM is the foundation of the future vision for cities and the experiences of smart city lighthouses.

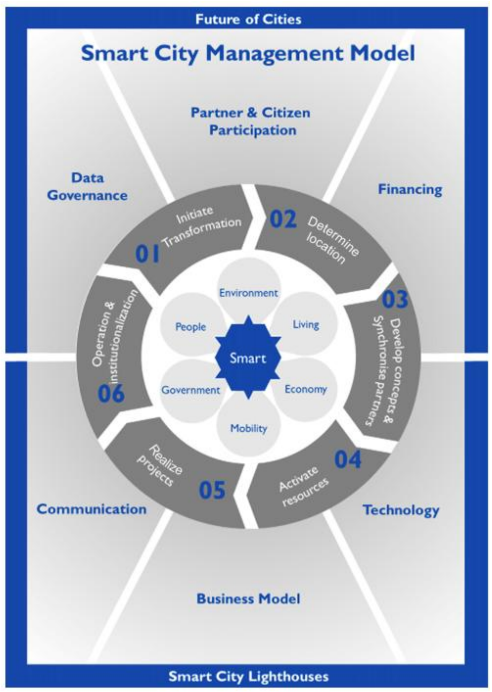

Figure 6 The Smart City Management Model Gassmann, et al. (2019)

Advantages and Challenges in Smart Cities

In smart cities, as in Gracias, et al. (2023), quantitative techniques are used to thoroughly evaluate and choose projects, ensuring they are beneficial, sustainable, and economically viable:

1. Cost-Benefit Analysis (CBA): This method assesses the financial characteristics of a project by comparing its costs against the expected benefits. It helps in understanding the economic feasibility and overall value of a project.

2. Life-Cycle Cost Analysis (LCCA): LCCA examines the overall cost of a project over its entire lifespan, including initial costs and ongoing operational expenses. This approach is particularly important for understanding long-term sustainability and environmental impacts.

3. Return on Investment (ROI) Analysis: This technique calculates the financial return from a project relative to its cost. It's crucial to ensure that a project is not only beneficial in terms of services or sustainability but also financially sound.

4. Multi-Criteria Decision Analysis (MCDA): MCDA allows for evaluating a project based on several principles, such as impact on the social, environmental impact, economic benefit, and technical feasibility. It helps in balancing various factors to select the most beneficial projects.

5. Big Data Analytics: This involves analyzing large volumes of data from many streams to uncover patterns, predict trends, and helps in decisions making based on information. In smart cities, this can relate to traffic patterns, energy usage, and other urban dynamics.

These methods collectively guarantee smart city missions are carefully chosen, balancing immediate costs with long-term benefits and aligning with broader urban development goals.

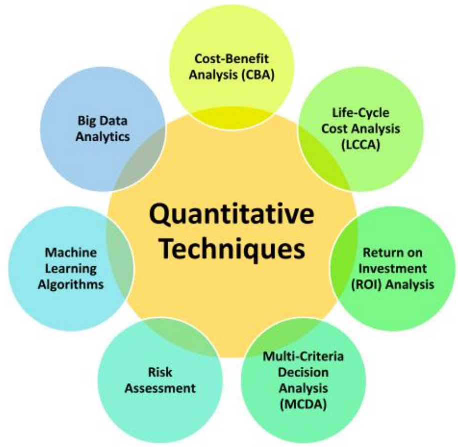

Figure 7 Quantitative Techniques for Smart Cities Gracias, et al. (2023)

2.3.5 VUCA

Volatility, Uncertainty, Complexity, and Ambiguity come from the world of the military and refer to the pace of change and the nature of issues that today's organizations face. The concept is highly relevant to smart cities.

The VUCA framework is relevant for smart city development. Smart cities operate in a complex and rapidly changing environment characterized by volatility, uncertainty, complexity, and ambiguity Batty (2016). This framework focuses on decision-makers to be adaptable, agile, and flexible in their approach to navigating and responding to these challenges.

The VUCA used to understand the challenges of managing emerging technology in smart cities. In developing countries, governments need to adopt adaptable approaches that balance the need for stable governance foundations with the need for agility in tailoring policies. This adaptation process can be facilitated by utilizing effective global models that are adjusted to suit local circumstances.

Realizing this objective will require governments to resolve the issue of fragmented authority and exert strong political will to ensure the effective enforcement of the smart city governance framework. To deal with volatility and policy uncertainty in governing novel technology in smart cities, governments in developing countries need to be strongly adaptive toward changing circumstances by maintaining the stability of governance structures and by being agile in contextualizing policies that have worked in other countries and modifying them to suit local conditions Tan, et al. (2020) .

The corporate environment today is characterized by four challenging developments. These include rising market volatility, a faster pace of change, increasing complexity, and the shift of power from companies to suppliers and customers. (Schön, 2012).Decision-makers in smart city development must be equipped with the capabilities to handle the VUCA environment effectively.

In Mack, et al. (2015), decision-makers face significant challenges that necessitate a departure from traditional decision-making models. The document focuses on the status of recognizing VUCA as a complex system that influences decision-making processes, where volatility and uncertainty are observable properties leading to ambiguity. It suggests that in highly dynamic and interconnected environments, decision-makers must adopt new models and approaches, moving away from simple, rational cause-and-effect mind models. This involves embracing more democratic decision processes within organizations, with decentralized competence and teams acting autonomously within a given framework. The interplay of VUCA elements is also crucial, with complexity influencing volatility, uncertainty, and ambiguity, specifically in areas like supply chain management. To effectively navigate these challenges, decision-makers must balance order and chaos within organizations, fostering innovation and efficiency while adapting to the unpredictable impacts of their decisions on VUCA dimensions.

Giang, et al. (2017) addresses the aspect of uncertainty in the decision-making processes within Smart City Living Labs. It acknowledges that dealing with complex urban projects involves inherent uncertainties due to the dynamic interplay of various stakeholders and unpredictable urban development factors. The reviewed methodologies, such as Multi-Agent Systems (MAS), System Dynamics (SD), and Multi-Criteria Decision Analysis (MCDA), differ in their capabilities to handle and evaluate these uncertainties.

Particularly, the paper notes that while MAS offers a robust framework for simulating stakeholder interactions, its direct approach to quantifying and managing uncertainty is not extensively detailed. Instead, methodologies like Bayesian Networks, which also feature in the discussion, are more adept at handling uncertainty through probabilistic methods and are thus more suitable for scenarios with unclear or unpredictable outcomes.

This focus on uncertainty underlines a critical challenge in modeling decision-making for smart city projects: the need for methodologies that not only represent the complexity of stakeholder interactions but also effectively address the uncertainties inherent in the rapidly evolving urban environment.

2.3.6 Disruptive Technologies

To understand the disruptive technologies in smart cities domain. Various definitions of smart cities have been proposed, all emphasizing the development for the digital society (Radu, 2020).The integration of disruptive technologies is a key aspect of smart city change. Smart cities go beyond simply automating repetitive tasks or optimizing space and infrastructure usage. Rather, they encompass innovative solutions that enhance urban living in terms of people, governance, economy, mobility, environment, and inclusive life quality Pereira, et al. (2020).

According to Radu (2020), smart cities involve the merger of information and communication technology with traditional infrastructures, leading to the creation of intelligent urban environments that facilitate efficient and sustainable urban development. These technologies include but are not limited to big data, Internet of Things, Artificial Intelligence, cloud computing, and blockchain. These technologies have the likely to transform various features of smart cities and significantly impact urban living.

The integration of disruptive technologies in smart cities has been extensively studied in the literature. The research conducted on disruptive technologies for smart cities highlights several crucial aspects.

Disruptive technologies such as the big data analytics Internet of Things, blockchain, artificial intelligence, have the possible to transform various aspects of urban living, including transportation, energy management, public safety, healthcare, and governance Streimikis, et al. (2021).

According to the literature, disruptive technologies can enable real-time data collection, analysis, and decision-making, improve resource allocation and management, enhance citizen participation and engagement, and optimize urban services and infrastructure. These technologies enable cities to collect and analyze vast amounts of data, make real-time decisions, and improve the quality of life for their residents.

The technologies movement like a big data and the Internet of Things has significantly contributed to the deployment of smart city initiatives Pereira, et al. (2020). These technologies enable the gathering, examination, and utilization of vast amounts of data, leading to improved efficiency and effectiveness in urban planning, resource management, and service delivery. Artificial Intelligence has emerged as a key disruptive technology in smart cities. AI has the capability to investigate massive amounts of data, identify patterns, and make predictions or recommendations, which can greatly enhance decision-making processes in various domains such as transportation, healthcare, and public safety. The integration in smart cities of these disruptive technologies has various applications that contribute to the overall development and improvement of the cities Gade (2021).

Derchi (2022) Focuses on the concept of disruption, particularly for digital technologies and their impact on industries such as Hospitality and tourism. It begins by defining disruption as a process, not a single event, influenced by changes in resource allocation, customer needs, and technological evolution. The Chain Reaction of the Technological Progression model, detailed in Derchi (2022), describes the transformative journey of technology through six distinct stages: Digitized, Deceptive, Disruptive, Demonetization, Dematerialization, and Democratization. Each stage represents a phase in the shift from traditional, linear, and local models to more global, exponential ones. The model begins with the "Digitized" phase, where processes and services transition from physical to digital formats. This is followed by the "Deceptive" phase, where technological advancements seem insignificant due to their initial small scale, often leading to underestimation of their potential impact. The subsequent stages – "Disruptive," "Demonetization," "Dematerialization," and "Democratization" – further illustrate the escalating impact of technology, leading to significant societal and industrial changes. This model encapsulates the dynamic and exponential nature of technological evolution, highlighting the profound changes it brings to industries and societies.

By leveraging disruptive technologies such as the IoT, AI, and big data, smart cities can collect and analyze real-time data to improve services and infrastructure, enhance resource management, and create new opportunities for economic growth.

Decision-makers, such as city governments and politicians, play a vital role in driving the adoption and implementation of disruptive technologies in smart cities. They are responsible for setting policies, regulations, and standards that govern the use of technologies and ensure their alignment with the overall goals of the city.

These decision-makers need to have an inclusive considerate of the possible benefits and limitations of disruptive technologies and make informed choices that prioritize governance, transparency, diversity, and inclusivity. They must also consider societal and environmental well-being, accountability, and fairness in their decision-making processes.

These decision-makers need to consider the possible advantages and drawbacks linked with the implementation of disruptive technologies. They must balance the desire for technological advancement with the need to protect citizens' privacy and ensure environmental sustainability. Moreover, decision-makers should also actively involve and engage citizens in the decision-making process.

Furthermore, it is important for decision-makers to involve citizens in the process of initiatives development and execution of smart city. Citizen participation and engagement are central for the accomplishment of these kind of initiatives, as highlighted by several authors. Through connecting residents in the decision-making procedure, cities can ensure that the technologies being implemented address the needs and concerns of their residents.The embracing and integration of disruptive knowledges in smart city initiatives, as in Pereira, et al. (2020), the need for capacity building and skills development. City staff and end-users, such as citizens, need to be trained and educated on how to design, integrate, and utilize these technologies effectively in a smart city context. Moreover, the integration and interoperability of different technologies pose a significant challenge. Without proper standards and frameworks, it can be problematic to seamlessly integrate different technologies and ensure their interoperability. Additionally, the rapid evolution of technology means that decision-makers must continuously stay updated on new disruptive technologies and their possible consequences for smart cities.

While the current literature provides valuable insights into the impact and application of disruptive technologies in smart cities, there are some gaps that need to be addressed. For instance, there is limited research on the risks and challenges associated with the use of disruptive technologies in smart cities. Additionally, there is an absence of standardized frameworks and governance for introducing new technologies in existing legacy environments. Moreover, there is a necessity for additional empirical studies that evaluate the actual impact and effectiveness of disruptive technologies in improving the life quality in smart cities. In terms of research needs, the literature highlights several areas that require further investigation in order to fully understand and harness the potential of disruptive technologies in smart cities.

These research needs include:

- The integrated use of different disruptive technologies in smart city initiatives. The development of sustainable and scalable infrastructure to support the implementation of disruptive technologies in smart cities.

- The establishment of standards and interoperability across different disruptive technologies in smart cities The assessment of the social, economic, and environmental impacts of disruptive technologies in smart cities.
- The implications of using disruptive technologies in real-time automated decision-making.

The security and privacy considerations in sharing and mining data through algorithms and automated systems. The role of resident engagement and contribution in the strategy and deployment of disruptive technologies in smart cities. The development of appropriate skills and training programs to enable the effective integration and usage of disruptive technologies in smart city milieus. The resolution of potential trade-offs between transparency and security in the implementation of disruptive technologies in smart cities.

The literature on disruptive technologies in smart cities, including works by Radu, Pereira, et al. and others, highlights the transformative role of technologies like IoT, big data and AI, in enhancing urban life. These technologies offer significant benefits in governance, mobility, and resource management through real-time data examination and decision-making. However, gaps exist, notably in the need for capacity building, integration challenges, and evolving governance frameworks. Additionally, the role of decision-makers is crucial, as they must balance technological advancement with privacy, environmental sustainability, and citizen engagement, highlighting a tension between the potential of disruptive technologies and the complexities of their practical, ethical, and inclusive implementation in smart cities.

2.3.7 Smart City Business Model

A business model describes an architecture for in what way a company's makes and delivers value to customers and the mechanisms employed to capture a share of that valueIt consists of a coordinated set of elements that include the flows of costs, revenues, and profits. The connection to profits highlights that a business's success relies just as much on designing and implementing its business model as it does on selecting the right technologies and managing physical assets and equipment. The business model acts as a framework through which technological innovations and expertise, combined with the use of both tangible and intangible assets, are transformed into ongoing profits. (Teece, 2018a).

Developed by Osterwalder and Pigneur, the Business Model Canvas (BMC) is a visual tool used to depict a company's logic and how it organizes its operations to create, deliver, and capture value. The BMC features a template comprising nine building blocks.

Its popularity stems because of its adaptability: the canvas may be employed to generate ideas and create new businesses, continually evaluate business viability, and analyze organizational structures. Additionally, its framework enables businesses to revolutionize their company models by restructuring or rethinking any of its nine components, potentially uncovering new markets or business prospects Timeus, et al. (2020).

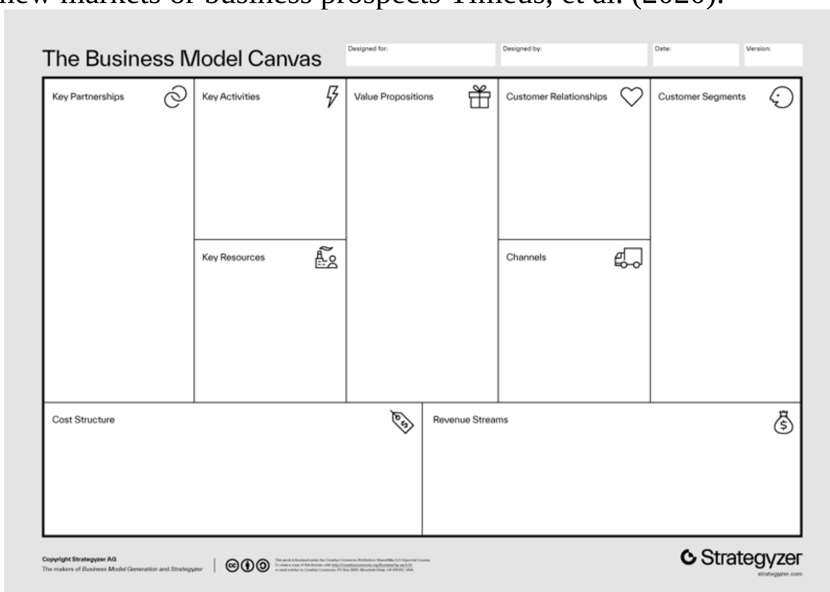

Table 3 The Business Model Canvas (BMC) Osterwalder, et al. (2010)

In short, the business model outlines the (industrial) logic by which customers are served and money is made Teece (2018).

During the last few years, Osterwalder's Business Model Canvas has become one of the most popular tools among entrepreneurs. The Business Model Canvas is a framework created for describing, analyzing and designing business models. It has been implemented and tested in various organizations (such as IBM and Ericsson), proving effective in simplifying the description and modification of business models to generate new strategic options.Moreover, this framework presents a clear description of the elements comprising a business model Díaz-Díaz, et al. (2017).

However, some researchers and practitioners have also used the Canvas within the smart city context Díaz-Díaz, et al. (2017).While public organizations and other nonprofit entities do not operate under the same incentives and requirements as private firms, they can still benefit from developing a business model framework to articulate how they provide social and environmental value, identify their beneficiaries, and ensure long-term sustainability Timeus, et al. (2020)

The 'smart city business model' refers to how a city government structures its services to generate and deliver value to its people in a manner that is economically sustainable, generally inclusive, and ecologically responsible. Timeus, et al. (2020).

2.3.8 The City Model Canvas

The paper by Timeus, et al. (2020) focuses on the expansion of business models for smart cities, particularly through the use of (ICT) to enhance urban infrastructure and services. The paper presents the idea of a 'city business model' and presents a realistic framework for analyzing it, namely the City Model Canvas (CMC) as in Table 4. This framework, based on the business model canvas used for firms, outlines fundamentals that city boards would contemplate while designing, delivering, and assessing smart services, including their financial, ecological, and community impacts.

<table>
<tr><td colspan="10">1. Mission statement What is the ultimate goal that the city seeks to achieve?</td></tr>
<tr><td colspan="2" rowspan="2">6. Key Partnerships
Who can help the city deliver the proposed value to the beneficiaries? Who can access key resources that the city council does not have?</td><td colspan="2">7. Key activities
What must the city council do to create and deliver the proposed value?</td><td colspan="2" rowspan="2">2. Value Proposition
What specific benefits are created and what specific problems does the proposed service solve or alleviate?</td><td colspan="2">4. Buy-in & support
Whose buy-in is needed in order to deploy the service (legal, policy, procurement, etc.)?</td><td colspan="2" rowspan="2">3. Beneficiaries
Who will directly benefit from the proposed services?</td></tr>
<tr><td colspan="2">8. Key infrastructure and resources & key regulatory framework
What key resources does the city council have to create and deliver the value? What infrastructure does it need? What is the key regulatory framework required?</td><td colspan="2">5. Deployment
How will the city solve the problems of the Value proposition specifically?</td></tr>
<tr><td colspan="5">9. Budget cost structure
What costs will the creation and delivery of the proposed services entail?</td><td colspan="5">10. Revenue streams
What sources of revenue for the city do the proposed services provide? What other sources of revenue does the city have?</td></tr>
<tr><td colspan="5">11. Environmental costs
What negative environmental impacts can the proposed services cause?</td><td colspan="5">12. Environmental benefits
What environmental benefits will the proposed services deliver?</td></tr>
<tr><td colspan="5">13. Social risks
What are some of the potential social risks that the proposed service entails? Who is most vulnerable as a result?</td><td colspan="5">14. Social benefits
What social benefits will the proposed services bring about? For whom will these benefits materialize?</td></tr>
</table>

Table 4 The City Model Canvas Timeus, et al. (2020)

The paper argues that smart cities should custom business models to assess the value they offer to citizens and how this value is created, delivered, and sustained. The authors discuss in what way the business model concept cannister benefit for city managements and they examine how they will generate and distribute community value over smart amenities, emphasizing the importance of considering the economic, ecological, and community costs and profits of these smart city facilities.

The CMC is described as a rounded decision-making agenda for city councils, enabling them to articulate how they will generate and distribute civic value over smart facilities in an carefully viable, socially comprehensive, and ecologically bearable manner. The framework consists of fourteen elements planned into four key parts, incorporating concepts of monetary viability, ecological balance, and community sustainability.

The city model canvas (CMC) acts as a detailed decision-making framework, aiding city councils in formulating and conveying the development and delivery of public value via smart services. It integrates various facets of a business model into a singular graphical layout, which is instrumental in evaluating current business models and crafting new ones. The CMC also encourages a multifaceted assessment of business models, considering economic feasibility, ecological sustainability, and community impact. However, it faces challenges in translating initial concepts into tangible, financially sound business cases and struggles to fully account for long-term savings and indirect advantages of smart city initiatives. These shortcomings underscore the necessity for supplementary methods or frameworks to enhance the CMC, ensuring the development of all-encompassing business strategies aimed at smart city developments.

Giourka, et al. (2019) focuses on the challenges cities face due to growing inhabitants progress and the need for smart solutions to be for strong economic, ecological, and community challenges caused by urbanization. The study reviewed various business model frameworks and established a real tool for assistance cities evaluate business models. This tool adapts mechanisms of the (BMC) and adds new unities that functioned by the smart city scopes. The planned smart city BMC (SC-BMC) provides a framework that supports the development and communication of a more rounded and combined opinion of a smart city business model, facilitating innovation towards sustainable value creation. This framework links the innovation of smart cities with sustainable value creation in business model development.

The paper discusses the trials confronted by cities in managing the complexities of smart city ventures, which involve a combination of public and private sector investments. These challenges include balancing the expenses and profits, along with uncertainties and risks, which are not always repeatedly elaborate in the decision-making procedure. Thus, city executives must grow a rich smart city venture program and productively plan business models to segment costs, profits, and dangers among community, cooperative, and market actors.

Smart City - Business Model Canvas

Key Actors Who are the smart city network key actors? *(Completed by the solution provider in collaboration with the City)* •*Actor 1 (city)* •*Actor 2 (end-user)* •*Actor 3 (core partner)* •*Actor 4 (supporting partner)* Who are the key suppliers? *(Completed by the smart city solution provider)* •*Supplier 1* •*Supplier 2* •*Supplier 3*	**Key Activities** Which key activities are required to realize the value proposition (i.e. build distribution channels, customer relationships, revenue streams, build products/services/platforms, install equipment) *(Completed by each actor involved in realizing the smart city solution)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	**Value Proposition** What value does each actor delivers? Which of the end users' problems is the smart city project helping to solve? What bundles of products and services does the project offers to each end user? Which end-users needs is the project satisfying? (i.e. performance, customization, price, getting the job done, cost reduction, risk reduction, accessibility, convenience/usability) What are the respective target values/thresholds/KPIs to be reached? *(Completed by each actor involved in the smart city project creating value)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	**Actor Relationships** Which type of relationship does each actor expect within the network? Which ones are established? How are they integrated with the rest of our business model? How costly are they? *(Completed by each actor involved in realizing the smart city solution)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	**Network Beneficiaries** Which target users is the value created for? How the target users benefit from the value created and what are their needs? What specific values each network beneficiary gets? (i.e. Community, business, research organizations, decision-making bodies/government and non-profit). *(Completed by the smart city solution provider in collaboration with each actor involved in realizing the project)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*
Key Actors Offerings (*) What offerings does each actor deliver? (i.e. technology, development of products/processes/services, R&D, Citizen Engagement) *(Completed by the smart city Key Actors in collaboration with the city)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):* **Key Actors Co-creation Operations (*)** Which key operations do the key actors perform? (i.e. sourcing of materials, systems's design, operation and monitor and impact monitoring of the smart city solutions, deliver value, city coverage and links to other stakeholders e.g. innovation hubs) (Completed by the smart city Key Actors in collaboration with the city) *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	**Key Resources and Infrastructure** What key resources are required to realize the Value Proposition (buildings, vehicles, machines, systems, point-of-sale systems, and distribution, networks) Our deployment channels? Our actor relationships? Revenue streams? *(Completed by the smart city solution provider in collaboration with the city)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	**Data (*)** What data will be made available from the services designed? To whom and under what conditions? Availability and types of Open Data (i.e. energy efficiency, climate indicators, traffic etc) *(Completed by the smart city solution provider in collaboration with the city and actors involved)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	**Deployment Channels** Through which channels do our customers want to be reached? How are we reaching them now? How are our channels integrated? Which ones work best? Which ones are most cost efficient? How are they integrating with the customer routines? *(Completed by the smart city solution provider in collaboration with the city and actors involved)* *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*	
Budget Cost What are the most important costs inherent for each actor deploying a smart city solution? Which key resources are the most expensive? Which key activities are the most expensive? What cost can be covered by each actor? Is there opportunitiy for blending public funding with private financing? Which costs are covered by each mechanism? (Completed by the smart city solution provider in collaboration with the city) *Actor 1 (city):* *Actor 2 (end-user):* *Actor 3 (core partner):* *Actor 4 (supporting partner):*			**Revenue Streams** For what value are the network beneficiaries really willing to pay? For what do they currently pay? How are they currently paying? How much would they prefer to pay? How much does each revenue stream contributing to overall revenues? Which actors have revenues? What are the non-monetary revenues? *(Completed by the smart city solution provider in collaboration with the city)* *Actor 1 (city)* *Actor 2 (end-user)* *Actor 3 (core partner)* *Actor 4 (supporting partner)*	
Environmental Impacts: Costs and Benefits What is the ecological cost of the smart city solution? (i.e. Greenhouse gas emissions, land use, energy and water used) What is the ecological benefit of the smart city solutions? % of reducing energy consumption % reducing the environmental footprint (Completed by the smart city solution provider and the smart city)			**Social Impacts: Values and Costs** What is the negative social value generated by the Smart City Solutions? (i.e. Social exclusion, digital illiteracy, accessibility to advanced services etc.) What is the positive social value generated by the Smart City Solutions? (i.e. Growth, job creation, air quality, less traffic etc.) *(Completed by the smart city solution provider and the smart city)*	

Table 5 The Smart City Business Model Canvas Giourka, et al. (2019)

The limitation of such model is the lack of empirical testing, making its effectiveness in real-world applications largely theoretical. The framework may struggle to provide to the exact and diverse needs of different cities, given their unique social, environmental, economic, and climatic conditions. Additionally, the complexity of integrating nonmonetary aspects and the challenges of comprehensive stakeholder engagement in the decision-making procedure add to its limitations. The requirement for constant adaptation to suit evolving smart city trends and projects further complicates its application.

