How does digital innovation have an effect on sustainable enterprises and how these issues correlate to urban development, and what is public opinion on them?

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Master of Science in Entrepreneurship

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First, I need to go through each of the 20 questions and convert them into scaled formats. Let me check each question one by one. (RESPONSE THOUGHT)

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Abstract

The paper researches the role of digital innovation practices towards the sustainability performance of enterprises in different parts of the world. These four major independent variables include the adoption of green technologies, the extent of digital integration, data analytics of sustainability, and the digital supply chain management which are specifically investigated in the research. Structured Likert-scale questionnaire in quantitative approach was used where 150 random people were sampled based on simple random sampling. The philosophy of research design is based on the positivist ideology and is provided in a deductive manner allowing testing of hypothesis by conducting statistical tests of correlation and regression analysis in the SPSS. The conclusions will attempt to expose any meaningful relationships that exist between digital innovation-based strategies and environmental, social and economic aspects of enterprise sustainability performance. A conceptual framework is also part of the study in an attempt to illustrate these relationships and hypothesis testable are proposed. The study makes a distinctive contribution to the increasing body of knowledge on the digital revolution in emerging economies in addition to providing useful information to policymakers and business entrepreneurs on how to sustain the development process with the application of technology.

Key words: *Adoption of Green Technologies, Level of Digital Integration, Use of Data Analytics for Sustainability, Digital Supply Chain Management, Sustainability Performance of Enterprises*

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Chapter 1: Introduction

1.1 Background to Study

The high rate at which digital innovation is being incorporated into the present economies has transformed the way business is being conducted particularly concerning sustainability. Digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI) and big data analytics, are not an option anymore; they are crucial instruments that help enterprises run efficiently, be competitive, and limit the negative impact on the environment by these enterprises. Technology offers real-time information with many features that enhance the way these enterprises carry out business, and in addition, with the use of predictive analytics and automation features, these companies get assisted by these features to manage resources efficiently, reduce carbon emissions and enhance transparency and accountability in operations (He et al., 2024). With the world becoming increasingly devoted to the notion of sustainability, digital innovation has emerged as one of the building blocks of representing green changes in a variety of industries.

At the same time, cities are undergoing changes in their operations due to the global shift toward urbanisation, especially by introducing smart city projects. Smart cities have been defined as cities that use advanced digital technologies to enhance infrastructure, services, and quality of life, trying to solve the Sustainable Development Goals (SDGs). Smart cities are conceptualised and realized with a long-term aim of environmental, social, and economic sustainability (Kuzior, 2024). Such a transformation increases the pressure to seek new technologically enabled businesses that can adjust their strategies in accordance with changing needs of the cities.

The trend of urbanisation has also added to the demand of having practices that are sustainable since the challenges associated with cities continue to rise, including air pollution, congestion, lack of resources, and poor infrastructure (Vijaygopal etal., 2023). Sustainable businesses, in this case, enterprises that have incorporated responsibility to the environment and society in their

mainstream strategies, are necessary in this case. Businesses support the growth of greener economies and inclusive growth and can be described as driving forces behind urban sustainable growth (Dana et al., 2022). The rise of smart cities, facilitated through the digital city infrastructure, provides an enabling ecosystem in which these businesses can flourish, network and expand their effectiveness (Azmi & Rozman, 2024).

Policy communities and governments all around the world are acknowledging this interdependence and are slowly integrating digital transformation as part of national development policies. An example of such a connection can be observed in Saudi Arabia, where the spread of information and communication technology (ICT) demonstrated a quantitative dependency between digital entrepreneurship and the enhanced environmental performance, revealing the positive correlation between innovations and sustainability (Alfehaid et al., 2024). Such synergies have triggered a renewed scholarly curiosity to understand the role of digital innovation in establishing more sustainable business operations and the subsequent role of the latter in shaping the very urban life.

The development has, however, been received with mixed feelings by society. Although digital innovation seems to have many positive sides, the concern about data privacy, unequal access, surveillance, and a lack of trust in digital governance models still bother the mass adoption. The citizens can raise concerns regarding the inclusivity and transparency of smart city programs, and, without the trust of the population, the digital-based sustainability initiatives in urban environments can be compromised (Usmani & Mehmood, 2024). Thus, the realisation of not just the practical, but also the social acceptance of digital innovation in sustainable business and smart cities is vital to the further development of policies and business decision-making, making them effective and embracive.

1.2 Research Problem

Despite the fact that the literature Hong Kong has provided on the significance of digital transformation on the quest towards sustainable business operation is indicating a substantial research gap in view of the extra significance of digital innovation on the operation of

sustainable business enterprises in an urban environment. Although many research studies focus on smart city formation or the transformation of green business models separately, little has been done regarding the intersection of these fields where digitalisation, sustainability goals, and urban planning meet (Safira et al., 2024). This dispersed body of knowledge can be considered a challenge to policymakers, urban planners, as well as leaders of enterprises that are interested in integrated, data-driven policies using digital tools to achieve maximum environmental and societal benefits.

Along with this theoretical gap, the significant lack of empirical evidence that would evaluate the view of the general population concerning the role of digital innovation in creating sustainable urban environments needs to be mentioned. Smart cities are often discussed as high-tech, effective, and sustainable ecosystems. Nevertheless, these discourses fail to consider the life experiences and views of actual citizens supposed to be served by these narratives. The fourth question that is seldomly explored is the public perception of digital innovation in urban planning with regarding inclusiveness, accessibility, transparency, and personal data privacy (Misiak-Kwit & Wiscicka-Fernando, 2024). The lack of attention may jeopardize the legitimacy and success of smart city projects because the acceptance of the population is essential to the successful implementation and long-term sustainability of the projects.

What is more is that the whole thing takes on an even more complicated twist in fast urbanizing as well as developing areas. In these environments, sustainable businesses often work in delicate ecological systems that are characterized by unreliable policy environments, poor infrastructure, and unreliable digital literacy. In such circumstances, digital innovation remains uncertain, as it could be a strong facilitator or an additional burden based on the context around (Anaman et al., 2025). Gaining insights into the specificities of how digital tools either facilitate or encumber the process of sustainable enterprise establishment in urban environments is critical to the inclusive and context- awareness policy interventions design.

Considering such complexities, this study aims at filling the above gaps by assessing the impact of digital innovation on sustainable enterprises, identifying the relationships between the impacts

on urban development in general and larger urban ecosystems, as well as assessing the general opinion of people on the implementation of digital innovation into the sustainable urban systems. By combining these interconnected elements in a single research contribution, the study adds to the academic language and actual policymaking, providing an idea of how digital transformation can be utilized better to assist in achieving sustainability objectives at urban levels.

1.3 Research Aim

To investigate the influence of digital innovation on sustainable enterprises and assess how this relationship correlates with urban development, including public perceptions regarding this transformation.

1.4 Research Objectives

1. To identify the impact of digital innovation on sustainable enterprises
2. To evaluate how the impact of digital innovation on sustainable enterprises correlates to urban development
3. To examine the public opinion on digital innovation and sustainable enterprises linked with urban development

1.5 Research Questions

Main Research Question

What is the impact of digital innovation on sustainable enterprises, and how does this influence urban development and public perception?

Sub-Questions

1. What are the effects of digital innovation on sustainable enterprise performance?
2. What contributions do digital innovations in sustainable enterprises make toward urban development?

3. What are public perceptions of digital innovation and its role in sustainable urban transformation?

1.6 Justification for the Study

The research is quite timely because two dominant trends in the world, digitalisation, and sustainable development are coming closer to each other, in particular, in an urban setting. With the ability to transform environmental, economic, and social pressures overwhelming cities across the globe, it is proposed that the future resiliency of cities can be offered through the combination of digital innovation with sustainable enterprise frameworks. The study adds value to the scholarly debate since it focuses on a multidimensional nexus between entrepreneurship, sustainability, digital innovation, and urban development (Alerasoul et al., 2022). This research endeavours to provide a more coherent perspective which integrates both theoretical and practical knowledge unlike many other studies which address these fields autonomously. Industrially, the findings will be of special value to business leaders and enterprise strategists who are aiming at applying digital technologies in a manner that can yield sustainable results. A collection of digital innovations, including AI and data analytics to IoT and automation, is already transforming industries, yet there is still no empirical evidence on how these technologies impact the sustainability performance of businesses. As environmental regulations tighten and customers demand more ethical behaviours of companies, the question of how to implement a digital strategy properly becomes important in terms of competitiveness and regulatory adherence (Li & Xu, 2024). The research outcome will grow into practical recommendations concerning the best way in which digital technologies can be utilized to maximize resource utilisation, reduce environmental impacts, and enable business sustainability.