2.3.9 Smart City Technology Integration Framework

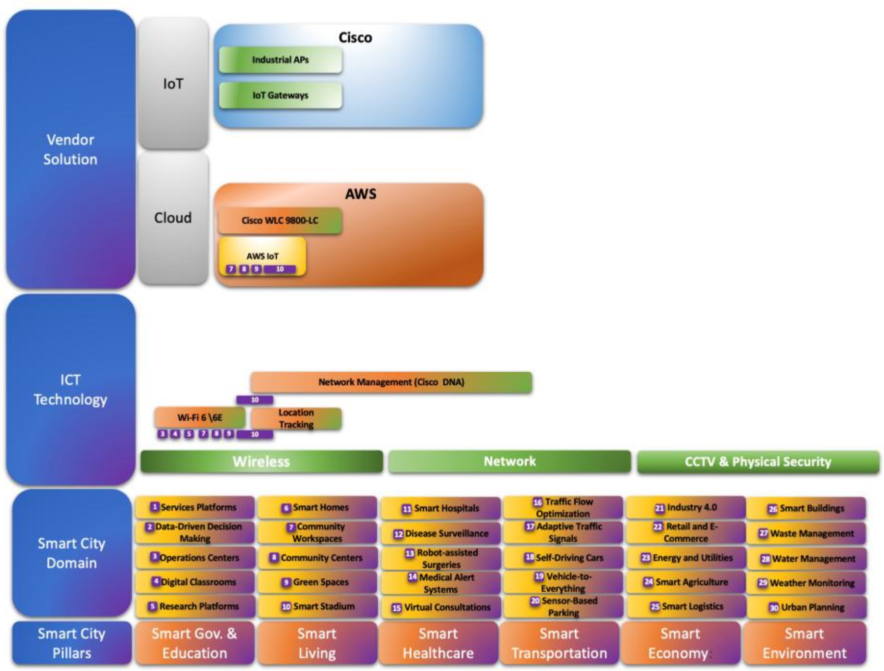

Figure 8 Smart City Technology Integration Framework

This framework represents an advanced conceptual model for integrating a multitude of technologies, vendor solutions, and functional domains within a smart city ecosystem. It delineates how different vendors and technological platforms aid in the advancement of smart cities services and the overall infrastructure in cities.

2.3.10 Vendor Solutions

The Vendor Solutions section focuses on offerings from Cisco and AWS. Cisco provides foundational solutions such as Industrial Access Points (APs) and IoT Gateways, which are instrumental for industrial IoT communication. These technologies form the core infrastructure necessary to connect diverse IoT devices. AWS, on the other hand, underpins the cloud infrastructure for smart city initiatives, offering solutions like Cisco WLC 9800-LC and AWS IoT. These solutions enable comprehensive management and connectivity for IoT devices. Together, Cisco and AWS solutions constitute a core component of smart city infrastructure, facilitating connectivity, efficient management, and scalability of services.

2.3.11 ICT Technology

The ICT Technology section includes IoT, Cloud, Wireless, and Network Management. The IoT component ensures that industrial devices and gateways are interconnected, allowing for real-time data collection and processing, which is essential for efficient smart city services. The Cloud provides a scalable and flexible infrastructure that supports data processing and storage requirements, thereby enabling the management and analysis of large data volumes generated by the city's IoT ecosystem. Wireless technologies, such as Wi-Fi 6/6E, are highlighted to demonstrate the use of cutting-edge connectivity to support seamless communication across diverse applications, such as smart homes and community centers. Moreover, location tracking capabilities are integrated to enable real-time monitoring of assets and individuals. Network Management, powered by Cisco DNA, facilitates centralized control and network optimization, thereby enhancing the efficient management of the entire network infrastructure within a smart city.

2.3.12 Smart City Domains and Pillars

This framework also illustrates how Smart City Domains are aligned with specific Smart City Pillars, showcasing the alignment of technological solutions with different facets of smart city development. The domains include wireless, network, and physical security (CCTV), which represent core ICT technologies that form the foundation of smart city initiatives. Each smart city domain is mapped to its corresponding smart city pillar to demonstrate how these technologies support various dimensions of urban living.

2.3.13 Smart Governance & Education

The Smart Governance & Education domain encompasses platforms such as services platforms, data-driven decision-making, operations centers, digital classrooms, and research platforms. These initiatives aim to enhance governance and educational services through technology-driven solutions, thereby increasing transparency in governmental processes and enriching learning experiences.

2.3.14 Smart Living

The Smart Living domain includes aspects such as smart homes, community workspaces, community centers, green spaces, and smart stadiums; they are designed to improve living standards of inhabitants by incorporating contemporary residential practices solutions and community engagement.

2.3.15 Smart Healthcare

The Smart Healthcare domain comprises capabilities such as smart hospitals, disease surveillance, robot-assisted surgeries, medical alert systems, and virtual consultations. These initiatives leverage technology to improve the efficiency of healthcare services and response times, and deliver advanced medical solutions.

2.3.16 Smart Transportation

The Smart Transportation domain covers solutions such as traffic flow optimization, adaptive traffic signals, self-driving cars, vehicle-to-everything (V2X) communication, and sensor-based parking. These technologies aim to enhance transportation efficiency, sustainability, and urban mobility while reducing congestion.

2.3.17 Smart Economy

The Smart Economy domain incorporates technologies such as Industry 4.0, retail and e-commerce, energy and utilities, smart agriculture, and smart logistics. These technologies aim to foster economic growth by integrating smart technologies into various industries, thereby making them more efficient and adaptive to evolving market demands.

2.3.18 Smart Environment

The Smart Environment domain focuses on technologies such as smart buildings, waste management, water management, weather monitoring, and urban planning. These initiatives underscore how technology can create a sustainable urban environment.

This framework illustrates how various vendor solutions, ICT technologies, and smart city domains converge to construct a cohesive smart city infrastructure. The importance of cutting-edge technology like cloud computing and the Internet of Things is emphasized. wireless networking and integrated network management in fostering sustainable, efficient, and responsive urban environments. This holistic approach not only enhances inhabitants' standard of living, but also ensures sustained economic growth and environmental sustainability.

2.4 Decision-Making Methods

Smart City decision-makers are the people who shape and drive the growth and application of urban initiatives and policies. They have a major impact on the direction and outcomes of smart city plans, making key decisions about technology, infrastructure, and urban planning to expand the excellence of life of city residents and advance economic and social development.

Decision-makers in smart city projects face the challenge of effectively managing sustainable development and avoiding threats caused by increasing complexity and uncertainty in urban environments (Szpilko, 2020).

Chai et al. Chai, et al. (2013) trying to solve the questions:

- What decision-making (DM) techniques have been commonly used?
- What are the connections and classifications of these DM techniques?
- How can the DM techniques outlined in the literature be successfully combined to accomplish complex decision-making objectives?
- What are the development status and research trends for uncertain SS?

Decision-making techniques are identified from three perspectives:

- Multicriteria decision-making (MCDM) techniques.

- Mathematical programming (MP) techniques.
- Artificial intelligence (AI) technique.

2.41 Multicriteria decision-making (MCDM)

MCDM is a multi-step process consisting of a set of methods to structure and formalize decision-making processes in a transparent and consistent manner. It allows for comparison among decision alternatives based on a set of evaluation criteria to which different weights may be applied Langemeyer, et al. (2016). It is also defined that MCDM consideing several principles in the decision-making procedure. The Analytic Hierarchy Process and technique for order of Preference by similarity to the ideal solution are examples of MCDM methods. They enable decision-makers to evaluate multiple complex and conflicting criteria Chai, et al. (2013).

MCDA, as in Giang, et al. (2017), involves evaluating and prioritizing different options based on multiple criteria. It is a structured approach for determining overall preferences among alternative choices. MCDA is particularly useful in situations where decisions requirement to be created considering various factors and where trade-offs between these factors are necessary. In urban planning and smart city projects, MCDA assists in evaluating different scenarios or solutions by considering multiple aspects like cost, environmental impact, social benefits, etc.

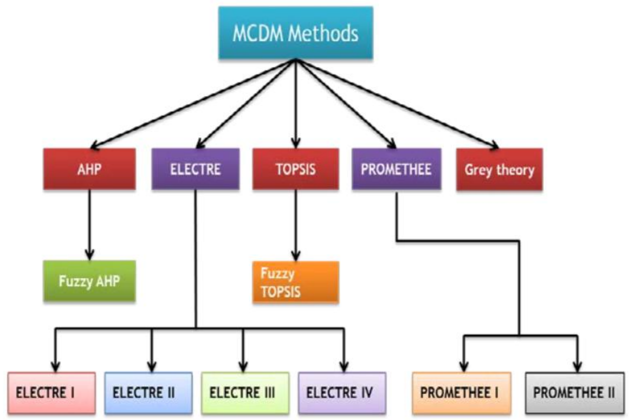

Figure 9 Hierarchical structure of MCDM Methods Aruldoss, et al. (2013)

Figure 9 depict the hierarchical view of MCDM methods and their types of Aruldoss, et al. (2013), Although there are other types as engineering value assessment (EVA).

2.4.2 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) as in (Frederick, 2017), is a structured technique for organizing and analyzing complex decisions based on mathematics and psychology. It was established by Thomas L. Saaty in the 1970s. AHP offers a complete and coherent framework for organizing a decision problematic, representing and measuring its fundamentals, for connecting those fundamentals to general goals, and evaluating alternative solutions Mishra, et al. (2018).

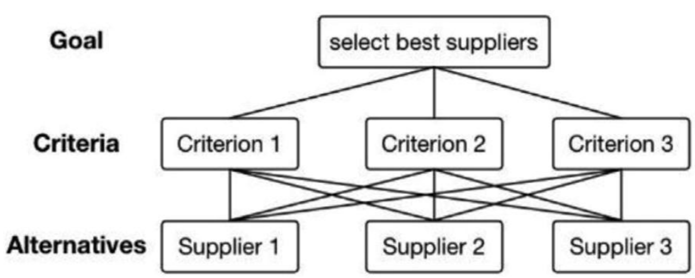

Figure 10 AHP Example Liu, et al. (2020)

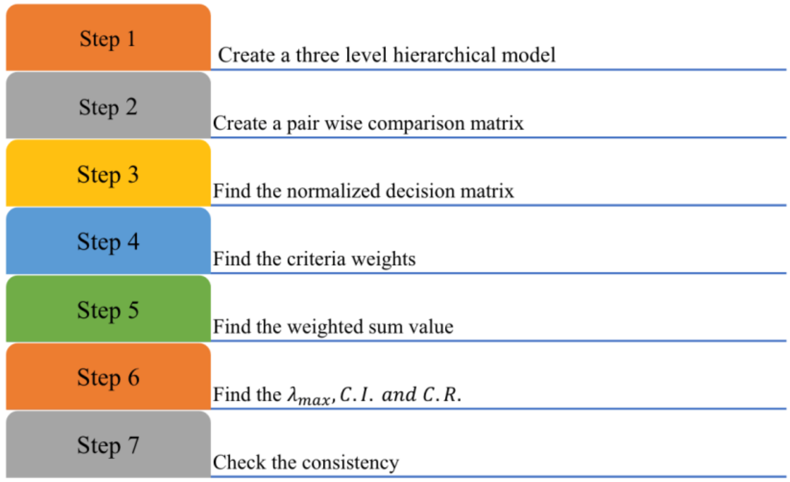

Figure 11 AHP Method Khan, et al. (2023)

The Analytic Hierarchy Process, well known as AHP, created by Saaty (1990), offers a systematic approach for sorting and evaluating intricate decision-making tasks, drawing on principles from both mathematics and psychology. AHP helps decision-makers face a problem in a comprehensive and rational framework. It uses a multilevel hierarchical structure of objectives, criteria, sub criteria, and alternatives to decompose a decision problem into more manageable parts. This method facilitates systematic evaluation of various elements of the decision problem by arranging them into a hierarchy descending from an overall goal to options at the bottom level. Central to AHP is the principle of paired comparisons, It compares the influence of each element on an element above it at each level of the hierarchy. This creates a set of weights or priority for every element based on the primary eigenvector of a matrix of judgments about pairwise comparisons. The elements' respective contributions or relevance in reaching the top-level aim are reflected in these weights.

2.4.3 AHP Structure

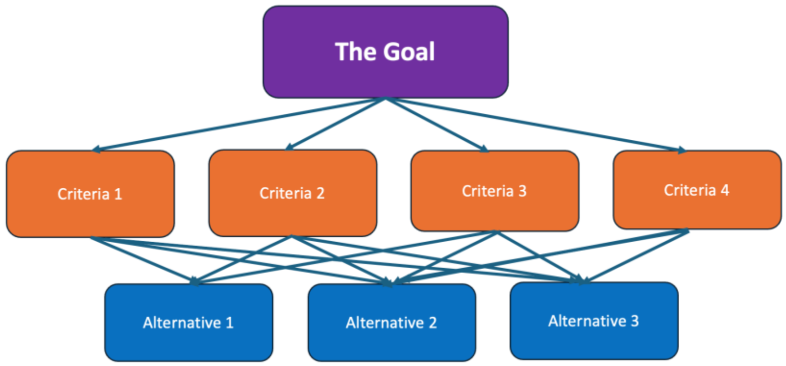

Figure 12 AHP Structure

The Analytic Hierarchy Process (AHP) is a methodical approach to structuring and evaluating intricate choices.

- **AHP structure as depicted in your image:**
  - **Level 1 Overall Objective (Goal)**

This is the highest level of the hierarchy and stands for the primary objective or the choice that must be made. It is the final goal that the decision-making process seeks to accomplish.

  - **Level 2 Criteria**

This level breaks down the overall goal into several sub-goals or criteria that are important for making the decision. These criteria are the basis on which the alternatives will be evaluated. They should be comprehensive and reflect different aspects of the decision. In the image, there are four criteria boxes that connect to the goal.

- **Level 3 Alternatives**

This is the bottom level of the hierarchy and includes the options or alternatives that are being considered to achieve the goal. Each alternative is evaluated based on the criteria above. In the image, there are three alternatives.

The lines between the levels indicate that each alternative is evaluated against each criterion to determine how well it meets the criterion. The AHP involves pairwise comparisons of both the criteria in relation to the objective and the options in relation to each condition. These comparisons are typically made using a scale of relative importance to generate a weight for each criterion and a score for each alternative under each criterion.

After completing all the necessary pairwise comparisons, the Analytic Hierarchy Process (AHP) determines a composite score for each option by computing a weighted total. This total is derived by considering both the significance assigned to each criterion and the performance rating of each option with respect to those criteria. The option that emerges with the greatest composite score is deemed the most suitable choice for attaining the objective, based on the established criteria.

The AHP is useful because it can handle both qualitative and quantitative data, and it helps to rationalize the decision-making process by providing a clear methodology to evaluate different factors that are often difficult to compare directly.

2.5 Dynamic Capabilities of the ICT Companies

The dynamic capabilities view originates in spirit from Schumpeter's innovation-based competition, where competitive advantage is based on the creative destruction of existing resources and novel recombination into new operational capabilities Pavlou, et al. (2011).

2.5.1 The Road to Dynamic Capabilities

The development of strategic management theories has significantly influenced our comprehension of how organizations maintain competitive advantage. An overview of the many stages and theoretical frameworks culminating in the framework for dynamic capabilities is presented below. (Teece, 2023):

- Industrial Organization Economics (1930-1950):
    - Focused on market structure, pricing practices, advertising, and investment. Ignored firm-specific differences and uniqueness. Emphasized external market conditions rather than internal firm capabilities.
- Agency Theory (1976):
    - Addressed the conflicts of interest between owners (principals) and managers (agents). Focused on "managing opportunism" and largely ignored the role of innovation in firm growth.
- Five Forces Model (1980):
    - Developed by Michael Porter, this model focused on analyzing the external factors affecting industry structure, such as competition and supplier power. Emphasized limiting competition rather than building unique internal capabilities or fostering innovation. Lacked emphasis on firm-specific strengths and unique capabilities.

- Resource-Based View (RBV) (1981-1990):
  - Emphasized The role that firm-specific resources play in differentiating lacked focus on how firms acquire or renew their resources over time, offering a static view of competitive advantage.
- Dynamic Capabilities (1997):
  - The dynamic capacities framework was presented by David Teece, Gary Pisano, and Amy Shuen. It described how firms adapt, build, and reconfigure capabilities in rapidly changing environments.

Addressed the limitations of previous theories by emphasizing adaptability, learning, and evolution of resources to sustain competitiveness in dynamic markets.

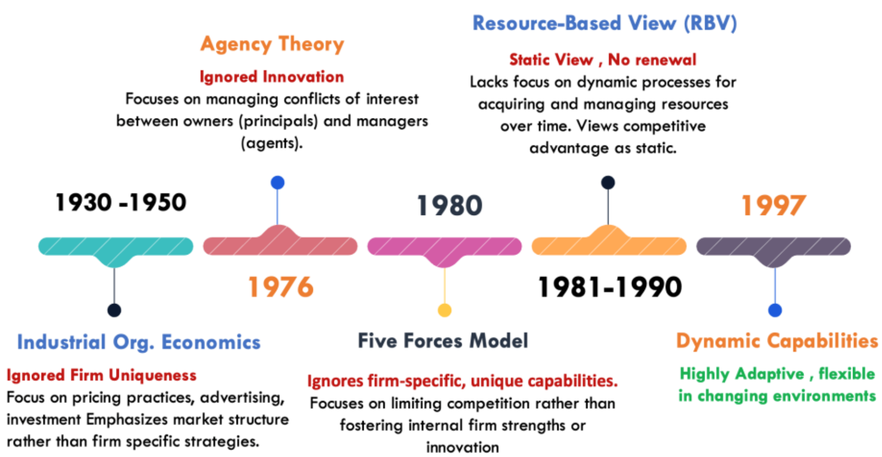

Figure 13 The Road to Dynamic Capabilities

The dynamic capacities framework signifies a transition from static, resource-based perspectives of competitiveness to a more adaptable viewpoint essential in fluctuating corporate settings. This growth underscores the necessity of perpetually enhancing internal skills to adeptly address economic and technology shifts.

David J. Teece, Gary Pisano, and Amy Shuen, in their work Teece, et al. (1997), explore the dynamic capabilities framework as a means to understand how firms create and capture wealth in rapidly changing technological environments. They contrast different strategic management theories, including Porter's competitive forces, strategic conflict using game theory, and the resource-based perspective. The paper highlights the importance of organizational processes, technological and complementary assets, market position, and path dependencies in shaping a firm's competitive advantage. The authors emphasize that a firm's historical choices significantly influence its current capabilities and future possibilities.

Teece and colleagues perceive competitive advantage in turbulent environments as arising from dynamic capabilities rather than from competitive positioning or industry conflicts. They coined the term "dynamic" to signify "the ability to renew competencies to align with a changing environment." Pavlou, et al. (2011).

The ability to identify a need or opportunity for change is one example of dynamic capabilities., develop a response to address it, and execute a plan of action. The firm's capacity for innovation, change adaptation, and modification implementation is outlined by its dynamic capabilities. that benefit customers while disadvantaging competitors. Three main categories can be used to classify dynamic capabilities:

- The verification, progress, collaboration, and appraisal of technical potential (and risks) about consumer demands emphasize the "sensing" of unknown future trends.
- Organizing resources to meet opportunities and needs and to extract value from these efforts (referred to as "seizing"); and

- continued regeneration (“transforming” or “shifting”) Teece et al., (2016)-P18.

A frameworks “identify the relevant variables and the questions which the user must answer” Porter, (1991).

Dynamic capabilities refer to a subset of capabilities directed toward strategic change, both at the organizational and individual levels. More specifically, dynamic capabilities are those capabilities that enable firms to create, extend, and modify how they make a living, including through alterations in their resources (tangible and intangible assets), operating capabilities, modifying the size and range of businesses, products, customers, ecosystems, and other aspects of their external environments. Helfat, et al. (2018)

Seizing entails recognizing and selecting commercial prospects that correspond with the organization's surroundings and its powers as well as its deficiencies. It entails effectively exploiting market opportunities while avoiding threats and integrating both exterior and interior knowledge, as well as information intricately linked to strategic decision-making, especially with decisions concerning investments. The capacity to seize starts with a strategy that recognizes valuable knowledge and is evaluated based on existing knowledge, leading to the choice of strategic options. An organization has a high seizing capacity if it can determine the potential value of information, convert important information into feasible business prospects that align with its fortes and softness, and make decisions accordingly.

Transforming entails improving, integrating, safeguarding, and, when needed, restructuring the business's tangible and intangible assets to prevent reliance on outdated methods and stagnation. This process entails implementing choices for new business mockups, offerings, or procedure improvements by establishing requisite procedures and practices, supplying appropriate facilities, and verifying the staff possesses adequate skills. Transformation is characterized by the tangible execution of long-term reinvention within the organization via reconfiguring resources, structures, and procedures.

Given the nearly never-ending changes and contending pressures inside the environments where diverse participants operate, additional dynamic capabilities become crucial for creating and capturing value. This necessitates that decision-makers cultivate innovative concepts of the design, creation, and launch of new or enhanced products, processes, services, and technologies (exhibiting innovative capability), while also considering ecosystems, forming fresh relationships, seeking strategic companies, and harmonizing and matching activities and skills both internally and externally (demonstrating collaborative and partnership capabilities).

Teece (Teece, 2018a) explains that dynamic capabilities in organizations are best understood about their overall capability portfolio, functioning at two levels. The foundational level includes operational and ordinary capabilities like routine activities, administration, and governance essential for efficiency in defined activities. Above this are dynamic capabilities, categorized into 'micro-foundations' and higher-order capabilities. Micro-foundations involve adjusting and recombining existing capabilities and developing new ones, representing second-order dynamic capabilities. These include new product development, expanding into new markets, assigning product mandates, and other astute managerial decisions in uncertain environments. Dynamic capabilities, as outlined by Teece, refer to the highest-order competencies—sensing, seizing, and transforming—which are essential for the innovation and selection of business models. These capabilities enable a company to address and exploit market opportunities and challenges effectively. They involve upgrading ordinary capabilities and directing them, along with partner firms' capabilities, toward high-value endeavors. This requires top management's focus and orchestration of both the firm's and its partners' resources to adapt to and shape changes in the market and business environment.

Decision-making in volatile circumstances is difficult as managers must swiftly select and execute actions. In fast-changing environments, dynamic capabilities refer to the ability to combine, strengthen, and rearrange both inside and outside expertise to respond to swiftly developing circumstances. Teece ,et al. (1997) , Pavlou, et al. (2011) .

Sidney G. Winter (Winter, 2003) explores the notion of dynamic capabilities in strategic management. It differentiates between ordinary capabilities, essential for a firm's current operations, and dynamic capabilities, which are crucial for adapting and innovating. Winter emphasizes that dynamic capabilities involve significant investment and are patterned, routine-based activities, contrasting with ad hoc problem-solving, which is more flexible and less costly. Winter discusses the potential downsides of investing in dynamic capabilities, noting that they may not always confer a competitive advantage, especially in environments with limited change opportunities. The paper concludes by suggesting a nuanced approach to understanding dynamic capabilities, focusing on how they fit within the specific context and attributes of individual firms rather than as a universal strategy for success.

Teece emphasizes the hierarchical nature of organizational capabilities, distinguishing between foundational operational capabilities and top order dynamic capabilities. The former includes routine activities essential for efficiency. Simultaneously, the latter, categorized into micro-foundations and higher-order capabilities, involves adapting, recombining, and developing new capabilities for innovation and business model selection.

Teece's approach views dynamic capabilities as a structured hierarchy within the organization, focusing on the organization's capability.to innovate and adapt to market changes.

2.5.3 Dynamic Capabilities Framework

The dynamic capabilities framework, as discussed by Pavlou, et al. (2011), as in Fig 3, emphasizes the critical role of dynamic capabilities in enabling organizations to respond effectively to turbulent environments, particularly in relation to New Product Development (NPD). This framework distinguishes dynamic capabilities from operational capabilities, identifying dynamic capabilities as the ability to sense environmental changes, learn and integrate new knowledge, and coordinate resources to adapt and reconfigure operational capabilities accordingly. These dynamic capabilities are seen as vital for organizations to maintain competitiveness and effectiveness, especially in rapidly changing markets. The framework thus provides a comprehensive model for understanding how organizations can develop and leverage these capabilities to innovate, adapt, and thrive amidst environmental uncertainty and turbulence.

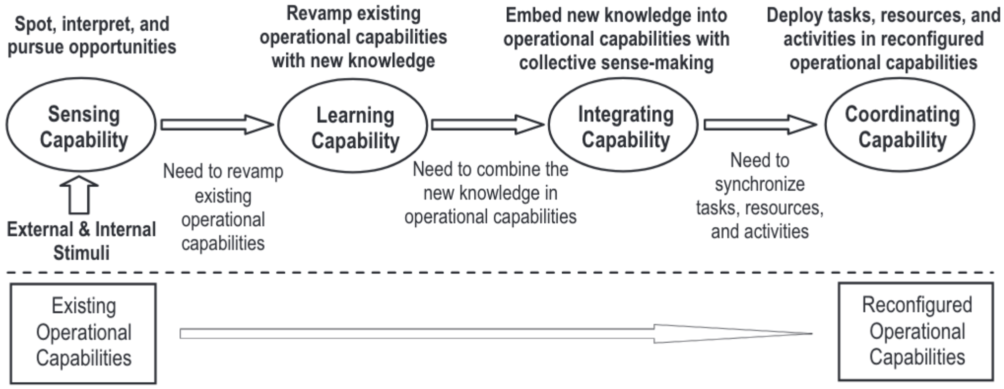

Figure 14 A framework for dynamic capabilities Pavlou, et al. (2011)

While Guenduez, et al. (2022) provides a comprehensive framework for understanding the elements necessary for successful smart city transformation, this framework emphasizes the dynamic managerial capabilities of smart city managers, which include sensing, seizing, innovating, integrating, and empowering abilities. These capabilities are vital for city administrations to drive smart city transformation effectively. The framework also highlights the importance of organizational readiness, which encompasses innovation readiness, resource readiness, a participatory and collaborative mindset, and strategic readiness. Organizational readiness is crucial as it enables a city administration to adapt to a changing environment and build smart city transformations successfully.

The framework suggests that the effectiveness of managerial actions in smart city developments is greatly affected by the level of organizational readiness. For instance, a city with high organizational readiness is more likely to implement innovative projects spearheaded by dynamic managers successfully. This interplay also highlights that the transformation toward a smart city is not just about technology or individual capabilities but also about creating an organizational culture that supports innovation, collaboration, and strategic change.

Dynamic capabilities represent a higher-order capability, encompassing various sub-capabilities. These sub-capabilities include four related yet distinct elements: absorptive capacity, adaptable capacity, innovative capacity, and network capacity Parida ,et al. (2016).

Companies with absorptive capability can recognize and leverage external knowledge for commercial use. Adaptive capability refers to a company's capability to classify and exploit emerging market opportunities swiftly. Innovation capability empowers companies to create new products or processes. Finally, network competence refers to a company's proficiency in establishing and using inter-organizational partnerships to obtain diverse resources possessed by other entities. Parida ,et al. (2016).

The dynamic capacities framework aims to clarify the origins of advantaged positions at the organizational level with time and provide managers with strategies to circumvent the zero-profit situation that arises when identical companies engage in highly reasonable marketplaces. Analogous to a model, a framework outlines from reality to discern categories of pertinent variables and their interconnections. Nonetheless, a framework is less specific not a model as it may not delineate the precise nature of current theoretical linkages.. (Teece, 2007).

Dynamic capabilities are performance KPIs for the enterprises in specific business environments:

- These ecosystems facilitate international trade and are wholly vulnerable to possibilities and constraints presented by swift technological advancements.
- Technological development is a multifaceted, systemic process rather than a singular occurrence, requiring the integration of various inventions to create services and goods that fulfil consumer demands.
- Robust international marketplaces are present for the trade of component products and services..
- Underdeveloped markets characterize these environments for exchanging technical and administrative expertise.

These characteristics are widespread in significant sections of the global financial system, particularly in high-technology industries. In these sectors, enterprise success today relies less on traditional textbook optimization or capturing economies of scale in production. Instead, success depends on discovering and developing opportunities, effectively combining internally and externally produced innovations, effective technology transfer within and between enterprises, Safeguarding intellectual property, enhancing optimal business practices, formulating innovative company models, rendering unbiased decisions, and guaranteeing defense from copying and copying by rivals. It also includes determining novel-ready rules in the worldwide marketplace. Traditional business success elements—Sustaining motivational harmony, possessing real assets, managing expenses, ensuring excellence, and optimizing stocks are essential yet inadequate for achieving sustained improved business outcomes. (Teece, 2007).

Executives play a pivotal responsibility in developing and utilizing dynamic capabilities, providing strategic direction, developing values of innovation and change, and coordinating and integrating various functions and departments. Successful dynamic capabilities require effective leadership, coordination, collaboration, and an organizational culture that fosters taking chances, learning, and ongoing enhancement. Dynamic capabilities enable large organizations to stay competitive, drive growth, and adjust to the always evolving business landscape Teece, (2016).

2.5.4 The Sensing Capabilities

Chirumalla (2021) sensing capabilities encompass initiatives that empower enterprises to continuously scan, learn, filter, shape, and assess novel possibilities. To develop these capabilities, access to facts, data, and knowledge is essential, along with the capacity to evaluate and shape emergent events. Effective sensing must transpire at every tier of the organization, with lower-level employees analyzing information for middle and upper management.

To support these activities:

- Individuals need clear info, practical understanding, and a creative mentality.
- Managers ought to emulate innovators by extracting insights from extensive data to predict which technologies to outline and which marketplace groups to entity.
- Identifying internal production requirements involves tasks like conducting desk research, brainstorming with team members, consulting with developers and suppliers, performing structural analyses, and carrying out exploratory tests.

Research and development must be synchronized with production. on feasible and desirable innovations in processes. Companies should possess strong capabilities to generate innovative ideas from a diverse range of stakeholders, develop a long-term technological vision, and set measurable objectives for their projects.

Developing creative sensing skills through digital technology enables organizations to formulate and evaluate several hypotheses, assisting managers in elucidating unforeseen occurrences and trends. Organizations require cognitive managerial competencies to identify and evaluate the extent of developing changes. By utilizing digital infrastructures such as IoT and AI, companies may gather and analyze extensive, real-time data for predictive purposes. At the point of use, digital technologies enable ongoing experimentation. Integrating both formal and informal scouting networks into strategic thinking enables organizations to detect emerging customer-centric trends and fosters entrepreneurship and digital attitudes across the organization.

While in Teece and Linden, (2017) sensing involves several key points:

- Definition and Importance: Sensing denotes the power of an organization to spot and interpret outside developments, trends, and changes in the market and technology landscape. It is an important component of dynamic capabilities, enabling firms to adapt and innovate continuously.
- Organizational Levels: Sensing occurs at all organizational levels. Lower levels are responsible for gathering data and insights about external developments, which are then interpreted and shaped by middle and top managers. This hierarchical approach ensures that information flows throughout the organization and reaches decision-makers effectively.

- Generative Sensing: This involves generating and testing various hypotheses about consumer demand and market conditions. Managers engage in generative sensing to identify unmet needs and opportunities for innovation.
- Proactive and Continuous Process: Sensing is not a single action but an ongoing procedure that must be embedded within the organizational structure. It involves proactive scanning and interpretation of market and technological trends to anticipate changes and opportunities before they become obvious.
- Application to Business Model Design: Effective sensing informs the design and adjustment of business models. By understanding external developments, firms can craft business models that align with market demands and technological advancements, ensuring long-term competitiveness and profitability.

Sensing is a fundamental dynamic capability that keeps companies updated in a rapidly changing environment by continuously monitoring and interpreting external signals and incorporating these insights into their strategic and operational decisions.

Konlechner ,et al (2018) agrees that sensing is how businesses continuously monitor the outside world to identify new avenues and chances for technical advancement. It involves the recognition of value, facilitated by prior knowledge and cognitive structures. Sensing activities include scanning, searching, exploration, learning, and Activity involving interpretation.

The goal of sensing is to find industry shifts and new technologies that are significant to the company and make thoughtful choices in an uncertain environment. It is a crucial part of dynamic capacities. as it allows organizations to adapt and act effectively to variations in their ecosystem.

Sensing capabilities in digitally enabled process innovation involve gathering and analyzing data to improve decision-making, identify and address issues in real time, and visualize and understand the production process. It requires collaboration, training, and a strategic approach to overcome challenges and fully leverage the potential of digitalization. Sensing capabilities Include the requirements and timeline. three types of sensing: data-driven, proactive, and -driven.. These capabilities enable firms to make informed decisions, improve processes, and identify opportunities for innovation Chirumalla, (2021).

Sensing involves both internal and external scanning, such as performing market research, examining consumer comments, and keeping an eye on market trends Teece, (2018). It involves also gathering information and insights from various sources, including complementary asset providers and external partners, to stay informed about changes in the industry and customer needs Helfat and Raubitschek, (2018).

Sensing needs vision, management acumen, or an analytical method that can stand in for it. It helps identify latent demand and potential market chances Teece,(2011). In huge organizations, sensing canister is aided by well-established practices, including ongoing R&D, looking outside for new technologies, and participating in joint development projects with partner organizations. Managers play a crucial role in sensing by collecting information, sensing market trends, and identifying potential opportunities for the firm. They are proactive and forward-thinking, constantly scanning the environment for new possibilities Teece, (2016).

Additionally, it describes an organization's capacity to recognize and understand emerging developments in its business environment. One of the most important components of dynamic capacities and is particularly important in environments characterized by deep uncertainty. Sensing requires strong dynamic capabilities and must complement the company's objectives. It involves proactively generating theories regarding the potential ramifications of patterns and events that have been observed, using actual alternatives analysis, generative sensing, sensemaking, and scenario planning. Sensing helps organizations anticipate and respond to new risks and opportunities in a corporate environment that is evolving quickly Teece, et al, (2016).

Some specific dynamic capabilities that fall under the category of sensing include market sensing, customer sensing, and technology sensing. These specific dynamic capabilities focus on the company's capacity to collect and analyze data regarding markets, clients,, and technological advancements, respectively Baía and Ferreira, (2024).

Sensing capabilities involve identifying new opportunities or risks in the market. These skills are essential for businesses. to stay ahead of the competition by recognizing emerging trends and responding proactively. To effectively sense opportunities, firms need to engage in the following practices:

- **Scan the Environment:**

This involves actively discovering new trends, technologies, or changes in consumer needs. It's about staying informed on what's happening externally that might impact the company.

- **Gather and Analyze Information:**

Firms need to collect information from a variety of sources, including market reports, customer behavior data, and competitive intelligence. This helps in spotting both opportunities and potential threats that can influence strategic decisions.

- **Develop Insights:**

Once the information is gathered, firms need to interpret it to understand where the market and technology are heading. Developing insights involves drawing conclusions and making informed predictions of the industry.

2.5.5 Practices to Recognize Sensing Capabilities

To build strong sensing capabilities, companies can engage in the following practices:

- Market Research: Systematically gathering data about consumers, competitors, and market conditions to help the company understand current trends.
- Investment in R&D: Putting money into research and development benefits businesses. innovate and stay ahead of technological changes, enabling them to identify new opportunities early on.
- Analyze Competitors: Continuously analyzing competitor activities provides insights into industry dynamics, helping a firm recognize threats or opportunities sooner than others.

- Customer Feedback: Getting direct input from clients allows businesses to comprehend their preferences and needs, which aids in spotting changes in client behavior or unmet demands that may present chances for innovation.

Sensing capabilities are about actively looking for, gathering, and interpreting information that can guide a company's strategy to react to or take advantage of modifications to the marketplace. This is a critical component of maintaining a competitive edge in dynamic environments.

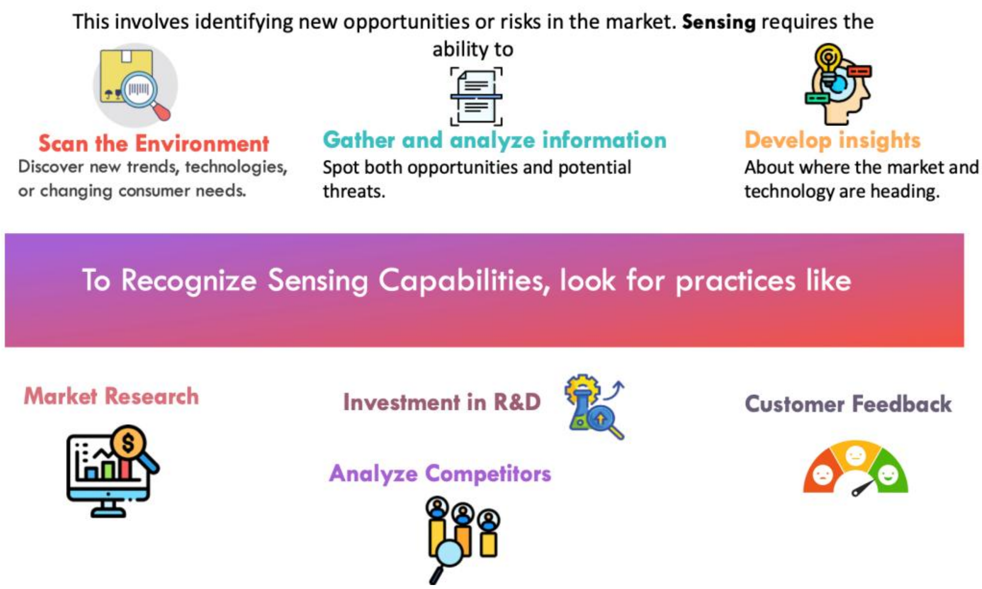

Figure 15 Dynamic Capabilities Sensing Capabilities

2.5.6 Sensing for Smart City

Sensing capabilities in the transformation of smart cities as in Guenduez and Mergel, (2022) relate to smart cities' capacity to managers to continually monitor and analyze the city's external environment, incorporating new problems, patterns, and efficient methods of other urban areas. This involves staying current with cutting-edge technologies such as big data analytics, sensor systems, IoT, and geospatial technologies. Sensing capability helps smart city managers identify challenges, opportunities, and potential problems and form knowledgeable decisions to propel the transition of smart cities.

Furthermore, the process of actively gathering and evaluating citizen information to pinpoint possibilities and risks in the city's surroundings is referred to as sensing in smart cities. It entails surveying the public and applying both qualitative and quantitative techniques to analyze the information gathered. The goal is to understand the problems and challenges faced by the city and its residents, which can then inform the development of solutions and initiatives. In the case study of Denton, Texas, citizen input revealed issues such as parking, streets, communication, and poverty, along with recommendations for remedies such as bettering parking, communicating more effectively throughout the city, addressing poverty with statistics, and boosting public transit and walkways. Chong ,et al. (2018).

2.5.7 The Seizing Capabilities

Seizing by Konlechner ,et al (2018) alludes to the proactive and decisive actions taken by organizations to exploit opportunities and implement technological change. It involves the rapid mobilization and deployment of resources and capabilities to Profit from identified opportunities and gain a competitive advantage. Seizing activities include strategic decision-making, resource reconfiguration, and continuous learning. It requires organizations to be agile, flexible, and responsive to changes in the external environment. A crucial part of dynamic capacities is seizing since it allows organizations to effectively and efficiently implement technological change and drive innovation. It involves taking calculated risks and being proactive in order to keep one step ahead of competitors and succeed in dynamic and uncertain markets. Seizing is about being agile and responsive to changes in the external environment, and being able to quickly adapt and capitalize on emerging trends and market shifts. It requires the ability to make strategic decisions and take decisive action to capture value and secure a position of advantage in the market. Seizing also involves making strategic decisions and choices in order to facilitate the adoption and utilization of novel technology. It requires organizations to reconfigure and manage their assets and organizational structures to adapt to changing markets and technological advancements. Seizing is a critical component of dynamic capabilities as it enables organizations to capitalize on new technologies and innovations and acquire an advantage in the marketplace.

Seizing capabilities in digitally-enabled process innovation involves taking action according to the knowledge and possibilities that sensing has revealed. This covers adaptable methods for identifying the root problem, evaluating opportunities, and providing managerial assistance in formulating a strong data layer, creating flexible, cross-functional teams and putting a strategy for ongoing digital improvement into action, making investments, allocating resources, implementing new technologies or practices, making decisions on resource allocation, putting money into technology and other resources, controlling the changes that are required, scenario planning, simulation, decision-making based on data analysis, optimizing production processes, leveraging digital tools and technologies, collaboration, training, and a clear strategy. These capabilities enable firms to effectively seize opportunities, prioritize initiatives, drive process innovation, capitalize on the potential of digitalization, enhance efficiency, achieve competitive advantage, translate opportunities into tangible outcomes, balance risk and reward, prevent issues, make proactive decisions, enhance productivity, quality, and efficiency, identify and address issues, make strategic decisions, drive continuous improvement, quickly adapt and respond to changes, implement new technologies and processes, leverage digital tools, optimize operations, and capitalize on the benefits of digitalization Chirumalla, (2021).

Seizing refers to the proactive and timely allocation of resources, capabilities, and investments by a firm to exploit new market opportunities and implement innovative business models. It is a critical aspect of dynamic capabilities and requires agility, flexibility, effective leadership, and decision-making. Successful seizing allows firms to o achieve a competitive edge by being the first to enter the market or offering unique value propositions to customers Teece, (2018).

Seizing is an important aspect of dynamic capabilities that entails the mobilization of resources to take advantage of possibilities and meet identified needs, and exploit the opportunities. It requires quick decision-making, resource allocation, and the ability to take action. Managers play a critical role in seizing by making strategic decisions, mobilizing resources, and coordinating activities. Successful seizing involves entrepreneurship, leadership, agility, and the ability to adapt and adjust plans as needed Teece, (2016).

The goal is to efficiently deploy resources, create value, and capture opportunities in the market Teece, et al, (2016). It is crucial for organizations to translate their insights and knowledge into action and gain a competitive advantage Baía and Ferreira, (2024).

It speaks to the company's capacity to react swiftly and successfully to challenges and opportunities that are recognized. Seizing capabilities are used to exploit or lessen risks or opportunities after they have been identified. This involves activities such as investing in new technologies, commercializing innovations, as well as creating and executing business plans for a range of goods and services Teece, (2018) .

So, the sizing capabilities of the opportunities are identified through sensing, and an organization must have the capability to seize them. Seizing capabilities focuses on taking action to capitalize on these opportunities and convert them into tangible value.

This involves:

- Capitalize on Opportunities:
    - Seizing involves mobilizing resources to take advantage of identified opportunities. This could include launching new products, entering new markets, or scaling existing operations.

- Appropriate Business Models:
    - Organizations must develop appropriate business models that can convert opportunities into economic value. This means creating value propositions that align with the identified opportunity and meet customer needs effectively.

- Allocating Resources:
    - Effective seizing requires allocating resources efficiently to support the new initiatives. This includes managing the risks associated with

investment and ensuring that resources (e.g., people, capital, technology) are deployed where they can be most impactful.

2.5.8 Practices to Recognize Seizing Capabilities

To develop and recognize strong seizing capabilities, firms can focus on the following practices:

- Ability to Innovate:
    - The ability to innovate is central to seizing opportunities. This involves developing new products, services, or processes that align with market demands and add value.
- Strategic Decisions:
    - Making informed and effective strategic decisions is crucial for seizing capabilities. This includes choosing which opportunities to pursue, determining how to approach the market, and deciding on investment levels.
- Agility in Reallocating Resources:
    - Successful seizing involves being agile and flexible in reallocating resources as needed. This agility ensures that resources are moved quickly to support new projects or initiatives, helping the firm respond rapidly to emerging opportunities.

Seizing capabilities are about taking advantage of opportunities by developing suitable business models, making strategic decisions, and effectively allocating resources to create value. These capabilities ensure that an organization can not only identify but also effectively capitalize on opportunities in dynamic market environments.

Figure 16 Dynamic Capabilities Seizing Capabilities

2.5.9 Seizing for Smart City

According to Teece, (2018) ‹seizing capability in smart city transformation refers to smart city managers' capacity to actively seek for and accept cutting-edge concepts, tools, and solutions that can advance the city's objectives. To accomplish the intended results of the smart city transformation, it entails being proactive, flexible, and capable of carrying out initiatives with effectiveness.. Smart city managers with seizing capability can identify and capitalize on opportunities for innovation and change, taking advantage of small windows of opportunity. They have a strategic mindset, are willing to take calculated risks, and are open to experimentation and adaptation in order to drive smart city transformation.

It also refers to the process of taking action based on the insights and opportunities identified through citizen engagement and data analytics. It involves analyzing the collected data, identifying patterns and trends, and implementing initiatives and projects to address the identified problems and opportunities. Seizing includes aligning the identified issues with the existing framework of the city, developing and implementing solutions, and collaborating with various stakeholders. In the case study of Denton, Texas, seizing involved subcontracting parking space management, leveraging citizen input and text analytics techniques, improving city infrastructure, utilizing technology for better communication and public engagement, and promoting a citizen-centric atmosphere. The goal of seizing is to guide the direction of future initiatives and actions, improve people's quality of life and make the city more environmentally friendly and efficient. Chong ,et al. (2018).

2.5.10 The Transformation Capabilities

Transformation by Konlechner ,et al (2018) refers to a comprehensive and systematic overhaul of an organization's structure, processes, systems, and culture. It involves acquiring new knowledge and technologies, reconfiguring existing resources, and implementing necessary changes to adapt to market and technological changes. Transformation is driven by the need to adapt to external pressures, such as technological advancements and changing market dynamics. It requires strong leadership, effective change management, and the alignment of people, processes, and technology. The goal of transformation is to improve organizational performance, enhance competitiveness, and achieve long-term sustainability. Successful transformation enables organizations to become more agile, innovative, and competitive in dynamic environments.

Transformation in digitally enabled process innovation involves reconfiguring the organizational setup and mindset to fully embrace and leverage digitalization. This entails combining IT and process expertise, offering tactical instruction tools, encouraging a broader perspective as well as leadership vision, taking a bottom-up, developing method, coordinating with the digitalization strategy, managing change, and advancing a continuous improvement culture, and adapting to new technologies and practices. It also involves developing a digital strategy, aligning organizational goals with digital transformation objectives, redefining business processes, restructuring organizational structures, developing new skills and competencies, fostering a digital culture, implementing change management practices, investing in digital infrastructure and technologies, integrating data and systems, establishing data governance and security measures, ensuring interoperability and connectivity, adopting agile and flexible approaches, collaborating with external partners and stakeholders, and continuously monitoring and evaluating the impact of digital transformation efforts. By developing these transformation capabilities, firms can successfully navigate the challenges and complexities of digitalization, drive organizational change, and unlock the full potential of digital-enabled process innovation Chirumalla, (2021).

Transformation involves a company's capacity to modify and adjust its current organizational structures, competencies, and resources in reaction to changes in the business environment.. It involves reconfiguring and realigning an organization's structure, culture, and capabilities to stay competitive and maintain long-term profitability. This process requires strong leadership, effective change management, and the ability to leverage dynamic capabilities to drive organizational change. Successful transformation enables firms to remain competitive, innovate, and achieve sustainable growth Teece, (2018).