To policy makers, the research implies a lot in terms of policies formulation and execution, which could result in promotion of innovation and sustainability in cities. With cities investing in smart infrastructure, digital progress must go hand in hand with social fairness, environmental sustainability and civic participation. The study highlights the importance of cohesive policy systems that can not only encourage innovation but also make such processes accessible,

transparent, and inclusive to all smart city endeavours (Patrascu, 2024). The paper encourages a comprehensive governance system that seeks to find technological advancement and sustainability at the same time. The next important reason is that the research dwells upon the subject of public opinion that is usually disregarded in the discussion of digital urban transformation. Most of the literature either tends to dwell on infrastructural development or innovations at enterprise level, forgetting how the citizens use, feel or gain about these changes. A more democratic approach, including the views of the people, can reveal the presence of mistrust, digital exclusion, or privacy concerns, which, otherwise, can undermine the successful adoption and implementation (Maningas & Matriano, 2024). The inclusion of these perspectives will help the research to increase the societal viability and validity of suggested solutions. Besides, this research is particularly relevant in the light of rapidly urbanizing areas and emerging economies. These regions have many small and medium-sized sustainable businesses that encounter systemic challenges such as poor accessibility to digital infrastructure, irregular policy endorsement, and weak digital literacy. The study can inform the stakeholders in such settings as it presents how digital innovation can become a catalyst, as opposed to a barrier, to sustainable growth (Rahajeng et al., 2024).

The research is developed in such a way that it will produce valuable outputs in the academia, business practice, and public policy. It contributes to the larger global goal of developing inclusive, smart, and sustainable cities by providing an in-depth insight into the impact of digital innovation on sustainable businesses and the latter in urban development.

1.7 Scope and limitations

The proposed study aims at analysing how digital innovation affects sustainable enterprises; in this case, it should be evaluated in the framework of urban development and the transformation of smart cities. The initial scope entails investigating the implementation of digital technologies, including the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and additional tools of ICT, into sustainable business models and the impact of the integrations on the work of enterprises, their sustainability performance, and the urban infrastructure. The study

focuses on the doubled position of digital innovation as a contribution to the development of enterprise and the sustainability of urban life (Li and Xu, 2024). They will involve businesses which have been categorized as sustainable, in relation to their environmentally friendly and societal accountable operations. These are businesses that are passionate about resource efficiency, low-carbon process, ethical supply chain, and community welfare. It is going to analyse the integration of digital innovation in the transformation strategies of such enterprises and analyse the resulting operational and environmental effects. Furthermore, the investigation will involve the contribution of such enterprises to the cities that are in the process of making intelligent changes - exploring aspects like the preparedness of digital infrastructure, environmental governance, smart public services, and the existence of policy that promotes green innovation (Sabiha & Saida, 2024). In terms of geography, the focus of the study will be on urban regions in the areas like Asia and Middle East, where the concept of smart city is most visible. The United Arab Emirates and Saudi Arabia are the countries that have been chosen because of their increased interest in the digital technologies' adoption under the sustainability and urban development agendas (Alfehaid et al., 2024). Such geographical focus would enable the contextual appreciation of the role played by digital innovation towards the achievement of sustainable urban development within the fast-modernizing economies.