Transformation is an essential part of dynamic capabilities is the capacity to change and adapt the organization's resources, procedures, and capabilities to grasp fresh chances and adjust to shifting market conditions. It necessitates the creation of new capabilities, innovation, and strategic adjustments. Managers are essential in spearheading and propelling transition because they establish a clear vision, coordinate resources, and cultivate an innovative and change-oriented culture. Strategic thinking, strong leadership, and the capacity to handle complexity and uncertainty are necessary for a successful transition Teece, (2016).

It often involves taking risks, making bold decisions, and embracing innovation and experimentation. Successful transformation requires strong leadership, effective change management, and the ability to balance agility with efficiency. It is the ability of an organization to adapt and change in response to evolving business environments, challenging existing norms, and embracing new ways of doing things. Transformation is essential for long-term success and growth Teece, et al, (2016).

Transforming capabilities involve reconfiguring and modifying the organization to ensure it remains competitive over time. These capabilities are necessary to continuously adapt the organization's structure, processes, and resources to align with evolving market conditions and new opportunities. Transforming capabilities involve:

- **Organizational Structures:**

This includes modifying organizational structures, processes, and asset configurations to align with new strategies or take advantage of evolving opportunities. It may involve changing hierarchies, adjusting workflows, and rethinking operational frameworks.

- **Managing Change:**

Managing change often involves retraining employees, acquiring new skills, and adopting new technologies. This helps the organization stay up to date with industry trends, customer demands, and technological advancements.

2.5.11 Practices to Recognize Transforming Capabilities

To identify strong transforming capabilities, organizations should focus on practices such as:

- **Organization Adapts to Change:**

  Successful transforming capabilities are demonstrated when an organization can adapt effectively to changes, such as shifts in market dynamics or technological advancements. This involves flexibility and resilience at all levels of the organization.

- **Restructures to Pursue Innovation:**

  Firms with transforming capabilities are able to restructure themselves to pursue innovative opportunities. This may mean reshaping teams, reallocating resources, or developing new roles that support innovation initiatives.

- **Develops New Competencies:**

  Organizations with transforming capabilities invest in developing new competencies that are required for future growth. This may involve upskilling employees, adopting new technologies, or establishing new partnerships to acquire specialized expertise.

Transforming capabilities are key to ensuring that an organization does not remain static but evolves with changing market conditions, technological advancements, and internal growth needs. By fostering flexibility and adaptability, companies can position themselves to sustain long-term competitive advantage.

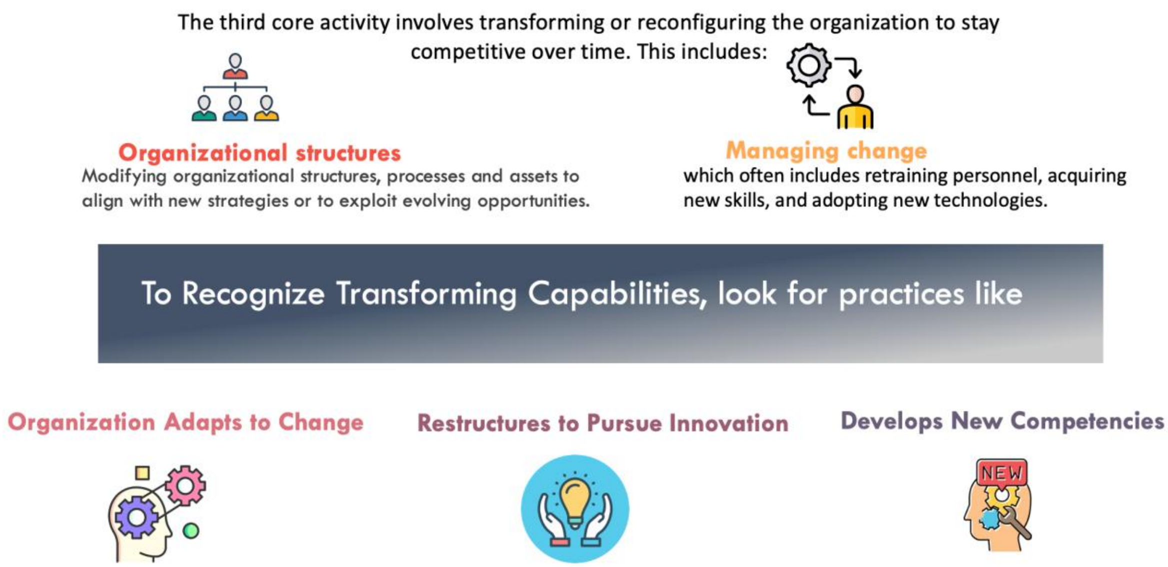

Figure 17 Dynamic Capabilities Transforming Capabilities

2.5.12 Transformation for Smart City

As stated by Guenduez and Mergel, (2022) smart city transformation entails putting new technologies, tactics, and practices into place to raise the standard of living for citizens, promote sustainability, and maximize the effectiveness of urban systems. To build a connected and intelligent urban context, this method incorporates digital technologies such as IoT, data analytics, and artificial intelligence. The objective is to make cities more resilient, sustainable, and habitable by addressing waste management, energy use, and traffic congestion. Smart solutions that enhance urban services, infrastructure, and governance must be co-created and implemented by residents, business sector partners, and city governments. municipal managers' dynamic managerial skills and municipal administrations' organizational preparedness are what propel smart city transformation. It improves the efficiency of the urban environment and quality of life by utilizing innovation, data, and technology. Modernizing many facets of cities to make them more ecologically effective, livable, and competitive is a continuous process that takes into account the needs of the economy, human capital, government, security, healthcare, and environment.

Transformation refers to the process of implementing significant adjustments and enhancements in connection to a smart city, determined by data analytics, citizen interaction, and sensing and seizing actions. To do so, the city must adopt new technologies, put creative solutions into practice, and rethink how it functions. A culture of creativity and cooperation, the integration of new technology and infrastructure, and modifications to current systems and procedures are all components of transformation. The objective of transformation is to build a smart city that can respond to the changing demands and difficulties of its citizens in a flexible and resilient manner. Technology, data analytics, and public involvement can be used to improve the quality of life for city dwellers, promote positive change, and improve the city's overall operation. Chong ,et al. (2018).

2.5.13 ICT Dynamic Capabilities Concept

Information and communication technology, or ICT, depends heavily on dynamic capabilities. They are a company's capacity to grow, integrate, and reorganize its own internal resources and capabilities to adapt to changing surroundings. Dynamic capabilities in the context of ICT capabilities oversee growing and improving these capabilities inside a company. It helps businesses to identify and take advantage of fresh opportunities in the digital sphere. It also includes things like looking for and scanning the surroundings for new opportunities, integrating internal and external knowledge resources, and learning from experiences both inside and outside the company. Additionally, it aids businesses in adjusting to changes in the digital landscape and technology breakthroughs. Through constant ICT infrastructure improvement, leveraging new technologies, and efficient use of digital tools and applications, they help businesses remain competitive. Dynamic skills are essential for improving and utilizing ICT capabilities inside businesses, enabling them to navigate the constantly changing digital world and keep a competitive edge during their digital transformation process. Alkhamery ,et al. (2021).

2.5.14 Dynamic Capabilities and Decision-Making

Konlechner ,et al. (2018) offer a comprehensive framework that illustrates how dynamic skills aid in the handling of technological change. It attempts to clarify how strategic managerial decision-making, resource reconfiguration, and ongoing learning are made easier by dynamic capabilities, which enable adaptation to technological changes. Ambidexterity, absorptive capacity, and technology management are three well-known theoretical lenses that are identified by the framework, which also examines how these ideas develop into dynamic capabilities.

- **Ambidexterity:** The ability of an organization to simultaneously investigate new prospects and take advantage of current capabilities is known as ambidexterity. When it comes to dynamic capacities, ambidexterity entails striking a balance between utilizing current resources and capabilities and exploring new markets and technology. In addition to utilizing their current capabilities, this enables firms to continuously innovate in response to technological progress.

- **Absorptive Capacity:** The ability of an organization to obtain, absorb, and utilize outside knowledge is known as its absorptive capacity. When it comes to dynamic capabilities, absorptive aptitude is essential for promoting the uptake and incorporation of new technology. It makes it possible for enterprises to recognize and comprehend emerging technological trends, gather pertinent information from outside sources, and use that information to spur innovation and change.

- **Technology Management:** Technology management focuses on the strategic management of technology within an organization. In relation to dynamic capabilities, technology management plays a key role in facilitating technological change. It involves the strategic decision-making processes related to technology adoption, development, and implementation. Effective technology management enables organizations to align their technological capabilities with their strategic goals and adapt to changing technological landscapes.

The framework emphasizes the roles that ambidexterity, absorptive capacity, and technology management play in the creation and application of dynamic capabilities. It highlights how crucial strategic decision-making, resource reallocation, and ongoing education are to effectively managing technological change. By combining these ideas into a thorough framework, the paper seeks to give readers a full grasp of how dynamic capabilities help businesses navigate and take advantage of technological change. The framework serves as a guide for researchers and practitioners in understanding and harnessing the power of dynamic capabilities to manage technological change and drive organizational success effectively.

2.5.15 The Dynamic Capabilities Life Cycle

The life cycle of capabilities as Ellonen *et al.*, (2011) is an introduction, growth, maturity, and decline. describes the development and evolution of capabilities over time, which is like a product or technology life cycle. Here's a detailed look at each stage:

- **Introduction:** This stage involves the initial creation and establishment of a capability within an organization. Capabilities are introduced through deliberate actions, investments, and efforts in areas such as research, learning, and building foundational processes. At this stage, capabilities are still being shaped, and their potential is yet to be realized fully. Companies often invest in acquiring knowledge and resources that form the building blocks of new capabilities.

- **Growth:** In the growth stage, the introduced capabilities start developing rapidly and gaining strength. Organizations improve these capabilities through learning-by-doing, experimentation, and refining practices. The emphasis is on enhancing efficiency, expanding the application of the capability, and gaining a competitive edge. The firm invests resources in building up and scaling these capabilities to address broader market opportunities and operational needs.

- **Maturity:** During maturity, the capabilities are well-developed, standardized, and integrated into the firm's daily operations. At this point, they have reached a level where they are performing at peak efficiency and generating consistent results. Companies may focus on maintaining the capability rather than growing it further, as it has already reached a stable state. Routines become well-established, and the benefits derived from the capability are optimized.

- **Decline:** In the decline stage, the relevance or effectiveness of the capability diminishes. Changes in technology, market needs, or organizational focus may render a capability obsolete or less valuable. The decline can happen gradually or be accelerated by external shocks (e.g., technological disruptions, and shifts in consumer preferences). Firms must decide whether to let these capabilities become redundant, reconfigure them to maintain value or substitute them with new capabilities to remain competitive.

- **Renewal or Redeployment:** Instead of allowing capabilities to decline, firms may decide to renew or redeploy them. Renewal involves modifying or upgrading an existing capability to align it with new opportunities or requirements. It can include adopting new practices, reengineering existing processes, or integrating new technology to revitalize the capability. Redeployment refers to using existing capabilities in new contexts or markets. This involves taking the established capability and applying it in different areas of the organization to extend its usefulness. The renewal or redeployment phase aims to extend the life of a capability by adapting it to changing environments and maintaining its strategic importance.

The life cycle is crucial because it illustrates how capabilities evolve in response to both internal organizational factors and external environmental pressures. To maintain competitive advantage, firms need to actively manage these life cycles—upgrading existing capabilities or substituting them with new ones as market needs evolve. Dynamic capabilities (such as sensing opportunities, seizing opportunities, and reconfiguring assets) play a key role in managing the transitions between these stages.

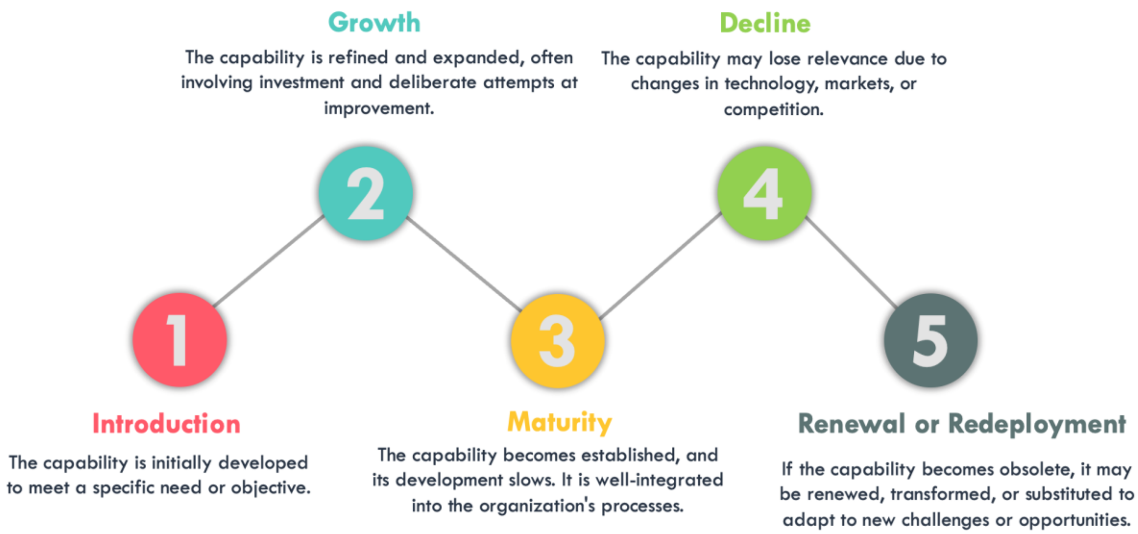

Figure 18 The Dynamic Capabilities Life Cycle

2.5.16 Measuring the Dynamic capabilities

Dynamic capabilities are measured using various approaches that align with their theoretical constructs and practical implications. A prominent method involves assessing managers' evaluations, which provides insights into how managers perceive their firm's ability to detect, capture, and reorganize resources in reaction to changes in the environment. This subjective approach is useful for capturing the nuanced and context-specific nature of dynamic capabilities. However, it is essential to mitigate common method bias by ensuring that data for measuring dynamic capabilities and performance outcomes come from different sources to avoid conflating perceptions with actual performance outcomes.

Another method focuses on financial data, such as R&D expenditures, to quantify dynamic capabilities. This approach assumes that higher R&D investments reflect a firm's capacity to innovate and adapt. For instance, studies have measured the dynamic capability by evaluating a firm's ability to reposition its product portfolio in response to market changes, as demonstrated in research on the semiconductor industry where improvement in manufacturing yield and cycle time post-new technology introduction was used as indicators of dynamic capabilities Macher and Mowery, (2009) .

Additionally, the development and validation of standardized scales have emerged as a rigorous method for measuring dynamic capabilities. One such scale, based on Teece, (2007) the framework, assesses organizational sensing, seizing, and transforming capacities through a structured set of items. This approach provides a reliable and valid measure that can predict various facets of business and innovation performance, thereby offering a comprehensive tool for empirical research and practical assessment Kump ,et al. (2019). This multifaceted approach to measurement ensures that the complexity and dynamic nature of capabilities are captured, allowing for a deeper understanding and better strategic management within organizations.

The following shows the method used in each paper :

- **Dao et al., (2016):** The study employs a survey method to gather data from managers in a Vietnamese IT company. The survey measures components of dynamic capabilities, including market development, marketing capability, innovation capability, entrepreneurial orientation, and enterprise reputation. These are linked to firm performance metrics to understand their impact. The data is collected through

Likert-scale items, and common method bias is mitigated by using different sources for capability and performance data.

  - **Method Name:** Structural Equation Modeling (SEM)
  - **Details:** The study uses SEM to analyze survey data collected from managers. SEM allows in order to investigate intricate connections between latent and visible factors, facilitating the assessment of how various components of dynamic capabilities (e.g., marketing capability, innovation capability) impact firm performance.

- **Ellström ,et al. (2021):** This study uses a qualitative approach to identify dynamic capabilities related to digital transformation. Interviews and focus groups with firm representatives and consultants are conducted to uncover specific routines such as cross-industrial digital sensing and digital strategy development. The dynamic capabilities are assessed by coding and analyzing the qualitative data to identify patterns and themes related to sensing, seizing, and reconfiguring capacities.
  - **Method Name:** Qualitative Content Analysis
  - **Details:** The study employs qualitative content analysis to identify and categorize routines related to dynamic capabilities. Data from interviews and focus groups are coded and analyzed to uncover patterns and themes in how firms manage digital transformation through sensing, seizing, and reconfiguring routines.

- **Macher and Mowery, (2009):** Dynamic capabilities in semiconductor manufacturing are measured through quantitative models that assess how quickly manufacturing yield and cycle time have improved when new process technologies were introduced. The study uses firm-level R&D data and IT practices to develop these models. The empirical specifications test how experience accumulation and knowledge codification impact these performance metrics.

  - **Method Name:** Quantitative Modeling (Regression Analysis)
  - **Details:** The study uses regression models to quantify the impact of R&D investments on manufacturing performance metrics such as yield and cycle time improvements. These models help to understand how dynamic capabilities facilitate process improvements in semiconductor manufacturing.

- **Laaksonen and Peltoniemi, (2018):** Assessing the influence of dynamic capabilities on regular capabilities and the ensuing performance of the firm is part of the measurement process. The study advises avoiding tautological arguments by utilizing longitudinal data and differentiating between dynamic and conventional capacities.. Financial data such as R&D expenditures and managers' evaluations through surveys are commonly used, but the authors emphasize the need for multidimensional constructs and firm-specific profiles to capture the uniqueness of dynamic capabilities.
  - **Method Name:** Longitudinal Analysis and Survey Data Analysis
  - **Details**: The study uses longitudinal data to assess the impact of dynamic capabilities on firm performance over time. Surveys are administered to gather managers' evaluations, and financial data is analyzed to distinguish between dynamic and ordinary capabilities, ensuring robust measurement.

- **Teece, (2007):**Dynamic capabilities are conceptualized and measured through the framework of sensing, seizing, and reconfiguring opportunities. This involves evaluating a firm's ability to sense new opportunities, seize them through strategic investments, and reconfigure resources to maintain competitiveness. The study uses case studies and qualitative data to illustrate these processes and how they affect business performance.

- **Method Name:** Case Study Analysis
- **Details:** The study uses case studies to illustrate the processes of sensing, seizing, and reconfiguring opportunities. Qualitative data from detailed case studies provide insights into how firms develop and leverage dynamic capabilities to maintain competitive advantage.

- **Kump ,et al. (2019):** The study develops and confirms a 14-item scale that depends on Teece's (2007) framework. The scale measures organizational capacities for sensing, seizing, and transforming through items that assess specific actions and routines within firms. The scale's reliability and validity are tested using exploratory and confirmatory factor analyses, and it serves as a indicator to creativity and company success.
    - **Method Name:** Exploratory and Confirmatory Factor Analysis (EFA and CFA)
    - **Details:** The study develops a 14-item scale to measure dynamic capabilities and tests its reliability and validity using EFA and CFA. These factor analyses help to ensure that the scale accurately captures the constructs of sensing, seizing, and transforming capacities.

These methods provide a comprehensive approach to measuring dynamic capabilities, utilizing both qualitative and quantitative data to capture their impact on organizational performance.

Table 6 Dynamic Capabilities Measurement Methods (Part1)

Paper	**Mathematical Model**	**Details**	**Advantages**	**Disadvantages**	**Information Gathering Method**
Dao et al. (2016)	Structural Equation Modeling (SEM)	Analyzes survey data to examine relationships between components of dynamic capabilities (e.g., marketing capability, innovation capability) and firm performance.	Allows for complex relationships and latent variables; provides robust statistical analysis	Requires large sample sizes; potential for common method bias	Surveys administered to managers assessing various components of market development and innovation

Table 7 Dynamic Capabilities Measurement Methods (Part2)

Paper	**Mathematical Model**	**Details**	**Advantages**	**Disadvantages**	**Information Gathering Method**
Ellström et al. (2021)	Qualitative Content Analysis	Codes and analyzes interview and focus group data to identify routines for digital transformation, focusing on sensing, seizing, and reconfiguring capacities.	Provides deep insights and context-specific understanding; flexible and adaptive	Subjective interpretation; time-consuming; harder to generalize findings	Interviews and focus groups with firm representatives and consultants undergoing digital transformation
Macher and Mowery (2009)	Regression Analysis	Uses quantitative models to measure the impact of R&D investments on manufacturing performance metrics such as yield and cycle time improvements.	Quantifies relationships; allows for control of variables; widely understood and applied	Assumes linearity; potential omitted variable bias; requires reliable and extensive data	Financial data such as R&D expenditures and performance metrics (yield, cycle time)
Laaksonen and Peltoniemi (2018)	Longitudinal Analysis and Survey Data Analysis	Assesses the impact of dynamic capabilities on ordinary capabilities and subsequent firm performance over time using longitudinal data and manager surveys.	Captures changes over time; mitigates issues of cross-sectional data	Requires long-term data collection; complex data analysis; potential for respondent bias in surveys	Longitudinal data and manager surveys over different time periods and contexts
Teece (2007)	Case Study Analysis	Uses qualitative data from detailed case studies to illustrate processes of sensing, seizing, and reconfiguring opportunities for maintaining competitive advantage.	Provides detailed, in-depth insights; captures real-world complexity	Limited generalizability; potential for researcher bias; time-consuming	Detailed case studies, including interviews and archival data
Kump et al. (2018)	Exploratory and Confirmatory Factor Analysis	Develops and validates a 14-item scale for measuring dynamic capabilities, ensuring accurate capture of sensing, seizing, and transforming capacities.	Ensures measurement validity and reliability; suitable for scale development	Requires large sample sizes; complex statistical techniques; initial development can be time-consuming	Structured surveys with Likert-scale items, administered to a large sample of respondents

Dynamic capabilities, as described by (Konlechner et al., 2018), are pivotal for evaluating a company's adaptability and sustained competitive advantage. Figure 1 illustrates three primary capabilities:

- **Sensing Capabilities:** "Identifying opportunities by gathering and interpreting information."
- **Seizing Capabilities:** "Mobilizing resources to capture opportunities, which includes developing partnerships and acquisitions."
- **Transforming Capabilities:** "Reconfiguring resources and structures to maintain competitiveness."

These capabilities allow companies to consistently and successfully take advantage of new possibilities and adjust to shifting surroundings.

2.6 Dynamic Capabilities Threshold

In this study Kump ,et al. (2019), Developing and validating a scale for measuring dynamic skills in companies required the use of exploratory factor analysis (EFA). The EFA process was initiated with the goal of identifying the underlying factor structure of the constructs of interest, namely sensing, seizing, and transforming capacities, as theorized by Teece (2007). Initially, a comprehensive set of 16 items was generated, reflecting these three dimensions of dynamic capabilities. These items were carefully crafted based on theoretical foundations and refined through expert feedback and pilot testing. The EFA was conducted on a sample of 269 companies, representing a diverse range of industries and organizational sizes, to ensure the generalizability of the findings.

Using principal axis factoring as the extraction method, the EFA aimed to uncover the latent structure of the items without imposing a predefined model. An oblique rotation

(Promax) was chosen to allow for the potential correlation between factors, consistent with the theoretical understanding that the capacities of sensing, seizing, and transforming are related yet distinct constructs. The analysis revealed a three-factor solution that closely aligned with the theoretical framework. Items that exhibited high factor loadings on their respective factors and minimal cross-loadings were retained, while items with significant cross-loadings, such as SE6 and T6, were removed to purify the scale.

The resulting factors were interpreted as follows: the first factor, Sensing, included items that measure an organization's ability to systematically scan and monitor its environment for relevant information; the second factor, Seizing, encompassed items related to the ability to recognize and capitalize on new opportunities; and the third factor, Transforming, captured the capacity to reconfigure resources and implement changes effectively. The reliability of each factor was assessed using Cronbach's alpha, with values of 0.88 for Sensing, 0.83 for Seizing, and 0.86 for Transforming, indicating high internal consistency.

About 66% of the variance in the data was explained by the three factors combined, indicating that the components that were found were responsible for a significant amount of the variance. Subscale intercorrelations ranged from 0.49 to 0.66, further supporting the theoretical model of related but distinct dimensions of dynamic capabilities. The results of the EFA provided empirical support for the theoretical constructs and served as a foundational step towards the subsequent Confirmatory Factor Analysis (CFA), which aimed to further validate the factor structure in a new sample.

The EFA in this study was instrumental in empirically validating the three-dimensional structure of dynamic capabilities, ensuring that the measurement scale accurately captured the constructs of sensing, seizing, and transforming. This rigorous approach to scale development not only enhanced the validity and reliability of the measurement instrument but also contributed to a deeper understanding of the dynamic capabilities framework within organizational contexts.

No.	Item	Factor		
		SE	SZ	T
SE1	Our company knows the best practices in the market	0.72		
SE2	Our company is up-to-date on the current market situation	0.82		
SE3	Our company systematically searches for information on the current market situation	0.95		
SE4	As a company, we know how to access new information	0.83		
SE5	Our company always has an eye on our competitors' activities	0.70		
SE6[a]	*Our company quickly notices changes in the market*	*0.40*	*0.48*	
SZ1	Our company can quickly relate to new knowledge from the outside		0.87	
SZ2	We recognize what new information can be utilized in our company		0.71	
SZ3	Our company is capable of turning new technological knowledge into process and product innovation		0.84	
SZ4	Current information leads to the development of new products or services		0.73	
T1	By defining clear responsibilities, we successfully implement plans for changes in our company			0.89
T2	Even when unforeseen interruptions occur, change projects are seen through consistently in our company			0.90
T3	Decisions on planned changes are pursued consistently in our company			0.61
T4	In the past, we have demonstrated our strengths in implementing changes			0.60
T5	In our company, change projects can be put into practice alongside the daily business			0.72
T6[a]	*In our company, plans for change can be flexibly adapted to the current situation*		*0.44*	*0.55*

Table 8 Pattern items for measuring Dynamic Capabilities Kump,et al. (2019)

Table 9 presents the results of the Exploratory Factor Analysis (EFA) for the dynamic capabilities scale, detailing the factor loadings for sensing, seizing, and transforming capacities. Each item within the sensing (SE1-SE5), seizing (SZ1-SZ4), and transforming (T1-T5) factors demonstrated strong loadings, ranging from 0.60 to 0.95, indicating robust measurement of the intended constructs. However, items SE6 and T6 exhibited significant cross-loadings, suggesting they did not uniquely measure a single factor, and were subsequently removed to improve scale clarity. The high Cronbach's alpha values (Sensing: 0.88, Seizing: 0.83, Transforming: 0.86) confirm the internal consistency of each factor, while moderate to high intercorrelations between subscales (0.49 to 0.66) align with theoretical expectations of related but distinct dimensions. Overall, the EFA results support the validity of the three-factor structure proposed by Teece (2007), ensuring that the refined scale reliably captures the dynamic capabilities of sensing, seizing, and transforming.

Confirmatory Factor Analysis (CFA) was used to confirm that the factor structure obtained from the Exploratory Factor Analysis (EFA) and to ensure that the measurement scale accurately captured the constructs of sensing, seizing, and transforming capacities within organizations, as theorized by Teece. After the initial EFA on a sample of companies identified a three-factor structure, CFA was conducted on a new sample of companies to confirm this structure. The CFA process involved specifying a model in which each of the 14 refined items loaded onto one of the three latent factors. The model was defined by setting up three latent variables: Sensing (SE1-SE5), Seizing (SZ1-SZ4), and Transforming (T1-T5). Various fit indices were used to evaluate the model's adequacy, including the Tucker-Lewis Index, Standardized Root Mean Squared Residual, Incremental Fit Index, Comparative Fit Index, Normed Fit Index, and Root Mean Square Error of Approximation. An adequate representation of the data by the proposed three-factor model was confirmed by these indices, which showed a good fit. Every item showed notable loadings on its corresponding factor, and the values showed a high correlation between the underlying constructs and the observable variables. The internal consistency was verified with Cronbach's alpha values for Sensing, Seizing, and Transforming, ensuring the reliability of the scale. The Average Variance Extracted exceeded the recommended threshold for all constructs, demonstrating good convergent validity, while discriminant validity was confirmed by comparing the AVE with squared correlations between constructs.

The results of CFA provided robust evidence supporting the validity and reliability of the three-dimensional structure of dynamic capabilities. Consequently, the measures obtained from both EFA and CFA can serve as thresholds for future case studies, providing a validated benchmark for assessing dynamic capabilities in various organizational contexts. This rigorous validation process not only reinforced the theoretical framework but also enhanced the empirical robustness of the scale, making it a valuable tool for both academic research and practical application in dynamic environments.

Sensing, seizing, and transforming are theoretically separate but connected abilities that make up dynamic capabilities (DC), a multifaceted construct. Furthermore, DC is thought of as a latent capacity that becomes apparent through observed behaviors and their results. Although prior researchers have proposed measures for DC that center on the frequency of activities that may contribute to DC (e.g., "People participate in professional association activities"; these items may contribute to sensing capacity but are not necessarily indicative of it), our items measure DC more directly. One way to do this is to ask about routines that directly show the presence of the capability (e.g., "Information on the current market situation is systematically searched for by our company," indicating established systematic sensing routines) or the outcome of the capability (e.g., "The best practices in the market are known by our company," indicating high sensing capacity).

As DC are viewed as organizational phenomena rather than individual ones, all of the items are presented in a depersonalized way, emphasizing organizational attitudes and results rather than individual ones (for example, "Market trends are always kept up-to-date by us" rather than "I am always up-to-date with market trends"). Additionally, DC should be viewed as a continuum rather than a binary ("have it" or "don't have it") idea, enabling more detailed explanations of the settings of DC in various businesses. Thus, like the majority of other DC scales, our items ask for incremental responses as opposed to straightforward "yes" or "no" responses. A six-point Likert scale, with "strongly disagree (1)" to "strongly agree (6)" as the extremes, was used for the answering format. Kump,et al. (2019).

2.7 Dynamic Capabilities Scale Consideration

Existing scales were used to operationalize sensing capacity, but items were modified to highlight routines and results that were already established. For instance, questions were developed to gauge the organization's knowledge of the state of the market and its ability to obtain fresh information. Items like "The company is capable of turning new technological knowledge into process and product innovation" and "It is recognized what new information can be utilized in the company" were used to gauge seizing. Items like "Decisions on planned changes are pursued consistently in the company" and "By defining clear responsibilities, plans for changes are successfully implemented in the company" are examples of operationalizations of transforming capacity that focus on the effective implementation and accomplishment of strategic renewal within the organization. Kump ,et al. (2019).

2.7.1 Data Collection Example

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	ID	SE1	SE2	SE3	SE4	SE5	SZ1	SZ2	SZ3	SZ4	T1	T2	T3	T4	T5
2	1	5	4	2	5	3	4	5	5	5	4	5	3	4	5
3	2	4	5	5	4	5	5	1	5	4	5	4	5	4	2
4	3	4	5	5	3	5	5	4	4	5	5	5	2	5	3
5	4	3	5	5	5	4	3	2	5	4	4	4	5	4	4
6	5	5	5	3	5	5	4	4	5	5	4	5	4	5	5
7	6	4	4	5	2	4	5	4	4	5	5	4	5	4	5
8	7	5	4	4	5	5	2	5	3	5	3	5	3	5	4
9	8	5	5	4	5	4	5	5	5	4	4	4	5	1	5
10	9	4	4	5	4	5	4	2	4	5	5	5	4	5	4
11	10	4	4	5	4	4	5	4	4	5	5	4	5	4	5
12	11	5	4	4	5	5	5	5	3	5	3	5	3	5	4
13	12	5	5	4	5	4	5	5	2	4	4	2	5	4	5
14	13	2	4	5	4	5	4	4	4	5	2	5	4	5	4
15	14	4	2	5	4	4	2	4	4	5	5	4	5	4	5
16	15	5	4	4	5	5	5	5	3	5	2	5	3	5	4
17	16	5	5	4	5	4	5	5	5	4	4	4	5	4	5
18	17	3	5	2	5	4	3	4	5	4	4	4	5	4	4
19	18	5	5	3	5	5	4	4	5	5	4	5	4	5	5
20	19	4	4	5	4	4	5	4	4	5	5	4	2	4	5
21	20	5	4	4	2	5	5	5	3	5	3	5	3	5	4
22	21	5	5	4	5	4	5	5	5	4	4	4	5	4	5

Table 9 Example of Data Collected in Excel File

In my research, the data collected from the survey will be systematically entered into an Excel spreadsheet to ensure accurate and organized data management. This spreadsheet will serve as a centralized repository for all survey responses, allowing for efficient data handling and preliminary analysis. Once the data is thoroughly reviewed and cleaned for any inconsistencies or missing values, it will be prepared for further processing using JASP, a statistical software. JASP will enable advanced statistical analyses and modeling, providing deeper insights into the dynamic capabilities of Solutions by STC and facilitating robust conclusions for my DBA thesis as in Figure 26.

2.7.2 ICT Company in Smart City Filed

There are numerous ways to understand the idea of a smart city. The researcher's perspective influences these interpretations. An ICT sector researcher may view this idea in terms of putting technology into place that help realize the smart city notion. For instance, while putting the smart city concept into practice, a number of ICT catchphrases are frequently employed, such as digital twins, the metaverse, digital transformation, the Internet of Things (IoT), ubiquitous computing, and many more. Because they view all

ICT systems as instruments to carry out a certain set of tasks, public offices, like communal administrations, place more emphasis on enabling technology than on the technologies themselves. As a result, they might focus especially on how to manage the resulting combination and how to integrate such a system into their current one. Furthermore, a management researcher might be more interested in the consequences of creating, managing, and preserving a smart city. El Hendy ,et al. (2022).

In order to maximize the value of digital infrastructure, the most advantageous and successful businesses have reportedly modernized and reimagined information flows, decision-making authority, and extra organizational capital. In order to implement new ICT technology and digital transformation strategies, they have redesigned their business processes. Many smart towns are built with ICT integrated into their design. El Hendy ,et al. (2022).

Fig. 18 provides an illustration of a basic framework outlining the participants, interested parties, and advantages of a smart city initiative Paroutis , et al. (2014). Implementing smart cities, achieving digital platforms, preserving the environment, and improving people's quality of life are made possible by solution providers, governments, and research and educational organizations. Dameri (2017).

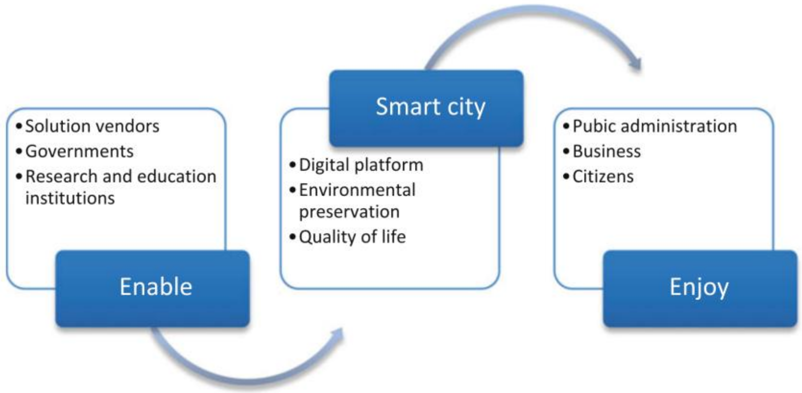

Figure 19 Actors, stakeholders and benefits in smart city Dameri (2017).

In El Hendy ,et al. (2022) An ICT Strategic Framework for the Smart City (SFSC) concept was created by them. In order to create a successful smart city, this sought to provide a three-tiered framework of a dependable and cooperative set of systems that can manage complex and dynamic situations. It did this by incorporating technologies and techniques that facilitate collaboration among all city-related systems. A new smart city that can facilitate collaboration among city stakeholders and function in various vertical domains integrating heterogeneous, mass-market, and horizontal technologies and services, as well as people, can be created by SFSC using an inventive three-view model that consists of a Technology View, Systems View, and Strategic View.

Major international technology companies like IBM, Cisco, and Siemens have generally been drawn to ICT systems due to their strategic position. For instance, according to IBM, a smart city is a "system of systems," with ICT systems serving as the digital nervous system of the city, gathering data from many sources that make up its infrastructure. Additionally, it emphasizes how ICT helps city leaders and planners decide how these systems function, interact, and exchange data to facilitate better decision-making practices. The use of new ICTs to facilitate the development of smart city ICT infrastructure and other smart systems has emerged as a study area. El Hendy ,et al. (2022).

Information and Communication Technology (ICT) companies are crucial in developing smart city infrastructure by building foundational ICT systems, implementing Internet of Things (IoT) solutions for interconnected devices, and managing the vast data these cities generate. They provide essential data analytics to inform city management decisions, cybersecurity to protect the infrastructure, and develop specific applications to improve urban services like traffic management and energy grids. Additionally, ICT companies ensure the integration of various technological components and assist in strategic planning, making them integral to transforming traditional cities into efficient, sustainable smart cities Kumar , et al. (2020).

Kumar , et al. (2020) built a mind map, this mind map as Fig.19 in provides a visual representation that showcases the integration of ICT infrastructure within the broader framework of smart city planning, highlighting its essential role in supporting various urban domains such as transportation, public safety, and utilities. By illustrating the interconnectedness of these elements, the mind map aids stakeholders, including policymakers and city planners, in understanding how ICT acts as the backbone for data-driven and interconnected urban environments, facilitating easier communication of complex strategies and the vital role of integrated ICT solutions in transforming cities into efficient, sustainable smart cities.

Figure 20 delineates the Using the Smart City Transformation Framework, the development process is divided into four main stages: planning, building infrastructure, implementing smart solutions, and ICT infrastructure.—with a significant focus on ICT infrastructure. This phase is crucial as it involves setting up the core technological backbone of the smart city, including data centers, network connectivity, and the extensive deployment of IoT devices and sensors that facilitate the collection, transmission, and analysis of data across urban services. The ICT infrastructure is the enabler of integrated smart solutions such as traffic management and energy systems, underpinning the operational efficiency and interconnectedness essential for the modern smart city. This segment ensures that the technological groundwork supports the overall vision of a seamlessly integrated and responsive urban environment.

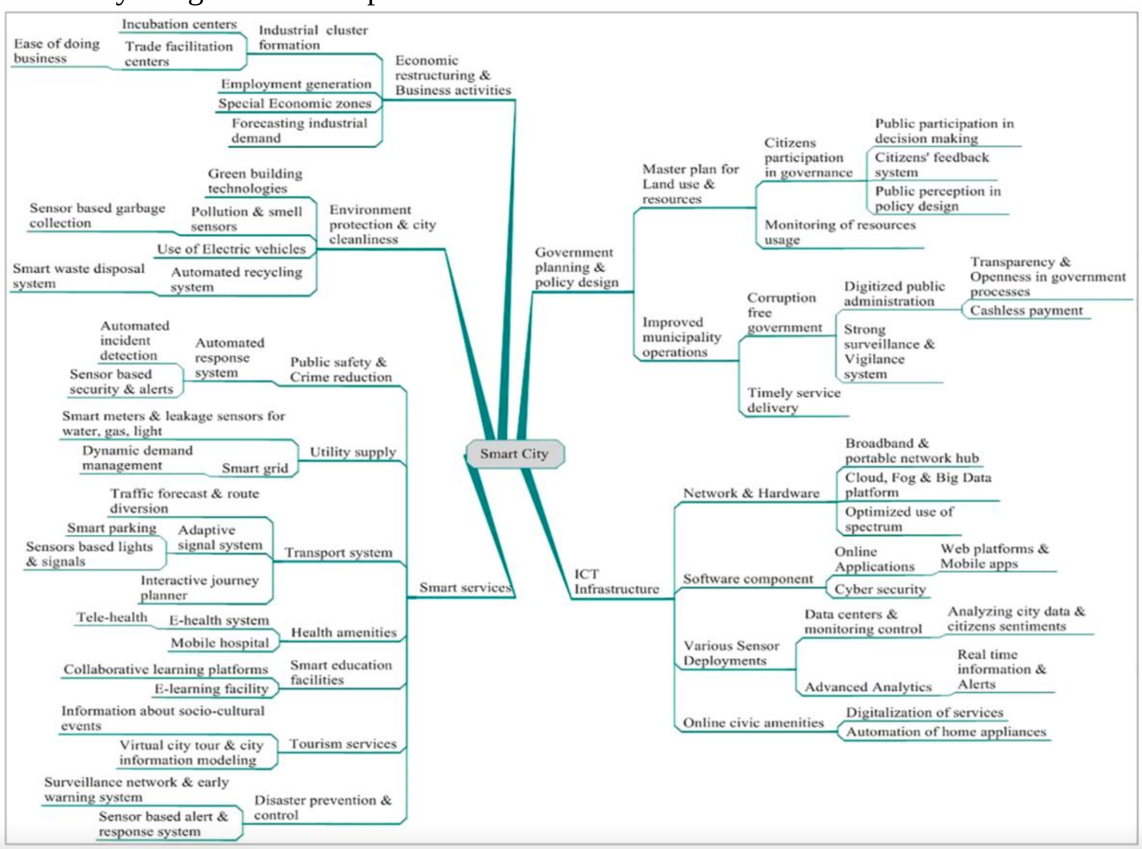

Figure 20 Smart City Mid Map Kumar, et al. (2020).

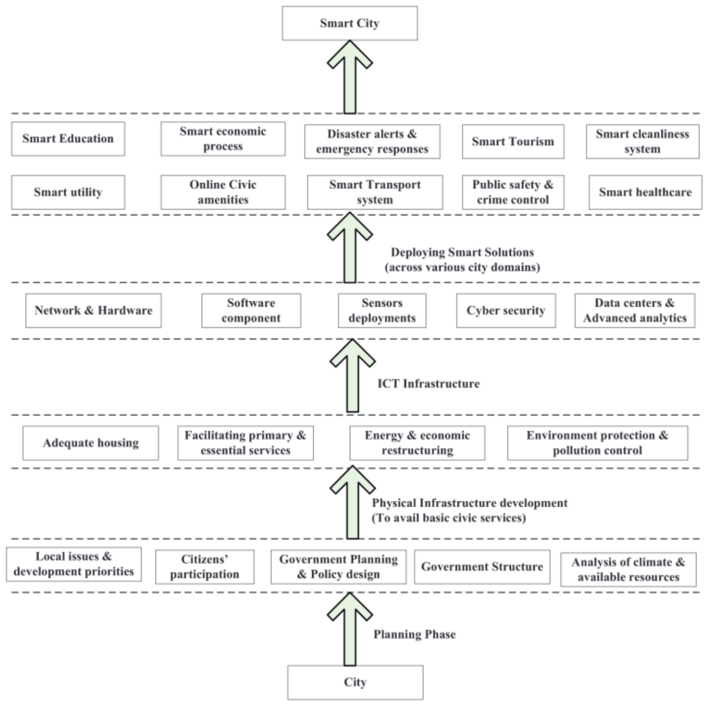

Figure 21 A framework for smart city transformation Kumar, et al. (2020).

2.7.3 Evaluating ICT Role

Since ICT is essential to implementing smart city projects and initiatives, a more thorough examination is necessary to determine how and to what extent ICT influences the way people live their everyday lives in cities and enhances their quality of life. These arguments must be examined independently. Speaking about the significance of ICT in creating a better city and how prevalent it is in smart initiatives is one thing, to be sure. For example, a Smart Mobility program that uses ICT to control public transportation networks or a Smart Energy project that uses ICT to control energy smart grids are examples of (a) how and to what extent ICT is the leading technology in smart projects and (b) how prevalent and supporting ICT is in projects pertaining to various aspects of a smart city. The purpose of this assessment is to determine the ICT weight in smart cities, which can be thought of as either an output (the number of e-services provided by the municipality) or an input (the number of people using broadband, for example). Speaking about the extent to which ICT contributes to the creation of both public and private tools, artifacts, or services that can improve the everyday lives of city dwellers, leading to advantages and ultimately greater well-being, is another consideration. Specifically, the impact of concrete and intangible benefits for citizens are quantified in this evaluation, which is viewed as the smart city's ultimate result. Dameri, (2017).

2.7.4 ICT Smart Projects Vs. Digital Projects

In Dameri, (2017) By examining smart city portfolios, the author proposes a framework to categorize and promote the importance of ICT in smart city initiatives. The survey's chosen criteria are explained in Figure 21.

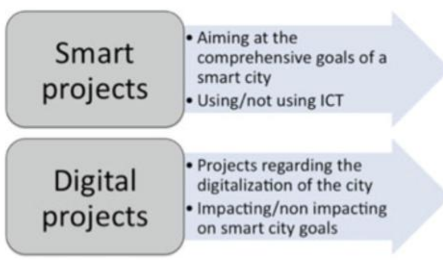

Figure 22 Smart and digital projects taxonomy Dameri, (2017)

All the projects have been classified as: – smart projects, aiming at some typical smart goals such as reducing greenhouse gases, improving building energy efficiency, improving the use of renewal energy sources.

- **Smart projects** are further divided into those who use or do not use ICT: Planning a new park in the city center has a favorable environmental impact without the use of ICT, whereas a solar energy smart grid can utilize it to control the optimal energy production and delivery.

- **Digital projects**, Aiming to digitize the city, digital projects are further divided into those that have an impact on or do not have an impact on smart goals. For instance, digitizing the Municipality's internal processes has no effect on the city's smart goals, but a smartphone app that alerts trucks to traffic in the city center does.

This classification produces four categories of projects:

1. Smart projects without the use of ICT;
2. smart projects that rely on ICT utilization;
3. smart projects, relying solely on behaviors, regulations, contracts, and other factors rather than technologies;
4. Energy, the environment, and urban infrastructures were mentioned in digital projects, excluding smart aims.

In El Hendy , et al. (2022) created a thorough ICT framework for the deployment of smart cities, as seen in Figure 22. There should be multiple levels or layers in the suggested architecture. Each layer must incorporate a particular kind of ICT, component, or process to guarantee that all elements of a successful smart city are present.

<table>
<tr><td rowspan="3">Strategic View</td><td rowspan="3">Smart City Governance and Analytics</td><td colspan="5">Smart City Resource Planning</td><td rowspan="6">Smart City Participants Awareness and Involvement</td></tr>
<tr><td colspan="2">Initiatives Funding and ROI</td><td>Policies and Driven Decisions</td><td colspan="2">Selection of Technology Provider</td></tr>
<tr><td colspan="2">Artificial Intelligence</td><td>Data Analytics
Visualization
Dashboards</td><td colspan="2">Trusted Service Managers</td></tr>
<tr><td>Systems View</td><td>Smart City Data Aggregation</td><td>Mash-Ups</td><td>Mobile Apps</td><td>Widgets</td><td>Portals</td><td>Interoperable APIs/Systems Integration</td></tr>
<tr><td rowspan="2">Technology View</td><td rowspan="2">Smart City ICT Infrastructure</td><td colspan="2" rowspan="2">Cloud Computing
Blockchain
Big Data</td><td colspan="2" rowspan="2">Smart City Tagging Technologies
1. Geolocation technologies
2. RFID Technology
3. NFC Technology
4. Internet of Things (IoT)</td><td rowspan="2">Industry 4
Li-Fi
5G
Wireless networks and Sensors networks
Smart Grid
Autonomous vehicles</td></tr>
<tr></tr>
</table>

Table 10 Strategic ICT Smart City Framework El Hendy, et al. (2022)

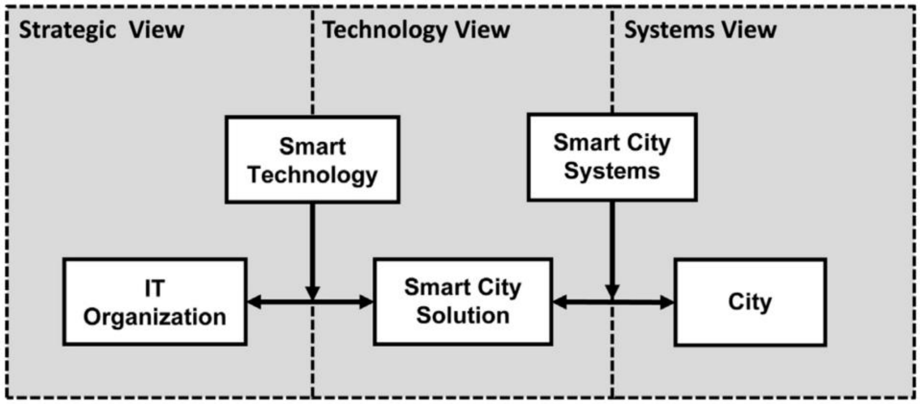

Figure 23 Perspectives on researching a smart city solution Paroutis , et al. (2014)

Smart City ICT Infrastructure (Technology View):

This layer must be put into place and incorporated with the required infrastructure as well as the city's current infrastructure. This layer preserves and describes the connection model or solution for the smart city. Any utility or service related to smart cities enters through this level. The Internet of Things (IoT), cloud computing, RFID, NFC, and wireless and sensor network technologies are the elements that make up this layer.