The research design was planned as mixed-method in the beginning which means that both qualitative and quantitative data will be used to give an in-depth picture. However. Due to time constraints and lack of professional network connections related to the field of research, the method has been converted to just quantitative method, which comprises of a survey to determine the public perception on the topic. Although this improves on the strength of findings, it comes in with some limitations. A major weakness is the biases that may characterize self-reported data in measuring the opinion of the people, especially in matters that are tricky and dynamic like digital innovation. Also, the study can be limited in the access to the variety of enterprises and municipal projects by the time, budget, or availability of the data. Another weakness is the sectorial variations where the intensity of digital innovation may have little or no differences across industries. This has a potential impact on the generalisability of results. Moreover, the rapid rates of digital technologies development create a problem regarding the

outdatedness of technological knowledge accumulated during the research. Finally, although the perception of the populace is a primary theme, it is likely to be influenced by cultural, demographic as well as socio-economic factors and this might interfere with uniformity of responses between various regions. Notwithstanding these shortcomings, the study establishes a sound basis of future research and provides useful information to present-day players in the academia, policy, and business. (NCI, 2024)

1.8 Structure of the Dissertation

This dissertation consists of five chapters that describe various issues of research on digital innovation, sustainable enterprises, and urban development.

Chapter1 – Introduction

The chapter presents research by giving a vivid background of the study. It defines the research problem and states the overriding purpose and objectives to be followed in the investigation. These objectives are attuned with the development of research questions. Also included in the chapter is the justification of the study as it is of academic, industrial and policy relevance. It ends with stating the scope and limitation of the study which provides a clear summary about what all is included in the study and what all is not.

Chapter 2 – Literature Review

This chapter is a critical review of literature on digital innovation, sustainable enterprises and smart urban development. It determines major themes; points out gaps in knowledge; and provides the conceptual framework, on the basis of which the study is informed.

Chapter 3 – Methodology

This is where the research design will be described including the approach to the research. It encircles data collection methods, sampling approaches and analysis plans, together with moral issues.

Chapter 4 – Data Analysis and Results

This chapter offers the findings. Findings are discussed concerning the research questions and explained with the help of appropriate visual tools.

Chapter 5 – Discussion and Conclusion

The last chapter is the discussion of the findings, and they are related to the literature and research aims. It is concluded with business recommendations, policy recommendations and recommendations on future research.

Chapter 2 – Literature Review

2.0 Introduction

The chapter critically reviews the literature source on the main subjects of research, digital innovation, sustainable enterprises, their overlap with urban development, and the opinion of the population on these topics. Considering scholarly literature in various fields, this chapter uncovers theoretical and empirical gaps in present-day knowledge, which the study in question plans to fill. The review begins with an understanding of the concept and progression of digital innovation then continues with a discussion on sustainable enterprise practices. It then explores the relationships of these two realms with urban development especially with smart cities. Lastly, it adopts community thoughts and interaction with digital innovation and sustainability in urban settings. Rahajeng et al. (2024)

2.1 Digital innovation

Digital innovation is the creation and use of new digital technologies and procedures that radically reshape the way business organisations are run, the process of doing business and also how value is created (Alerasoul, Tiberius & Bouncken, 2022). It entails the incorporation of high-end digital products, including the Internet of Things (IoT), artificial intelligence (AI), big data analytics, cloud computing, and blockchain technology, into the activities of organisational operation and contributes to the increase in efficiency, responsiveness, and better customer interactions (He et al., 2024). Digital innovation has widespread impacts across various industries and serves as an avenue towards automation, the use of data that facilitates decision-making, and better connectivity among stakeholders (Maningas & Matriano, 2024). The technologies are not only making it easier to streamline the operations of the organisations, but they are also making it easier to come up with new products, services as well as new business models, which were otherwise impossible.

Digital innovation is not merely an adoption of technology, but it is also a strategic tool that transforms the way organisations do business and compete. Firms that use digital innovation

have gained flexibility, faster adaptation of emerging demands in the market, and capability of tailoring their products or services to suit the ever-changing demands of the consumers. Another example is that big data analytics enables companies to parse enormous amounts of data and find consumer patterns, enhance supply chains, and resource distribution and make business decisions more informed and sustainable (He et al., 2024). AI technologies are also useful in forecasting models that may predict the market or indicate results that have inefficiency in operations hence the intervention of the environment in a more proactive way.

Digital innovation plays the central role in entrepreneurship and positions itself as the force that ensures the co-evolution of entrepreneurial venture and innovative technology. This coevolution facilitates the development of new solutions that could handle complicated multi-layered aspects including environmental sustainability and urbanisation (Alerasoul et al., 2022). The success of digital entrepreneurship relies on the capacity to utilize the new digital technologies, entering the ranks of new digital business ecosystems disrupting the old business environment and focusing on the issue of sustainability as well as profitability. The most outstanding case is the digital finance innovations, as it addresses the common finance barriers and allows green startups and other sustainable businesses to access capital more easily (Kong et al., 2022). Such platforms of digital finance apply the most sophisticated algorithms and blockchain to promote transparent, efficient, and inclusive funding processes and promote the investment into sustainable and environmentally friendly business models. This is especially significant to the small and medium sized enterprises (SMEs) and startups who are not likely to have conventional credit history or collateral.

Digital innovation has also been identified as one of the main drivers of Sustainable Development Goals (SDGs) among the governments, especially digital government initiatives. The application of technology in these programs is the primary means of seeing the true transformational power of the enterprise, as well as sustainable urban development by increasing transparency, efficiency of operation, and citizen participation in the processes of governing the state (Li & Xu, 2024). E-governance systems, open data platforms, etc. provide citizens with the power to influence the process of decision-making and control the use of common resources.

This encourages trust and accountability which are necessary in making sustainable urban projects successful. Besides, digitalized public services mean more streamlined bureaucracy and lower administrative load, which generates more favourable and resilient business environments.

Digital innovation is also important, in terms of conceptualisation and operationalisation of smart cities that are urban areas incorporating advanced digital technologies to improve the quality of life of residents and meet the goals of sustainability (Zygiaris, 2013). Digital innovation is the key to smart cities, which is integrating physical infrastructure, governance systems, and even public services within unified, data-driven ecosystems (Kuzior, 2024). As an example, IoT-based sensors detect the air quality, traffic, and energy consumption levels in real-time, so the city planners can look into how to use the resources available to them more efficiently and worsen the situation on the environment. Such innovations are used not only to make cities sustainable in terms of the environment but also economically and socially resilient.

Nonetheless, institutional arrangements and governance strategies tend to trail the choice of these innovations as well as facilitate their success or failure. To efficiently organise the work of smart city projects, it is necessary to coordinate the work of several key entities such as the state, small and large business, as well as the civil society sphere (Safira et al., 2024). Pollination of the policies, investments priorities, and regulations is quite relevant in attainment to those digital innovations providing equitable and sustainable results. The effective scaling of these innovations is of critical importance using institutional capacity-building and cross-sectoral partnerships. In addition to urban planning, digital transformation leads to business innovation in terms of sustainability of business models. Companies are also going digitally to remodel their products, processes, and even strategies of engaging customers so that they can minimize environmental footprints and embrace social responsibility (Gil-Gomez et al., 2020). An example of this strategy is the introduction of the Industry 4.0 technologies, including cyber-physical systems, sophisticated robotics, and real-time data analytics by firms to allow accurate tracking and streamlining of the resource consumption across the production cycles (Silvestre & Tirca, 2019). Such inventions help with sustainable practices, in which the circular economy approaches cut waste and ensure that the available materials are reused repeatedly.

Although there is a lot of potential behind digital innovation, there are a few problems. The digital gap is still a major obstacle, and the gaps in the availability of digital technologies have prevented access to innovation advantages in an equal manner (He et al., 2024). This gulf is not only set internally but even across the countries that make some businesses and societies unable to contribute to digital economy and enjoy the advantages of sustainability. This is because the marginalized communities such as those in the rural setups or low-income communities rarely have the kind of digital infrastructure and education to benefit well on these technologies. The only way to address this gap is by closing it because the effects of digital transformation must be all-inclusive and accessible to everyone. Also, information asymmetry, which assumes that two or more actors may have different and/or improved information, may cause inefficient resource distribution; moreover, it inhibits the usefulness of digital tools in their promoting the sustainable impact (Kong et al., 2022). Focus on digital ethics, data privacy, and cybersecurity areas make the landscape more complicated and necessitate a capable system of governance where the use of digital technologies becomes responsible and transparent.

It is also essential to align strategies of digital innovation and sustainability goals. Digital technologies are not necessarily sustainable, because they might accidentally rely more on energy and even produce electronic waste unless properly maintained (He et al., 2024). Unwanted side effects of the overall increase in energy consumption by data centres, and growing e-waste are all to be dealt with using environmentally friendly innovation practice. Thus, companies and policy makers should move towards integrative strategies that reconcile advances in technology, environmental and social goals. Examples of measures meant to correlate innovation and sustainability are life cycle assessments, implementation of green IT, and responsible sourcing of digital parts.