Smart City Data Aggregation (Systems View):

The middle layer of the suggested model is this one. The objective of this layer is to aggregate actual data from many sources, collect it through various means, such portals and widgets, and offer supplementary smart apps that enable smart city members to access the data collected in this layer. To enable the collection of actual data from several sources, each component of this layer is implemented in an object or software integrated. By offering compatible APIs, smart city systems can be integrated with one another.

Smart City Governance and Analytics (Strategic View):

After processing all of the data gathered, the High Level of the framework makes it available to the public and decision-makers. This is the layer that handles and analyzes data. Compliance, authentication, security, and privacy are all managed by the Trusted Service Manager. The strategic role, which allows politicians to alter current policies and base decisions on the situation, is another significant function of this level. Additionally, investment return is estimated and smart city technology providers are chosen at this level. Finally, smart city resource planning, the top layer, covers the entire model. Optimizing all of the framework's resources is the main goal of this section. A crucial vertical support component of the system is everyone's awareness and participation in the smart city El Hendy, et al. (2022).

Strategic View	Smart City Governance and Analytics	Overall combined strategic plan • ICT is highly optimized and used in all city domains. • Sustainability competence is built into all smart city domains. • Better decision making. • Development and continuous improvement. • Governance and security plans for the smart city.
Systems View	Smart City Data Aggregation	• Largely integrated smart city systems that provide real-time data and reporting. • Availability of data from all smart city participants in a regulated and secure manner based on the authorized level of access. • Effective high-level solutions (Fit for Purpose).
Technology View	Smart City ICT Infrastructure	• Various interface points using several technologies. • Two-way communication by implementing well-established channels among the entirety of smart city members. • Various data points capturing technologies through a unified ICT infrastructure that serves diverse smart city domains.

Table 11 Proposed ICT Strategic Framework El Hendy ,et al.(2022).

2.7.5 ICT Smart City Governance

Information Communication and Technology (ICT) is important for policymakers in a smart city, as it aids in data collection, improves governance through better-informed decisions, and helps develop suitable policies. In a Smart City, In addition to using new technology, governance entails encouraging openness in data exchange and decision-making. Employing tools and methodologies that enhance situational awareness is crucial for streamlining discussions and negotiations, facilitating collaborative decision-making that can tackle the complexities of smart city initiatives. Research indicates that smart governance is essential as a key driver of innovation and sustainable economic development within the smart city framework, influencing the success or failure of projects Tran Thi Hoang ,et al. (2019).

2.8 Critical Success Factors – CSF

A critical success factor (CSF) is a key element or activity that is necessary for an organization, project, or strategy to achieve its goals and be successful. CSFs are essential components that must be done well for a business or project to thrive. They help an organization focus on what is most important for success and guide decision-making and resource allocation.

Below are some key insights from various studies on critical success factors:

- **Business Process Management (BPM) Critical Success Factors:**

The successful implementation of BPM relies on the fit between business processes and the business environment. Continuous improvement and ensuring that business tasks align with the supporting information systems are essential. A theoretical framework grounded in contingency theory, dynamic capabilities, and task-technology fit is critical for BPM success. This framework helps to identify both generic and specific CSFs that are applicable across industries. The role of continuous alignment between organizational strategy, processes, and technology is crucial in this context Trkman, (2010) .

- **Smart City Projects Critical Success Factors:**

For smart city projects, factors such as citizen engagement, smart governance, and ICT (Information and Communication Technology) integration are vital. These elements help to ensure that urban development aligns with sustainability goals. However, the role of intellectual capital (i.e., the skills and knowledge of individuals) and governance is often underestimated in favor of focusing on technological aspects. Therefore, in addition to technology, it is critical to incorporate strong governance and active citizen participation Kogan and Lee, (2014).

- **Knowledge Management (KM) Critical Success Factors:**

KM success relies on several factors, encompassing measurement, IT infrastructure, roles and duties, leadership, and culture. Leadership plays a pivotal role by modeling behavior, promoting knowledge sharing, and ensuring the proper flow of information. Additionally, having a well-defined structure for managing knowledge is essential for organizations to achieve efficiency and competitive advantage Hasan Ali, (2002).

- Enterprise Resource Planning (ERP) Critical Success Factors: In the context of ERP systems, research has identified various CSFs, like the backing of upper management, user training, project management, and clear goals and objectives. However, not all of these factors have been empirically proven to be critical across different cases, which suggests that CSFs may vary based on specific organizational contexts. Thus, it is essential to focus on the factors that have been empirically demonstrated to contribute to ERP success Ram and Corkindale, (2014).

- Smart Governance as a CSF for Smart Cities: In the implementation of smart city initiatives, smart governance is a crucial CSF. Governance frameworks that focus on e-government and transparent decision-making processes enhance the overall success of smart city projects. By ensuring that governance mechanisms are integrated into the management of smart city resources, cities can better handle urban complexities and improve citizens' quality of life Anindra *et al.*, (2018).

- Project Management Critical Success Factors: For construction and engineering projects, key success factors include project characteristics, contractual arrangements, and the effective management of project participants. These factors significantly influence outcomes related to budget, schedule, and quality. Using expert opinions to identify and manage these factors ensures that project resources are efficiently allocated Chua *et al.*, (1999) .

3.8.1 Link Dynamic Capabilities to CSFs

Key aspects of dynamic capabilities, including perceiving, seizing, and transforming, are represented by the survey's items. To derive Critical Success Factors from these dimensions, it is to identify the key areas that directly impact project success. The same data can serve to understand which capabilities are most critical to the success of ICT dynamic capabilities ins mart city filed projects.

- **Using Dynamic Capabilities Data to Derive CSFs**

The existing survey items already reflect key activities that contribute to success. To derive CSFs, we can group and interpret the survey items based on their importance to successful outcomes. Let’s consider the dimensions and the corresponding items:

- **Sensing Capabilities (SE) as CSFs**
    - **CSF: Market Awareness and Competitor Analysis**
        - Items like "Our company knows the best practices in the market" and "Our company always has an eye on our competitors' activities" directly relate to how well the organization stays informed about market trends and competitor moves.
        - **Critical Success Factor:** the capacity to comprehend and monitor the competitors, technological opportunities, and market environment with effectiveness.

- **Seizing Capabilities (SZ) as CSFs**
    - **CSF: Opportunity Recognition and Conversion**
        - Items such as "Our company can quickly relate to new knowledge from the outside" and "Our company is capable of turning new technological knowledge into process and product innovation" show how the company can seize opportunities by leveraging external information.
        - **Critical Success Factor**: The capacity to recognize and convert important information into opportunities and innovations, which have a direct impact on agility and growth.

- **Transforming Capabilities (T) as CSFs**
    - **CSF: Effective Change Implementation**
        - Items like "By defining clear responsibilities, we successfully implement plans for changes in our company" and "Decisions on planned changes are pursued consistently in our company" reflect the organization's ability to effectively implement change.
        - **Critical Success Factor:** The capacity to implement planned changes effectively, ensuring consistency, resource allocation, and team alignment.

- **CSFs Based on Survey Findings**

The categorization and structure of these CSFs are derived from the responses to the survey items. Each dynamic capability dimension can correspond to specific CSFs crucial for smart city projects.

For instance:

- High scores in sensing indicate strong market awareness, which is a CSF for keeping the organization ahead in dynamic environments.
- Strong seizing scores can translate to a CSF of being agile in adopting new innovations.
- High transforming scores indicate an effective CSF for executing strategic projects.

- **Develop a CSF Index**

These results need to be formalized by taking into account a critical success factor index that is derived from the average scores of each capability dimension. For example:

- Calculate the average score for all sensing items to create a "Market Awareness CSF Index."
- Repeat for seizing and transforming.
- This index will provide a comprehensive picture of how your company performs across critical areas essential for the success of smart city projects.

It can effectively use the data from your existing survey to derive CSFs by interpreting the dynamic capabilities (sensing, seizing, transforming) as areas that directly contribute to success. Specifically:

- **Sensing** translates to **Market Awareness CSF**.
- **Seizing** translates to **Opportunity Recognition and Conversion CSF**.
- **Transforming** translates to **Effective Change Implementation CSF.**

These CSFs represent the foundational elements that contribute to your organization's ability to undertake and complete smart city projects successfully.

- **Organize Survey Items into CSF Categories**

We already have the survey data measuring sensing, seizing, and transforming capabilities. We will aggregate these items to create CSF indices. Here's an example of how to proceed:

- Defining CSF Categories:
  - CSF for Market Awareness (derived from Sensing):
    - Survey Items: SE1, SE2, SE3, SE4, SE5
  - CSF for Opportunity Recognition (derived from Seizing):
    - Survey Items: SZ1, SZ2, SZ3, SZ4
  - CSF for Change Implementation (derived from Transforming):
    - Survey Items: T1, T2, T3, T4, T5

3.8.2 Critical Success Factor and AHP

Critical Success Factors (CSFs) can be evaluated and ranked using the Analytic Hierarchy Process (AHP), a multi-criteria decision-making method. Crucial elements that impact the success of strategic initiatives are known as Critical Success Factors (CSFs), and prioritizing them ensures that an organization's IT portfolio and business goals are in line. AHP offers a methodical framework to ascertain the relative significance of different CSFs by converting qualitative evaluations from experts into quantitative rankings Kim, (2022).

Employing AHP for CSF assessment entails conducting pairwise comparisons of CSF dimensions and sub-criteria, enabling experts to evaluate their relative significance within a coherent framework. This approach assists in determining which aspects should be prioritized to attain the intended strategic results. Utilizing AHP enables firms to concentrate on the most vital components, hence improving transparency, consistency, and strategic alignment in decision-making.

2.9 Cronbach's alpha Reliability

A standard measure for assessing a scale's internal consistency that shows the level of correlation between items within a construct is Cronbach's alpha. Tavakol and Dennick, (2011) It offers a numerical coefficient between 0 and 1, with elevated values signifying enhanced dependability of the items in assessing a shared latent variable. To confirm the validity of the survey tool evaluating the three dynamic capabilities—sensing, seizing, and transforming—this study calculated Cronbach's alpha values. Cronbach's alpha for the sensory dimension was 0.897, indicating that its constituent parts were exceptionally consistent with one another. Nunnally and Bernstein, (1994) . The alpha values for the seizing and transforming dimensions were both 0.698, indicating moderate consistency within the permissible range DeVellis and Thorpe, (2021).

The evaluation of reliability using Cronbach's alpha is a crucial phase in the validation of survey instruments, as it ensures that the items effectively measure the desired construct. A score of 0.70 is typically regarded as the minimum acceptable level for research, although values above 0.80 are frequently favored to signify strong reliability Hair *et al.*, (2010). When Cronbach's alpha falls below the acceptable threshold, it may suggest that certain items have weak correlations, necessitating revision or elimination Field, (2024). In this context, the elevated Cronbach's alpha for sensing indicates that this dimension is effectively represented by the chosen items, while the moderate values for seizing and changing highlight areas that may require additional refinement

The internal consistency or dependability of a collection of scale or test items is gauged by Cronbach's alpha. It establishes the degree of relatedness between a group of elements. To put it another way, it aids in determining how well a survey or questionnaire's components measure the same underlying construct.

2.10 The Likert scale system

The Likert scale system, ranging from "Strongly Disagree" to "Strongly Agree," was used in this study to collect responses related to dynamic capabilities. This five-point scale is particularly favorable for the study as it provides a balanced approach, allowing participants to express varying levels of agreement or neutrality regarding each statement. The Likert scale effectively captures nuanced opinions and attitudes; this is necessary to comprehend the intricate aspects of sensing, seizing, and transforming. Offering a neutral midpoint allows respondents who may not have a strong opinion to indicate their neutrality, reducing forced responses that might skew the data Joshi *et al.*, (2015) . The scale also facilitates ease of response and interpretation, contributing to the reliability of the data gathered, as evidenced by the high Cronbach's alpha for the sensing dimension. This consistency in capturing participant attitudes makes the Likert scale an ideal choice for measuring perceptions of dynamic capabilities.

2.11 The Findings from Literature Review

To grasp the subtle complexities of the smart city concept, an in-depth exploration of its six foundational pillars, smart environment, economy, living, people, governance, and mobility, is imperative for delineating the comprehensive strategy for cultivating sustainable and efficient urban ecosystems. Within this schema, the preeminence of smart governance is accentuated for its critical function in guiding the strategic orientation and policymaking processes foundational to the efficacious deployment of smart urban initiatives. This scholarly inquiry rigorously examines a spectrum of decision-making technologies, particularly emphasizing Multi-Criteria Decision-Making (MCDM) techniques, among which the Analytic Hierarchy Process (AHP) is distinguished for its unparalleled proficiency in deconstructing complex decisions into a structured hierarchical framework. AHP's methodology promotes a methodical and transparent decision-making paradigm, facilitating the integration of diverse criteria and the viewpoints of various stakeholders, thus significantly improving the quality of decision-making within relation tosmart governance. The superiority of this method in navigating the complex challenges urban environments present is highlighted, affirming its efficacy in not only streamlining the decision-making process but also in providing a resilient framework that is in harmony with the strategic imperatives of smart urban developments. Through the prism of AHP, this discourse elucidates the potential of smart governance to harness sophisticated decision-making instruments to unravel complex research dilemmas, thereby paving the way for more enlightened, sustainable, and resident-focused urban governance methodologies.

In my DBA thesis, I can leverage this paper Kump ,et al. (2019) to measure the dynamic capabilities of Solutions by STC by applying the validated 14-item scale created to evaluate an organization's ability to sense, seize, and transform. Utilizing this scale will allow me to systematically evaluate how effectively Solutions by STC can identify and interpret market trends (sensing), make strategic decisions and capitalize on opportunities (seizing), and implement and manage organizational changes (transforming). By integrating this scale into my research methodology, I can quantitatively assess the dynamic capabilities of Solutions by STC, compare them with industry benchmarks, and provide actionable insights on areas requiring enhancement to maintain a competitive edge in the rapidly evolving telecommunications

2.12 Future Work and Research Points

The discusses the future work in relation to developing smart cities, especially in India. It acknowledges certain limitations of the research, such as its heavy reliance on expert opinions and its focus on identifying and prioritizing barriers to smart city development within specific categories. Future research directions suggested including further evaluation of the recognized barriers to understand their causal relationships in smart city initiatives,

The future work outlined in Bolívar, et al. (2016) focuses on further exploring and understanding the various configurations of Smart Governance and their impacts. This involves studying how different forms of Smart Governance impact cities, varying along the dimensions of organizational processes, technology use, and innovation. Future research aims to examine the changes and outcomes at different levels, including changes in government efficiency, relationships with external actors, and overall city improvements. Additionally, there is an emphasis on analyzing how contextual factors such as administrative cultures and political, demographic, and technological factors influence the implementation and effectiveness of smart governance. This approach will provide deeper insights into the multifaceted nature of Smart Governance and its role in urban development and governance.

The future work outlined in Tran Thi Hoang, et al. (2019) focuses on enhancing smart governance and citizen participation in smart city projects. A significant emphasis is placed on integrating various decision-making methods, particularly combining Multi-Criteria decision-making (MCDM) with mathematical and AI methods, to optimize complex decision-making processes. The research highlights a need to concentrate on the later stages of smart city project implementation, specifically on assessing decision-making tools and ensuring active engagement of multiple stakeholders, including citizens. It calls for the development of negotiation and consensus-building tools to facilitate better stakeholder collaboration, especially in scenarios involving conflicting interests. Addressing these aspects will lead to more inclusive, effective, and sustainable smart city development.

Future work in relation to the paper by Giang, et al. (2017) would likely focus on practical application and validation of the proposed models in real-world Smart City projects, enhancing methods for managing uncertainty in complex urban environments, and implementing advanced simulation techniques. It would also involve deeper engagement with diverse stakeholders and the integration of emerging technologies like IoT and AI to refine decision-making processes. Additionally, long-term impact studies to evaluate the effectiveness of these models in improving urban development and quality of life in smart cities would be crucial for advancing the field and ensuring that theoretical frameworks translate effectively into practical, impactful solutions.

Since strategic change can only be implemented as quickly and to the extent allowed by an organization's capacity Teece (2016) there is a need to understand which organizational capabilities are required for smart city transformation. The capacity to transform depends on an organization's capability to integrate, build, and transform its resource base, to innovate and swiftly implement new processes, products, or services, or modify or reconfigure existing ones that better match the changing environment (Adner & Helfat (2003); Helfat & Raubitschek (2018); Pavlou & et al. (2011); Teece et al. (1997)) Guenduez, et al. (2022).

Kump,et al. (2019) Through industry-specific modifications and longitudinal studies, future research should concentrate on improving and expanding the dynamic capabilities scale while validating it in various organizational, cultural, and geographic contexts.. Investigating the causal relationships between dynamic capabilities and performance outcomes, as well as their interaction with other organizational capabilities, will provide a deeper understanding of their role in achieving competitive advantage. Employing advanced analytical techniques alongside qualitative approaches can offer new insights into the complexities of dynamic capabilities. Additionally, designing practical interventions for capability development and exploring policy implications will enhance the practical relevance and application of dynamic capabilities in fostering innovation and organizational adaptability.

CHAPTER III:
THE RESEARCH METHODOLOGY

3.1 Overview of the Research Problem

Dynamic capabilities are crucial for ICT companies striving to maintain competitiveness and drive innovation. These capabilities involve effectively integrating and recombining internal and external resources, enabling firms to swiftly adapt to technological advancements and changing market demands. Effective leadership, characterized by foresight and insight, is essential in identifying opportunities and efficiently managing resources. By leveraging dynamic capabilities, ICT companies foster continuous learning and reconfiguration, which fuels innovation. This includes integrating ICT with physical and organizational assets to develop adaptive infrastructures. Prioritizing dynamic capabilities ensures ICT firms remain agile, sustain competitive advantages, and promote ongoing business growth and innovation in rapidly evolving environments (Abro et al., 2011).

This research addresses the need to investigate and construct strategic frameworks that enable ICT companies to strengthen their dynamic capabilities. By doing so, ICT firms can better navigate the complexities of smart city projects, ensuring their contributions are impactful, timely, and aligned with broader urban development goals. This study's ultimate goal is to close the gap between theoretical knowledge and real-world application. providing actionable insights that enable ICT companies to thrive in the smart city ecosystem.

3.2 Operationalization of Theoretical Constructs

Operationalizing theoretical constructs is essential for translating abstract concepts into measurable variables, ensuring empirical validity in research. In this study, the Dynamic Capabilities Theory serves as the foundational framework for assessing how ICT companies navigate the smart city market. The three core dimensions—Sensing, Seizing, and Transforming—are operationalized through a structured survey that captures organizational competencies in adapting to technological and market changes.

1. Sensing Capabilities» : ensing refers to an ICT company's ability to identify emerging trends, gather market intelligence, and remain aware of competitors' activities in the smart city landscape. Organizations with strong sensing capabilities proactively scan their environment, ensuring they stay ahead of industry advancements.

- **Operationalization and Measurement:**
  - Awareness of best practices in the smart city market.
  - Keeping up to date with market trends and changes.
  - Systematic information searching on smart city developments.
  - Accessibility to new knowledge sources (e.g., research institutions, regulatory updates).
  - Monitoring competitor activities to maintain competitive positioning.
  - Speed in recognizing market shifts and disruptions.

- **Survey Indicators:**
  - "Our company knows the best practices in the smart city market."
  - "Our company systematically searches for information on the current market situation."

- “Our company quickly notices changes in the market.”

2. Seizing Capabilities : seizing refers to the organization’s ability to act upon new opportunities by integrating external knowledge into its innovation and decision-making processes. Companies with strong seizing capabilities can translate market insights into strategic actions that drive product and service development.

- **Operationalization and Measurement:**
    - Ability to process and utilize new knowledge for competitive advantage.
    - Recognition of technological advancements relevant to smart city solutions.
    - Transforming external knowledge into product and process innovation.
    - Speed of response to changing market needs.
    - Effectiveness in managing innovation risks and uncertainties.

- **Survey Indicators:**
    - “Our company quickly relates to new knowledge from the outside.”
    - “Our company is capable of turning new technological knowledge into process and product innovation.”
    - “Our company effectively manages innovation risks.”

3. Transforming Capabilities : transforming represents an organization's ability to continuously adapt, restructure, and implement change projects successfully. It ensures that ICT companies can sustain long-term innovation and remain resilient in a dynamic business environment.

- **Operationalization and Measurement:**
    - Clear responsibilities and leadership in implementing change.
    - Organizational resilience in managing disruptions.
    - Commitment to consistently executing strategic transformations.
    - Ability to implement change projects without disrupting daily operations.
    - Flexibility in adapting plans based on unforeseen circumstances.

- **Survey Indicators:**
    - "Decisions on planned changes are pursued consistently in our company."
    - "In our company, plans for change can be flexibly adapted to the current situation."
    - "Even when unforeseen interruptions occur, change projects are seen through consistently."

3.3 Research Purpose and Questions

The aim of this study is to assess the dynamic capabilities of ICT company in the implementation of smart city projects. By applying Dynamic Capabilities Theory, the study aims to assess how well the company can sense, seize, and transform opportunities within the rapidly evolving smart city ecosystem. This study will develop an analytical framework using methods such as Exploratory Factor Analysis (EFA) and Analytic Hierarchy Process (AHP) to systematically measure and benchmark these capabilities.

By understanding these capabilities, the research will:

- Provide actionable insights to improve strategic decision-making in smart city projects.

- Identify critical success factors (CSFs) necessary for sustainable smart city implementations.
- Contribute to the academic discourse on dynamic capabilities in ICT firms operating in volatile, uncertain, complex, and ambiguous (VUCA) environments.

3.3.1 Research Questions

How can the dynamic capabilities of ICT company be evaluated to determine their effectiveness and areas for improvement in smart cities projects implementation?

3.4 Research Design

The research design of this study is systematically structured to investigate and evaluate the dynamic capabilities of ICT companies in smart city projects. Recognizing the importance of strategic adaptability in rapidly evolving technological environments, this study employs a quantitative approach guided by the dynamic capabilities theory. The design includes clear methodological steps, outlined below, to ensure rigorous data collection and analysis, ultimately aiming to produce statistically reliable, actionable insights:

3.4.1 Research Type : Quantitative research design**.**

3.4.2 Guiding Theory : Dynamic capabilities theory.

3.4.3 Data Collection Tools

- Structured questionnaires specifically designed to measure dynamic capabilities (sensing, seizing, transforming).
- Utilization of a Likert Scale for responses.

3.4.4 Sample and Population :

- Target Population: Professionals from a major ICT company in Saudi Arabia involved in smart city projects.
- Sampling Method: Purposive sampling.

3.4.5 Data Analysis :

- Exploratory Factor Analysis (EFA) to identify underlying factors.
- Analytic Hierarchy Process (AHP) to prioritize critical success factors (CSFs).

3.4.6 Ethical Considerations :

- Informed consent from participants.
- Ensuring confidentiality and anonymity.
- Participants can withdraw at any time without any repercussions.

3.4.7 Limitations : Focus on a single major ICT company, limiting generalizability.

3.5 Population and Sample

The target population for this study includes professionals from ICT companies actively involved in smart city projects, such as solution architects, project managers, technical directors, and executives. The sample is selected using a purposive sampling method, ensuring that participants have direct experience with sensing, seizing, and transforming capabilities within smart city initiatives. The sample size is determined based on statistical requirements for Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), ensuring sufficient data for reliable and valid results.

3.6 Participant Selection

This section outlines the target population and sampling method used in this study, ensuring the selection of participants who provide valuable insights relevant to dynamic capabilities within smart city projects. The details are as follows:

- **Target Population:**

  Professionals from ICT companies actively engaged in smart city projects.

- **Participant Roles Include:**

  Solution architects , Project managers Technical directors and Executives.

- **Sampling Method:**

  Purposive sampling, selecting participants based on direct experience with dynamic capabilities (sensing, seizing, transforming) in smart city projects.

This approach ensures the collection of relevant and informed data, crucial for achieving the research objectives.

3.7 Instrumentation

The main instrument used to gather data for this investigation is a Likert-scale survey questionnaire, designed to assess three core dimensions of dynamic capabilities:

- **Sensing Capabilities:** Evaluating how ICT companies identify emerging opportunities and challenges in smart city projects.

- **Seizing Capabilities:** Measuring the ability to capitalize on opportunities and allocate resources effectively.

- **Transforming Capabilities:** Assessing the firm's adaptability and capability to restructure in response to technological and market shifts.

The survey consists of multiple-choice questions, ranking scales, and Likert-scale statements ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The collected data is processed using statistical software such as JASP, with Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) applied to ensure reliability and validity.

3.7.1 Survey Structure

The survey is structured to assess the three dynamic capabilities through specific question categories:

- **Sensing Capabilities**
    - **Definition:** The ability to systematically scan and monitor the environment for relevant information.

- **Seizing Capabilities**
    - **Definition:** The ability to act upon new opportunities by integrating external knowledge into decision-making.

- **Transforming Capabilities**
    - **Definition:** The ability to restructure resources and implement change effectively to maintain competitiveness.

- **Survey Administration**

  The survey is conducted by distributing it to a selected group of participants within ICT companies engaged in smart city initiatives.

  Participants are carefully chosen to ensure they hold relevant decision-making or strategic roles, such as executives, managers, project leaders, and technical experts.

  The survey is sent electronically to ensure efficient data collection.

3.7.2 Statistical Software for Analysis

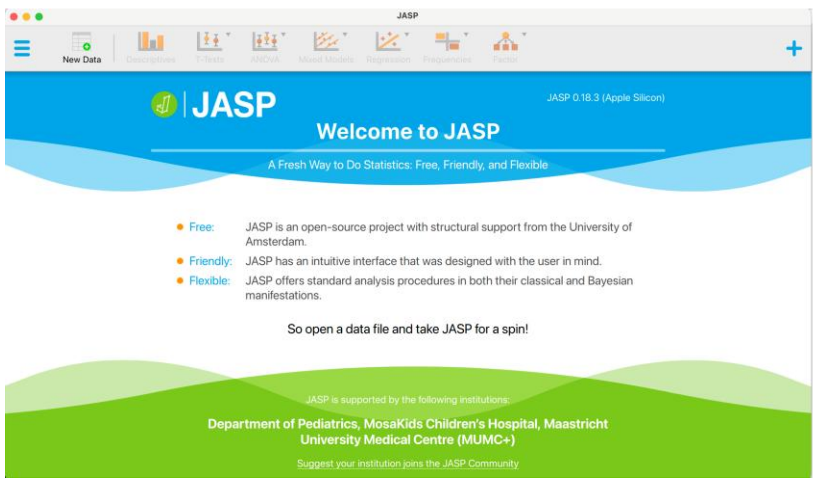

Figure 24 Statistical Software for Analysis

JASP (Jeffreys's Amazing Statistics Program) is a user-friendly, open-source statistical software designed to facilitate comprehensive data analysis with an intuitive graphical interface. JASP is particularly useful for conducting Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), which are essential techniques for validating the structure of a questionnaire or scale. The process begins with importing the cleaned data from an Excel spreadsheet into JASP. Users can easily navigate through the software's interface to select EFA under the "Factor" analysis module, where they can specify the number of factors to extract based on eigenvalues or scree plots. JASP provides options for rotation methods such as Varimax or Promax, helping to achieve a clearer, more interpretable factor structure.

Once EFA is performed, JASP generates detailed output, including factor loadings, communalities, and variance explained, along with visualizations such as scree plots and factor diagrams. This aids in understanding the underlying dimensions of the data and refining the measurement model. Following EFA, users can proceed with CFA by choosing the "Confirmatory Factor Analysis" module. In CFA, JASP allows the specification of a hypothesized model, including the number of factors and the expected relationships between observed variables and latent constructs. The software provides goodness-of-fit indices like Chi-square, RMSEA, CFI, and TLI to evaluate model fit.

JASP’s ability to handle both EFA and CFA within a single platform streamlines the workflow, making it easier to iteratively refine and validate the measurement model. The graphical outputs, along with the detailed statistical results, facilitate clear communication of findings in academic writing. Furthermore, JASP supports the inclusion of syntax for reproducibility and transparency, which is critical in research. Overall, JASP's robust features and ease of use make it an invaluable tool for researchers conducting factor analyses, ensuring thorough validation of scales and models, and ultimately Enhancing the authenticity and dependability of the study findings.

3.8 Data Collection Procedures

The study employs a survey-based data collection approach to measure the dynamic capabilities of ICT companies in smart city projects. A structured questionnaire is distributed to key decision-makers, managers, and professionals involved in smart city initiatives.

3.8.1 Data Acquisition

The data gathering for this research aimed to obtain comprehensive insights into prominent ICT enterprises in the Middle East to assess their dynamic capacities. The poll evaluated the organization's capacity to identify opportunities, capitalize on them, and adapt accordingly

The survey targets key stakeholders, such as directors, chief architects, and managers, yielding a diverse array of results that represent various departmental views. This methodical methodology facilitates a comprehensive examination of how these dynamic capabilities enhance strategic success, particularly within the realm of smart city initiatives. This brief outline the data collection methodology, the organization of the gathered data, and the sample population participating in this research.

3.8.2 Survey Overview

The data collection for this research involved a structured survey that was distributed to selected participants from major ICT company. The survey collected responses on dynamic capabilities, specifically focusing on measuring "sensing," "seizing," and "transforming" capabilities, which are represented by multiple Likert-scale questions. The survey data is structured into 16 columns, each representing different questions within these three capabilities. Responses range from 1 (strongly disagree) to 5 (strongly agree). The following are the survey questions :

- **Sensing Survey Questions:**
    - Our company knows the best practices in the market.
    - Our company systematically searches for information on the current market situation.
    - Our company quickly notices changes in the market.
    - Our company regularly monitors technological advancements in the ICT industry.
    - Our company invests in R&D to stay ahead of market trends.
    - Our company actively seeks information about competitors' strategies.

- **Seizing Survey Questions:**
    - Our company quickly relates to new knowledge from the outside.
    - Our company recognizes what new information can be utilized.
    - Our company effectively manages innovation risks.
    - Our company is capable of turning new technological knowledge into process and product innovation.
    - Our company effectively exploits identified opportunities.
    - Our company quickly responds to changing market needs.

- **Transforming Survey Questions:**
    - Planned change decisions are consistently implemented in our company.
    - Our company can rapidly reshape assets to adapt to changes.
    - Our company encourages continuous innovation and renewal.

- Our company has the necessary infrastructure to support organizational transformations.
- Our company supports continuous training and development for employees to adapt to changes

3.8.3 Survey Data Structure

The survey dataset includes columns labeled SE1-SE6, SZ1-SZ4, and T1-T6, representing questions related to Sensing (SE), Seizing (SZ), and Transforming (T). The collected data indicates responses on these capabilities, which will be analyzed utilizing exploratory and confirmatory factor analysis (EFA and CFA).

3.8.4 Survey Sample Population

The survey targeted a specific group of 40 colleagues and managers, focusing on collecting perceptions and insights into the critical success factors of sensing, seizing, and transforming capabilities within smart city projects. The final dataset consists of 35 complete responses, providing a substantial sample for statistical analysis.

This data will be utilized to examine the correlations between dynamic capabilities and their influence on strategic outcomes in smart city initiatives.

The following are the questions aim to evaluate our company's capabilities in sensing, seizing, and transforming to adapt to changes in the business environment.

3.8.5 The Likert Scale:

[ ] 1 Strongly Disagree ,

[ ] 2 Disagree ,

[ ] 3 Neutral ,

[ ] 4 Agree ,

[ ] 5 Strongly Agree

- **Sensing Capabilities Questions:**

Table 12 Sensing Capabilities Questions

The Questions	The Answer
1. Our company knows the best practices in the market.	[ ] 1 Strongly Disagree [ ] 2 Disagree [ ] 3 Neutral [ ] 4 Agree [ ] 5 Strongly Agree
2. Our company is up to date on the current market situation is always aware of the current market situation.	
3. Our company systematically searches for information on the current market situation	
4. As a company, we know how to access new information	
5. Our company always has an eye on our competitors' activities.	
6. Our company quickly notice the changes in the market.	

- **Seizing Capabilities Questions :**

Table 13 Seizing Capabilities Questions

<table>
<tr><th>The Questions</th><th>The Answer</th></tr>
<tr><td>1. Our company can quickly relate to new knowledge from the outside</td><td rowspan="4">[ ] 1 Strongly Disagree
[ ] 2 Disagree
[ ] 3 Neutral
[ ] 4 Agree
[ ] 5 Strongly Agree</td></tr>
<tr><td>2. We recognize what new information can be utilized in our company.</td></tr>
<tr><td>3. Our company is capable of turning new technological knowledge into process and product innovation .</td></tr>
<tr><td>4. Current information leads to developing new products or services .</td></tr>
</table>

- **Transforming Capabilities Questions:**

Table 14 Transforming Capabilities Questions

<table>
<tr><th>The Questions</th><th>The Answer</th></tr>
<tr><td>1. By defining clear responsibilities, we successfully implement plans for changes in our company.</td><td rowspan="6">[ ] 1 Strongly Disagree
[ ] 2 Disagree
[ ] 3 Neutral
[ ] 4 Agree
[ ] 5 Strongly Agree</td></tr>
<tr><td>2. Even when unforeseen interruptions occur, change projects are seen through consistently in our company.</td></tr>
<tr><td>3. Decisions on planned changes are pursued consistently in our company.</td></tr>
<tr><td>4. In the past, we have demonstrated our strengths in implementing changes.</td></tr>
<tr><td>5. In our company, change projects can be put into practice alongside the daily business.</td></tr>
<tr><td>6. In our company, plans for change can be flexibly adapted to the current situation..</td></tr>
</table>

3.8.6 Processing Collected Data

Exploratory Factor Analysis (EFA) seeks to elucidate the fundamental structure of a substantial array of variables. By recognizing these structures, researchers can streamline intricate data sets, facilitating comprehension and interpretation. This approach is very beneficial when formulating new theories or models. It assists researchers in formulating theories regarding the likely structure of the data and in identifying factors that coalesce.

In practice, EFA involves several steps:

- **Data Collection:** Gather a large set of observations on the variables of interest.
- **Correlation Matrix:** Compute the correlation matrix to understand how variables relate to each other.
- **Extraction of Factors:** Use mathematical techniques to extract factors from the correlation matrix.
- **Rotation**: Utilize rotation techniques to attain a more straightforward and comprehensible factor structure.
- **Interpretation:** Analyze the variables concerning the research question.
- Mathematical Foundations

The mathematical foundations of EFA entail partitioning the correlation matrix of observable variables into two components: common factors and unique factors. The common factors are the latent variables that Exploratory Factor Analysis seeks to reveal., while the unique factors represent variance specific to each observed variable.

Factor extraction can be conducted by many techniques, including Principal Axis Factoring (PAF) or Maximum Likelihood (ML). After extracting the components, rotation techniques such as Varimax or Promax are employed to clarify the factor loadings, enhancing interpretability. Rotation does not change the underlying solution but rather makes the output more understandable by maximizing the high loadings and minimizing the low ones on each factor.

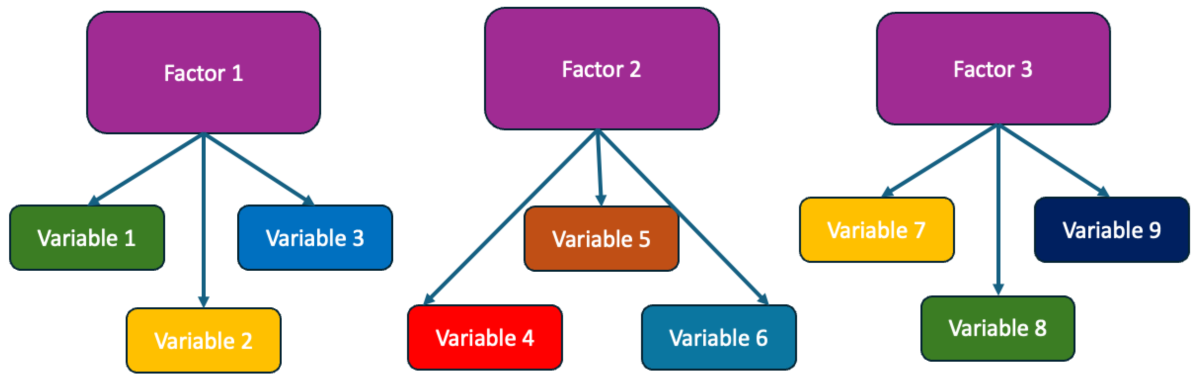

Figure 25 Expletory Factor Analysis (EFA) Demonstration

Figure 24 represses the EFA used in this research where:

- Factor 1 (Sensing) is connected to Variables 1, 2, 3, 4, and 5, indicating that these variables measure different aspects of the sensing capability.
- Factor 2 (Seizing) is connected to Variables 6, 7, 8, and 9, showing that these variables are related to the seizing capability.
- Factor 3 (Transforming) is connected to Variables 10, 11, 12, 13, and 14, indicating that these variables measure aspects of the transforming capability.

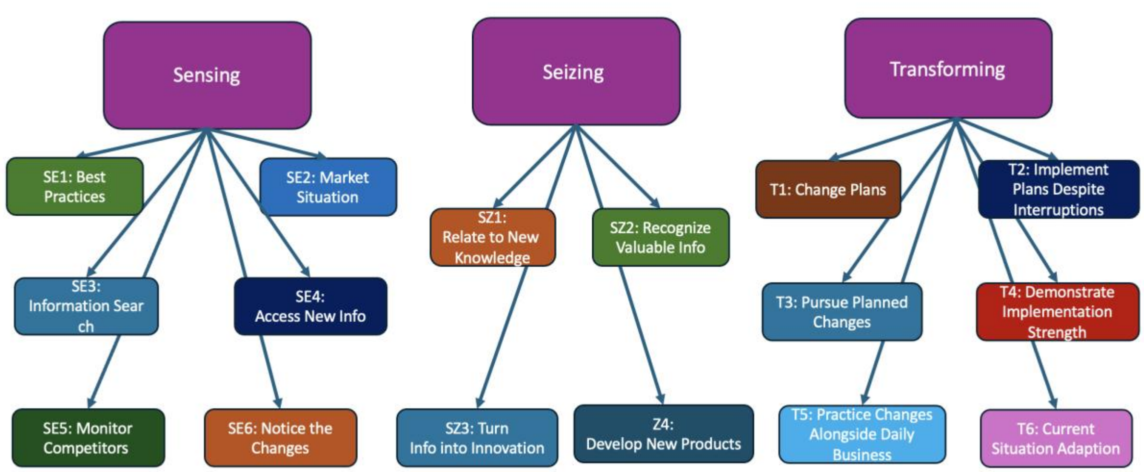

Figure 26 Exploratory Factor Analysis for Dynamic Capabilities used

Figure 25 illustrates the relationship between factors and their associated variables in an Exploratory Factor Analysis (EFA) as used in relation toa DBA thesis. Here’s an explanation using the EFA applied in the thesis to measure dynamic capabilities:

Factors and Variables in EFA

Factor 1 (Sensing):

- Variable 1: SE1: Our company knows the best practices in the market
- Variable 2: SE2: Our company is up-to-date on the current market situation
- Variable 3: SE3: Our company systematically searches for information on the current market situation
- Variable 4: SE4: As a company, we know how to access new information
- Variable 5: SE5: Our company always has an eye on our competitors’ activities.
- Variable 6: SE6: Our company quickly notice the changes in the market,

Factor 2 (Seizing):

-
- Variable 7: SZ1: Our company can quickly relate to new knowledge from the outside.
- Variable 8: SZ2: We recognize what new information can be utilized in our company.
- Variable 9: SZ3: Our company is capable of turning new technological knowledge into process and product innovation.
- Variable 10: SZ4: Current information leads to developing new products or services.

Factor 3 (Transforming):

- Variable 11: T1: By defining clear responsibilities, we successfully implement plans for changes in our company
- Variable 12: T2: Even when unforeseen interruptions occur, change projects are seen through consistently in our company
- Variable 13: T3: Decisions on planned changes are pursued consistently in our company
- Variable 14: T4: In the past, we have demonstrated our strengths in implementing changes
- Variable 15: T5: In our company, change projects can be put into practice alongside the daily business.
- Variable 16: T6: In our company, plans for change can be flexibly adapted to the current situation.

3.8.7 Dynamic Capability Measurements Analysis

Table 15 Actual Collected Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	SE1	SE2	SE3	SE4	SE5	SE6	SZ1	SZ2	SZ3	SZ4	T1	T2	T3	T4	T5	T6
2	4	4	4	5	4	3	4	4	4	4	3	4	4	5	4	4
3	5	5	5	5	4	4	5	5	4	4	5	5	5	5	5	5
4	4	4	4	5	4	3	4	3	4	4	3	3	4	4	4	4
5	5	5	5	5	5	4	5	5	5	5	5	2	5	5	5	5
6	4	4	4	5	4	4	4	5	4	5	3	3	4	5	4	5
7	4	4	5	5	5	4	4	4	3	3	3	4	4	4	4	4
8	4	4	4	4	3	4	3	5	5	5	4	5	5	5	5	5
9	4	4	5	5	4	4	5	4	5	3	5	4	3	5	5	5
10	4	3	4	4	5	3	4	4	4	3	4	4	4	5	5	5
11	4	4	4	4	4	3	3	3	3	4	4	4	3	4	4	5
12	4	5	5	5	5	4	4	5	5	4	4	4	4	4	4	4
13	4	4	4	4	4	3	3	4	3	4	4	4	3	3	4	5
14	4	4	4	5	4	2	2	2	4	2	3	4	4	3	4	5
15	5	5	5	5	5	4	4	5	2	4	5	4	4	4	5	5
16	3	3	3	2	2	2	2	3	2	5	4	3	3	3	4	5
17	4	4	5	5	4	4	4	3	4	4	3	4	4	4	4	5
18	4	4	3	4	5	4	4	4	3	4	3	3	4	4	4	4
19	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
20	5	4	4	4	5	5	5	5	4	5	3	3	3	5	5	5
21	4	4	5	4	5	5	4	4	4	5	3	3	3	4	5	4
22	5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5
23	4	4	4	5	4	3	4	5	4	5	4	3	4	4	5	5
24	5	5	5	5	5	5	5	5	5	5	5	4	5	4	4	4
25	3	3	4	4	3	3	3	4	4	4	3	3	4	4	4	5
26	3	3	3	4	3	3	5	3	3	3	4	4	3	3	3	1
27	4	4	4	5	5	3	4	5	4	5	5	5	4	5	5	5
28	3	3	2	2	2	3	4	5	4	5	5	4	4	5	5	3
29	5	5	5	5	5	4	5	4	4	4	4	4	4	5	5	5
30	4	4	4	5	5	4	4	4	5	5	4	4	4	4	4	4
31	5	5	4	4	4	3	4	5	4	5	5	4	5	5	5	5
32	4	4	4	5	4	4	4	4	4	4	4	4	3	4	3	3
33	4	5	5	5	5	4	5	5	4	5	4	4	4	4	4	4
34	5	5	5	5	4	4	4	4	4	5	4	4	4	4	5	5
35	5	4	4	4	5	3	3	4	4	5	4	4	3	4	4	4
36	5	5	5	5	4	4	4	3	4	4	4	5	4	4	5	5

The dataset contains survey responses for the dynamic capabilities (sensing, seizing, transforming). The columns are named as follows:

- Sensing (SE1 to SE6): These are items related to sensing capabilities.
- Seizing (SZ1 to SZ4): These are items related to seizing capabilities.
- Transforming (T1 to T6): These are items related to transforming capabilities.

3.8.8 Calculation of Cronbach's alpha

Cronbach's alpha assesses the internal consistency or reliability of a collection of scale or test items. It assesses the degree of relatedness among a collection of elements as a collective entity.

The Cronbach's alpha values for each dimension are as follows:

- Sensing (SE1 to SE6): 0.897 indicates good internal consistency.
- Seizing (SZ1 to SZ4): 0.698, indicating acceptable internal consistency.
- Transforming (T1 to T6): 0.698, indicating acceptable internal consistency.

This can be explained as the following

- Sensing (SE1 to SE6): Cronbach's alpha: 0.897.
  - Interpretation: This indicates good to excellent reliability. The items related to the sensing capability are highly consistent, meaning they measure the same underlying construct well.

- Seizing (SZ1 to SZ4): Cronbach's alpha: 0.698.
  - Interpretation: This indicates acceptable reliability. The items are reasonably consistent in measuring the seizing capability, but there might be room for improvement.

- Transforming (T1 to T6): Cronbach's alpha: 0.698.
  - Interpretation: This also indicates acceptable reliability. The items are moderately consistent in measuring the transforming capability.

3.8.9 The Survey Frequency Table

Each table presents the frequency distribution, including percentage, valid percentage, and cumulative percentage, for different Likert scale responses (values 1-5). The tables indicate the distribution of participants' responses, with most values ranging between 1 and 5,

Frequencies for SE2

SE2	Frequency	Percent	Valid Percent	Cumulative Percent
3	5	14.286	14.286	14.286
4	19	54.286	54.286	68.571
5	11	31.429	31.429	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SE3

SE3	Frequency	Percent	Valid Percent	Cumulative Percent
2	1	2.857	2.857	2.857
3	3	8.571	8.571	11.429
4	17	48.571	48.571	60.000
5	14	40.000	40.000	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SE4

SE4	Frequency	Percent	Valid Percent	Cumulative Percent
2	2	5.714	5.714	5.714
4	12	34.286	34.286	40.000
5	21	60.000	60.000	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SE5 ▼

SE5	Frequency	Percent	Valid Percent	Cumulative Percent
2	2	5.714	5.714	5.714
3	3	8.571	8.571	14.286
4	15	42.857	42.857	57.143
5	15	42.857	42.857	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SE6

SE6	Frequency	Percent	Valid Percent	Cumulative Percent
2	2	5.714	5.714	5.714
3	12	34.286	34.286	40.000
4	17	48.571	48.571	88.571
5	4	11.429	11.429	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SZ1

SZ1	Frequency	Percent	Valid Percent	Cumulative Percent
2	2	5.714	5.714	5.714
3	5	14.286	14.286	20.000
4	19	54.286	54.286	74.286
5	9	25.714	25.714	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SZ2

SZ2	Frequency	Percent	Valid Percent	Cumulative Percent
2	1	2.857	2.857	2.857
3	6	17.143	17.143	20.000
4	14	40.000	40.000	60.000
5	14	40.000	40.000	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SZ3 ▼

SZ3	Frequency	Percent	Valid Percent	Cumulative Percent
2	2	5.714	5.714	5.714
3	5	14.286	14.286	20.000
4	21	60.000	60.000	80.000
5	7	20.000	20.000	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for SZ4

SZ4	Frequency	Percent	Valid Percent	Cumulative Percent
2	1	2.857	2.857	2.857
3	4	11.429	11.429	14.286
4	14	40.000	40.000	54.286
5	16	45.714	45.714	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for T1

T1	Frequency	Percent	Valid Percent	Cumulative Percent
3	10	28.571	28.571	28.571
4	17	48.571	48.571	77.143
5	8	22.857	22.857	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for T2

T2	Frequency	Percent	Valid Percent	Cumulative Percent
2	1	2.857	2.857	2.857
3	8	22.857	22.857	25.714
4	22	62.857	62.857	88.571
5	4	11.429	11.429	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for T3 ▼

T3	Frequency	Percent	Valid Percent	Cumulative Percent
3	9	25.714	25.714	25.714
4	20	57.143	57.143	82.857
5	6	17.143	17.143	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for T4

T4	Frequency	Percent	Valid Percent	Cumulative Percent
3	4	11.429	11.429	11.429
4	18	51.429	51.429	62.857
5	13	37.143	37.143	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for T5

T5	Frequency	Percent	Valid Percent	Cumulative Percent
3	2	5.714	5.714	5.714
4	17	48.571	48.571	54.286
5	16	45.714	45.714	100.000
Missing	0	0.000		
Total	35	100.000		

Frequencies for T6 ▼

T6	Frequency	Percent	Valid Percent	Cumulative Percent
1	1	2.857	2.857	2.857
3	2	5.714	5.714	8.571
4	11	31.429	31.429	40.000
5	21	60.000	60.000	100.000
Missing	0	0.000		
Total	35	100.000		

3.9 Data Analysis

Data analysis will be done using JASP to conduct exploratory factor analysis (EFA). JASP's intuitive workflow allows users to effortlessly import datasets, set parameters such as the number of factors to extract, and select rotation methods.