2.2 Sustainable enterprises

Sustainable enterprises refer to the organisations that take it upon themselves to incorporate environmental, social and economic issues regarding their core business conceptions and processes. In contrast to traditional companies, which are mainly interested in profit

maximisation, sustainable companies are involved in a more ambitious task that includes environmentally friendly minimisation of the impact on the environment, social justice, and future economic efficiency (Anaman et al., 2025). The multidimensional strategy would correspond to the principles of sustainable development, which aims at ensuring the satisfaction of current needs in a way that would not restrict the potential of future generations to satisfy their own needs (Bocken et al., 2019). Such businesses therefore perform at the point of eco-stewardship, social accountability, and economic results.

The main theme of sustainable enterprises embraces the concept of increasing environmentally acceptable enterprises, which tend to reduce the effects of adverse occurring factors to the natural ecosystem. Among them are measures to mitigate greenhouse gases as well as to better manage energy and water resources, strategies to manage the waste by applying principles of circular economy and to source the materials ethically (Bocken et al., 2019). As an example, a sustainable business tends to use renewable forms of energy, introduce energy-efficient manufacturing processes, and produce commodities with the lifecycle in mind so as not to waste them. Circular economy model has become increasingly important as a means of environmental protection and ensuring resource efficiency because it focuses on the reuse, recycling, and repurposing of material to ensure resource loop close (Bocken et al., 2019). The trend is informed by the increased global concern over climatic change, depletion of resources, pollution and social injustices which have caused companies to reconsider the historic take-make-dispose model and embrace the concept of sustainability as a business strategy.

Besides, sustainable business takes into account the social aspect of their work by promoting ethical treatment of employees, guaranteeing safety and health conditions, contributing to the improvement of the community, and increasing inclusiveness. These are social commitments towards achieving the greater objective of social equity and better quality of life to the stakeholders. Companies which can positively incorporate social and environmental factors also expect to gain a higher level of customer loyalty, brand value and risk reduction which places them competitively in an ever-changing environment of sustainability in the market. The micro, small and medium enterprises (MSMEs) are critical components of the sustainability aims which

is the main focus of today's economic world, especially in the developing economies where MSMEs represent an important portion of the economic life (Anaman et al., 2025). When compared to larger corporations, MSMEs usually possess fewer resources, however they are highly agile and adaptable in terms of employing sustainable practices. They are particularly close to local communities and therefore, are able to generate context-dependent solutions, which accommodate environmental and social issues. Some of them are community-based waste management systems, renewable energy technology including installing solar panels, and local workers employment and training (Anaman et al., 2025). These enterprises usually become the birth source of new solutions in sustainability, and this can later be scaled or adapted by bigger businesses.

Sustainable enterprise changes are directly connected to the innovation and testing of sustainable business models. These models reframe the concept of value creation, the popular form of which encompassed social and environmental values as well as customary economic returns. Innovating in sustainable business models requires a constant state of adaptation and imagination, as companies start looking at new possibilities to integrate sustainability in products and processes. To illustrate, businesses can shift their linear production processes to circular economy strategies that focus on recovering resources, extending product life cycle and closed-loop supply systems (Bocken et al., 2019). Sustainable business models have involved the use of digital technologies as their enablers. By adopting digital tools, big data analytics, IoT, blockchain, AI, enterprises will be able to increase transparency, drive more efficient utilisation of resources and engage the stakeholders in a more meaningful manner (Gil-Gomez et al., 2020). Digital tools can help achieve sustainability goals, e.g. real time monitoring of energy consumption, predictive maintenance of machines and supply chain traceability. In specific, blockchain adds value as source of immutable and transparent records, thus contributing to trust and accountability in the upstream sourcing and the production processes, allowing companies to make value chains more ethical and sustainable.