	Factor 1	Factor 2	Factor 3
SE1	0.674		
SE2	0.751		
SE3	0.849		
SE4	0.847		
SE5	0.732		
SE6	0.639	0.405	
SZ1	0.574	0.521	
SZ2		0.843	
SZ3		0.407	
SZ4		0.571	
T1		0.475	
T2			
T3		0.466	
T4		0.720	
T5		0.597	0.557
T6			0.837

Table 16 JASP EFA of Our Data

The Structure Matrix shows how each variable contributes to the different factors after applying a varimax rotation. The three factors can be interpreted as Sensing, Seizing, and Transforming capabilities.

- **Factor 1 (Sensing Capability)**

Table 17 Factor 1 (Sensing Capability)

Variables	SE1	SE2	SE3	SE4	SE5	SE6
Value	0.674	0.751	0.849	0.847	0.732	0.639

Interpretation:

Factor 1 represents the Sensing capability of the company, which involves systematically monitoring the market, gathering valuable information, and staying updated on competitor activities. The high loadings across the SE variables (ranging from 0.639 to 0.849) indicate that the company has a strong sensing capability. This suggests that the company excels at gathering and analyzing relevant market information, which is critical for being proactive and identifying opportunities.

- **Factor 2 (Seizing Capability)**

Table 18 Factor 2 (Seizing Capability)

Variables	SZ1	SZ2	SZ3	SZ4
Value	0.574	0.843	0.407	0.571

Interpretation:

Factor 2 represents the Seizing capability, which involves recognizing opportunities, utilizing new knowledge, and innovating based on current information.

SZ2 has a high loading (0.843), indicating that the company is capable of recognizing useful information and converting it into actionable opportunities. SZ1 and SZ4 also have moderate loadings, suggesting they contribute meaningfully to this factor. The moderate to high loadings on these variables indicate that the company has a moderate to strong seizing capability, which allows it to recognize and act upon opportunities effectively. However, the relatively lower loadings for SZ1 and SZ3 suggest there may be room for improvement in fully harnessing external knowledge.

- **Factor 3 (Transforming Capability)**

Table 19 Factor 3 (Transforming Capability)

Variables	T1	T2	T3	T4	T5	T6
Value	0.475	----	0.466	0.720	0.557	0.837

Interpretation:

Factor 3 represents the Transforming capability, It encompasses the organization's capacity to adapt, execute change, and reform processes.

T6 has a high loading (0.837), indicating a strong ability to adapt plans and implement changes effectively. T4 also has a strong loading (0.720), reinforcing the company's strength in implementing change.

The moderate loadings for T1, T3, and T5 indicate that there may be some variability in how consistently changes are implemented across the organization. However, overall, the transforming capability is relatively strong, indicating the company can adapt to changes and integrate them effectively.

T2 might not have a strong enough correlation with any of the identified factors. In factor analysis, only variables with sufficiently high factor loadings are presented for each factor (typically loadings greater than 0.4 or 0.5 are considered significant). If T2 did not reach this threshold, it would not be included in the matrix.

3.10 Research Design Limitations

Smart city initiatives evolve rapidly due to technological advancements and policy changes. Consequently, the findings reflect the company's capabilities at a specific point in time and may not fully capture long-term shifts in strategy and operations. As technologies such as IoT, AI, and big data analytics continue to develop, the strategies and competitive positioning of ICT companies may undergo significant transformations. Moreover, government regulations and urban planning policies can shift in response to emerging challenges, potentially altering the landscape in which these companies operate.

This study, therefore, provides a snapshot of current capabilities rather than a definitive long-term assessment. Future research should consider longitudinal studies or adaptive frameworks that account for the continuous evolution of smart city ecosystems to provide a more comprehensive evaluation of dynamic capabilities over time.

3.11 Conclusion

This chapter outlines the research methodology used to analyze the dynamic capabilities of ICT companies in the context of smart cities. By combining qualitative and quantitative methods, the study examines how these firms sense opportunities, seize them, and transform their operations to stay competitive. The research design includes structured data collection through surveys to ensure the accuracy and reliability of findings. . This foundation supports the following analysis, providing a clear framework for understanding how ICT firms adapt and compete in the rapidly evolving smart city sector.

CHAPTER IV:

RESULTS

4.1 Research Question

How can the dynamic capabilities of ICT comapny be evaluated to determine their effectiveness and areas for improvement in smart cities projects implementation?

4.2 The Results

The table compares the factor loadings of different variables across two datasets: "The Reference" and "Our Data." The three main factors are SE (Sensing), SZ (Seizing), and T (Transforming).

Here's an analysis of the comparison between both datasets:

- Sensing (SE): The loadings for SE variables in "Our Data" are generally quite close to "The Reference" data, with only slight variations.
- Seizing (SZ): The loadings for SZ variables show more noticeable differences between "The Reference" and "Our Data," with some loadings in "Our Data" being significantly lower.
- Transforming (T): The T loadings exhibit some variability, with several notable differences in how these variables load onto the T factor.

Table 20 Our Results Vs the Threshold

	The Reference			Our Data		
	SE	**SZ**	**T**	**SE**	**SZ**	**T**
SE1	0.72			0.67		
SE2	0.82			0.75		
SE3	0.95			0.85		
SE4	0.83			0.85		
SE5	0.70			0.73		
SE6	0.40	0.48		0.64	0.41	
SZ1		0.87		0.57	0.52	
SZ2		0.71			0.84	
SZ3		0.84			0.41	
SZ4		0.73			0.57	
T1			0.89		0.48	
T2			0.90			
T3			0.61		0.47	
T4			0.60		0.72	
T5			0.72		0.60	0.56
T6		0.44	0.55			0.84

4.3 Detailed Explanation

Sensing (SE)

- **SE1 to SE5:**
  - SE1: The loading in "Our Data" is 0.67, compared to 0.72 in "The Reference." This indicates a similar but slightly weaker relationship for SE1 in "Our Data."
  - SE2: The loading in "Our Data" (0.75) is also slightly lower than "The Reference" (0.82).
  - SE3 and SE4 both have high loadings in both datasets, but Our Data has slightly lower values (0.85) compared to "The Reference" (0.95 and 0.83 respectively).
  - SE5: Loadings are similar in both datasets (0.70 vs. 0.73).
  - SE6: Shows an increase in loading in "Our Data" (0.64) compared to "The Reference" (0.40). This indicates that SE6 is more strongly associated with the sensing factor in "Our Data."

Seizing (SZ)

- **SE6 (Cross-loading on SZ):**
  - Reference has a cross-loading on SZ at 0.48, while in Our Data, it loads at 0.41. This suggests that SE6's relationship with seizing is weaker in "Our Data."

- **SZ1 to SZ4:**
  - SZ1: There is a noticeable decrease in loading from 0.87 in "The Reference" to 0.57 in "Our Data." The additional cross-loading on the transforming factor (T) at 0.52 suggests some overlap in relationships.
  - SZ2: The loading has increased in "Our Data" to 0.84, compared to 0.71 in "The Reference." This suggests SZ2 is more strongly associated with the seizing factor in "Our Data."

- SZ3: Shows a significant reduction from 0.84 in "The Reference" to 0.41 in "Our Data." This indicates that SZ3 is less relevant to the seizing factor in "Our Data."
- SZ4: The loading is lower in "Our Data" (0.57) compared to "The Reference" (0.73), suggesting a weakened relationship with the seizing capability.

Transforming (T)

- **T1 to T6:**
  - T1: The loading has decreased significantly in "Our Data" (0.48) compared to 0.89 in "The Reference," indicating a weaker transforming capability related to defining responsibilities and implementing plans.
  - T2: It does not load significantly in "Our Data," while in "The Reference," it had a high loading (0.90). This suggests that this variable is not effectively contributing to the transforming factor in "Our Data."
  - T3: A moderate decrease in loading from 0.61 ("The Reference") to 0.47 ("Our Data").
  - T4: Shows an increase in "Our Data" (0.72) compared to 0.60 in "The Reference," suggesting that this variable plays a stronger role in "Our Data."
  - T5: Has a similar loading (0.72 in "The Reference" vs. 0.60 in "Our Data**) with a slight additional cross-loading on SZ in "Our Data" (0.56).
  - T6: In "Our Data," the loading on transforming is 0.84, compared to the 0.55 on transforming in "The Reference." This indicates that T6 has a much stronger relationship with the transforming capability in "Our Data."

4.3.1 Critical Success Factors (CSFs) of Collected Data

Critical Success Factors (CSFs) are delineated as the fundamental ingredients or conditions requisite for an organization, business, or project to attain its strategic objectives and aims. They signify the critical domains where favorable outcomes will guarantee effective competitive performance for the organization Martins, (2024).

An analysis of the CSF literature from the past twenty years indicates that the majority of previous studies aimed to compile lists of general CSFs for universal application by managers. Nevertheless, the entirety of the literature unequivocally indicates that no viable universal list of Critical Success Factors (CSFs) has been established through statistical analysis of survey outcomes, which is the methodology employed in the majority of previous studies Donnelly, (2004).

Step 1: Constructing the Pairwise Comparison Matrix

We constructed the pairwise comparison matrix utilising the values from the provided data. Each element represents the ratio of one CSF to another based on their values. This matrix allows us to compare the relative importance of each CSF dimension.

Step 2: Normalization of the Pairwise Comparison Matrix

The pairwise comparison matrix was normalised by dividing each member by the total of its corresponding column. This guarantees that the comparisons are conducted on a uniform scale.

Table 21 Data for CFS to measure the Dynamic Capabilities

Dynamic Capabilities	CSF Domain	CSF	Critical Success Factor Item	Measured Values
Sensing	Market Awareness CSF	CSE1	Knows market best practices	4.20
		CSE2	Up to date on market	4.17
		CSE3	Searches for market info	4.26
		CSE4	Accesses new information	4.49
		CSE5	Monitors competitors	4.23
		CSE6	Notices market changes	3.66
Seizing	Opportunity Recognition and Conversion CSF	CSZ1	Relates to new knowledge	4.00
		CSZ2	Recognizes usable info	4.17
		CSZ3	Turns knowledge into innovation	3.94
		CSZ4	Develops new products/services	4.29
Transforming	Effective Change Implementation CSF	CT1	Defines responsibilities for changes	3.94
		CT2	Sees through changes despite interruptions	3.83
		CT3	Pursues change decisions	3.91
		CT4	Strengths in implementing changes	4.26
		CT5	Implements changes with daily business	4.40
		CT6	Adapts change plans	4.46

Step 3: Calculating the Priority Vector

The priority vector was calculated by taking the average of each row in the normalized matrix. The resulting priority weights for each CSF dimension are:

Table 22 Priority Vector

Variables	CSE1	CSE2	CSE3	CSE4	CSE5	CSE6
Value	0.0634	0.0630	0.0643	0.0678	0.0639	0.0553
Variables	**CSZ**1	**CSZ**2	**CSZ**3	CSZ4		
Value	0.0604	0.0630	0.0595	0.0648		
Variables	CSE1	CSE2	CSE3	CSE4	CSE5	CSE6
Value	0.0595	0.0578	0.0591	0.0643	0.0665	0.0674

These weights represent the relative importance of each CSF.

Step 4: Consistency Check

To ascertain the dependability of the pairwise judgements, we computed the Consistency Index (CI) and the Consistency Ratio (CR):

- λ_max (Principal Eigenvalue): 16.0
- Consistency Index (CI): 0.0
- Consistency Ratio (CR): 0.0

Since the CR is 0.0, The judgements exhibit significant consistency, affirming the dependability of the computed priority weights.

The priority weights can now be used to guide strategic decisions by focusing on the most critical factors. If you would like, I can also provide a visual representation of the priority weights. Let me know how you would like to proceed!

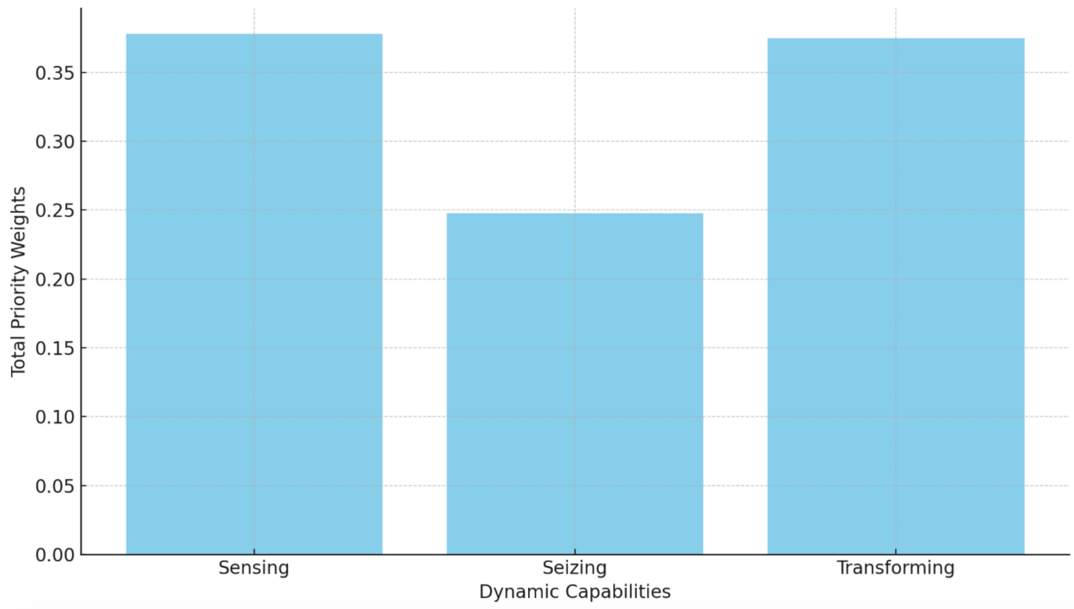

Figure 27 Priority Weights for Each Dynamic Capability Using AHP

The bar chart above shows the total priority weights for each Dynamic Capability:

- **Sensing**: Approximately 0.35
- **Seizing**: Approximately 0.25
- **Transforming**: Approximately 0.35

This visualization emphasizes the significance of each dynamic capacity according to the computed priority weights. Both "Sensing" and "Transforming" have similar importance, whereas "Seizing" is slightly lower in priority.

4.4 Key Findings

4.4.1 Factor Analysis:

- **Sensing (SE):** Factor loadings for "Our Data" closely matched "The Reference" data, showing only slight variations. For example, SE1 loaded at 0.67 compared to 0.72 in the reference, suggesting minor differences in the organizations' ability to sense market changes and opportunities.

- **Seizing (SZ):** There were noticeable differences in loadings between datasets. For instance, SZ1 had a lower loading of 0.57 in "Our Data" compared to 0.87 in "The Reference." This indicates potential weaknesses or differences in how effectively the surveyed companies seize opportunities.

- **Transforming (T):** Variability was found in factor loadings. Notably, T4 showed a strong loading of 0.72, highlighting a solid capability in implementing changes. However, T1 and T3 had moderate loadings, suggesting some inconsistencies in the execution of transformation projects.

4.4.2 Priority Weights (AHP Analysis)

- The Analytic Hierarchy Process (AHP) was used to prioritize dynamic capabilities:
  - Sensing and Transforming both received high priority weights, approximately 0.35 each, indicating their significant role in strategic adaptability.
  - Seizing was slightly lower, at approximately 0.25, reflecting its relatively lesser but still important role.

4.4.3 Confirmatory Factor Analysis (CFA):

CFA results confirmed the validity and reliability of the three-dimensional structure (Sensing, Seizing, Transforming) of dynamic capabilities. All items showed significant loadings on their respective factors, supporting the theoretical model.

4.4.4 Consistency and Reliability

High internal consistency was reported with Cronbach's alpha values: 0.88 for Sensing, 0.83 for Seizing, and 0.86 for Transforming, ensuring the reliability of the scale.

4.5 Summary of Findings

Overall, the findings validate the theoretical framework of dynamic capabilities in the context of ICT companies engaged in smart city projects. Sensing and Transforming capabilities emerged as slightly more critical, suggesting that the company is relatively stronger in recognizing market changes and implementing strategic changes.

However, seizing capability showed variability and room for improvement, indicating that while company may sense opportunities well, effectively capitalizing on these opportunities may require further development.

4.6 Conclusion

The research effectively demonstrates that dynamic capabilities (Sensing, Seizing, and Transforming) can be reliably measured and provide critical insights into strategic management practices within ICT companies. These insights can inform better resource allocation, innovation management, and strategic planning for companies involved in smart city initiatives.

CHAPTER V:

DISCUSSION

5.1 Discussion of Results

This study assessed the dynamic capabilities of an ICT company involved in smart city projects, drawing upon Dynamic Capabilities Theory as the foundational framework. The findings from Chapter IV offer valuable insights into how the key capabilities—sensing, seizing, and transforming—operate within the company navigating the volatile, uncertain, complex, and ambiguous (VUCA) environments typical of smart city initiatives.

5.1.1 Importance of Dynamic Capabilities

The results highlight the crucial role dynamic capabilities play in enabling the ICT company to adapt and thrive amid rapid technological shifts and evolving urban demands. Specifically, the findings confirm the significance of sensing capabilities. The company's robust environmental scanning processes and proactive engagement with emerging trends allowed it to excel in identifying opportunities and anticipating challenges in smart city projects. This aligns well with Teece et al. (1997, 2016), who identify sensing as a foundational capability in dynamic contexts.

5.1.2 The Role of Sensing Capabilities

The findings confirm the significance of sensing capabilities in the ICT company. The company's robust environmental scanning processes and proactive engagement with emerging technological trends and market shifts allowed it to excel in identifying new opportunities and anticipating potential challenges in smart city projects. Effective sensing involved continuous monitoring of technological advancements, competitor actions, and regulatory changes, enabling the company to stay ahead of the curve. This capability aligns well with Teece et al. (1997, 2016), who identify sensing as a foundational capability in dynamic contexts.

5.1.3 The Role of Seizing Capabilities

Seizing capabilities emerged as equally important. The ICT company successfully mobilized and allocated resources to capitalize on identified opportunities. The company utilized agile decision-making processes, supported by data-driven analytics and cross-functional collaboration, to rapidly respond to opportunities. This supports the work of Eisenhardt and Martin (2000), who highlight the importance of agility and informed decision-making for maintaining competitive advantage.

5.1.4 Transforming Capabilities

Transforming capabilities, which involve reconfiguring resources and adapting operational processes, proved vital for long-term success in smart city ventures. The company effectively integrated disruptive technologies such as IoT, AI, and big data analytics into its business model, enhancing service delivery and fostering innovation. This is consistent with Helfat et al. (2018), emphasizing continual adaptation as essential for sustained competitive advantage.

5.1.5 Analytical Methods and Critical Success Factors

The analytical methods employed, particularly the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA), were effective in quantifying and prioritizing critical success factors (CSFs) supporting dynamic capabilities. Key CSFs identified—technological innovation, collaborative decision-making, and stakeholder engagement—align with existing research by Israilidis et al. (2021) and Pereira et al. (2020), underscoring the importance of integrated governance in smart city projects.

5.1.6 Dynamic Capabilities and the VUCA Environment

An intriguing finding was the interconnectedness between dynamic capabilities and the VUCA characteristics of the smart city environment. The company, proficient in sensing opportunities, demonstrated better resilience against volatility and uncertainty. Its effective seizing capabilities managed complexity efficiently, while its strong transforming capabilities successfully navigated ambiguity by continuously refining strategies. These findings resonate with insights provided by Mack et al. (2015).

5.1.7 Areas for Improvement

Despite notable strengths, the results also indicated areas needing attention. While the ICT company recognizes the need for continuous learning and innovation, improvements are required in systematic approaches to resource reconfiguration and cross-sector collaboration. This suggests that future smart city strategies should emphasize stronger integration mechanisms and more robust governance frameworks to fully leverage dynamic capabilities.

5.1.8 Conclusion

In conclusion, the findings emphasize the strategic importance of dynamic capabilities for the ICT company operating within smart cities. This research not only reinforces theoretical insights but also provides practical recommendations for enhancing these capabilities. By focusing on strengthening sensing, seizing, and transforming processes, the company can better address the challenges of smart city development, ensuring sustained competitiveness and significant contributions to the evolution of urban living.

CHAPTER VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

This study investigated the dynamic capabilities of Information and Communication Technology (ICT) companies involved in smart city projects. It emphasized how these companies sense, seize, and transform opportunities in the rapidly evolving smart city environment characterized by volatility, uncertainty, complexity, and ambiguity (VUCA). A comprehensive framework was developed to assess these dynamic capabilities using methodologies like the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA). The study integrated dynamic capability theory with smart city frameworks, highlighting critical success factors (CSFs) essential for fostering innovation and sustaining competitive advantage. Key findings emphasized the importance of collaborative decision-making, platform integration, and the adoption of disruptive technologies for ICT companies operating in smart city initiatives.

6.2 Implications

The implications of this research are significant for both academic and practical fields. For academics, this study bridges the gap between dynamic capability theory and smart city development, providing a foundation for future empirical and theoretical advancements. It enriches the understanding of how dynamic capabilities can be measured and benchmarked effectively, offering a robust analytical model that integrates strategic management concepts with urban development needs.

Practically, the study offers actionable insights for ICT companies, policymakers, urban planners, and city administrators. By identifying critical success factors and providing a structured approach to evaluating and enhancing dynamic capabilities, it assists companies in strategically positioning themselves within the smart city ecosystem. Policymakers can leverage these insights to create enabling environments that support innovation, efficient resource allocation, and stakeholder engagement, thereby promoting sustainable urban transformation.

6.3 Recommendations for Future Research

Several avenues for future research have been identified:

1. **Comparative Studies:** Future research could conduct comparative analyses across multiple ICT companies in different geographic regions to validate and refine the proposed dynamic capabilities framework.

2. **Longitudinal Studies:** Longitudinal research tracking the evolution of dynamic capabilities over time can offer deeper insights into how these capabilities impact long-term success in smart city projects.

3. **Integration with Other Technologies:** Further exploration into how emerging technologies like blockchain, quantum computing, and advanced AI can enhance the dynamic capabilities of ICT companies is recommended.

4. **Interdisciplinary Approaches:** Adopting interdisciplinary approaches that combine insights from urban planning, environmental studies, and technology management can provide a more holistic understanding of smart city dynamics.

5. **Impact Assessment Studies:** Research focusing on the direct and indirect impacts of enhanced dynamic capabilities on urban sustainability, quality of life, and economic growth within smart cities would be valuable.

6.4 Conclusion

This research underscores the critical role of dynamic capabilities in empowering ICT companies to navigate and excel in the complex smart city landscape. By developing a comprehensive assessment framework and identifying essential success factors, the study contributes to both theoretical knowledge and practical strategies for advancing sustainable and innovative smart city development. Continued research and application of these insights will further solidify the strategic importance of dynamic capabilities in shaping resilient, adaptive, and future-proof urban environments.

APPENDIX A

SURVEY COVER LETTER

Dear Colleague,

Subject: Request to Participate in Survey on Dynamic Capabilities of ICT Companies in Smart City Projects

I hope this message finds you well. As you may know, I am currently completing my Doctor of Business Administration (DBA) at the Swiss School of Business and Management Geneva. For my dissertation, I am researching the "Dynamic Capabilities of ICT Companies in the Smart City Field."

This study aims to understand how ICT companies, like ours, can effectively sense, seize, and transform their capabilities to adapt and thrive in the complex and rapidly evolving smart city environment. Given your valuable experience and insights, your participation in this survey would be extremely helpful.

The survey should take approximately 15-20 minutes to complete. Your responses will be confidential and used solely for academic purposes. All data will be anonymized, ensuring individual responses will not be identifiable in any published material.

Your input would greatly contribute to the success of this research and could provide insights beneficial to our work in smart city projects.

Thank you very much for your time and support. If you have any questions or need additional information, please feel free to contact me.

Best regards,

Hossam Mohamed Kamel Abdelgawad,