Entrepreneurship is vital in the promotion of sustainable enterprise agenda. Entrepreneurs have been known to be innovators of new solutions in sustainability that have had disruptive impacts

on traditional markets and system change. Entrepreneurship and sustainability are creating a very dynamic ecosystem that thrives on creative opportunities in the business sector created due to solutions to environmental challenges, including sustainable energy solutions, waste-to-resource technology, greener farming methods, and green transportation (Alerasoul et al., 2022). Such small business ventures do not only help the economy to grow but also allow environmental safety and social wellness. Moreover, sustainable entrepreneurship leads to the development of social entrepreneurs whose agenda is on impact rather than profit, usually targeting underserved populations and encouraging social inclusion. These ventures combine business knowledge with a mission-oriented model, using digital technologies so that they are able to grow their impact effectively and sustainably.

Sustainable enterprises have various challenges although they are of great importance. The regulatory environments are sometimes complicated and fragmented and to add to that there is even poor enforcement of the environmental and social standards. Financial risk is caused by market uncertainties, including changes in green products demand and the presence of other less sustainable products that are relatively affordable (Anaman et al., 2025). There are also consumer differentiations and preferences which restrict market incentive in sustainability.

2.3 Relationship of digital innovation and sustainable enterprises with urban development

Digital innovation and sustainable enterprises have been inherently connected to urban development as a complex nexus whose importance in creating sustainable and resilient cities is gaining widespread awareness. Smart cities and urban development are changing the world at lightning speed, as they incorporate innovative digital technologies and more entrepreneurs focused on sustainable business solutions. This section investigates how digital innovation informs sustainable enterprises, how the two influence the development of urban centres and the synergy that transpires as a result of integration. Digital innovation has proved to be one such force that is rapidly transforming our urban cityscapes by making them leaner, more networked and more environmentally conscious (Zygiaris, 2013). The use of Smart cities is iconic of this change, using smart technologies, including the Internet of Things (IoT) and big data analytics,

artificial intelligence (AI), and technologies in information and communication (ICT) to best optimize infrastructure, energy consumption, transportation, governance, and citizen engagement (Maningas & Matriano, 2024). Cities can also be responsive to the environmental challenge, economic opportunities and social needs by integrating digital technologies into urban cloth.

Among the key features of digital innovation in urban development is that it allows monitoring processes and making decisions in real-time and data driven. Sensors and related gadgets deliver energy consumption, road traffic patterns, quality of pollution and resource utilisation streams of data. This information will enable the city designers and businesses to streamline their activities, minimize waste, and maximize service delivery, which will be helpful in regard to sustainable citizenship in urban development (Safira et al., 2024). As example, digital platforms support the integrating energy management systems, balancing between green energy sources and city consumption, minimizing carbon footprints and increasing the safety of energy. In addition, the e-government projects also serve to enhance urbanisation due to the innovation of transparency, efficiency, and participation of citizens. Li and Xu (2024) note that digital government helps to enhance enterprise transformations and sustainability in urban economies faster by enabling the optimisation of administrative procedures, the provision of convenient digital services, and the establishment of the culture of innovation. These developments make it possible to develop enabling environments in which sustainable enterprises can flourish and make meaningful contribution towards achievement of urban development goals.

Sustainable enterprises act as key actors in urban sustainability to tackle environmental and social issues caused by fast urbanisation. These businesses engage in the creation of green products and services and the efficiency of resources used and the social inclusion of people (Dana et al., 2022). Examples of sustainable enterprises in urban areas are renewable energy producers, green buildings companies, green transport companies, waste management companies, and social businesses involved in community building. The contribution of sustainable enterprises is not limited to sustainability of the environment, but social well-being through provision of local employment opportunities to the marginalized community and inclusive economic development (Anaman et al., 2025). In cities, this social aspect is paramount

since socio-economic differences may be particular, and sustainable business frequently creates a bridge by behaving in a community-focused way.

Urban entrepreneurship facilitates sustainable growth in the enterprise space as it is the source of innovative solutions to exploit digital technologies. Coevolution of entrepreneurship and innovation leads to the emergence of new business models combining sustainability objectives and digital transformation (Alerasoul et al., 2022). Urban startups and MSMEs use digital tools to strengthen the scaling power, market accessibility, and the efficiency of resource utilisation (Sabiha & Saida, 2024). To illustrate, digital finance platforms have played a central role in ensuring that green start-ups raise capital, especially in developing economies whose financial resources may be restricted (Kong et al., 2022). The nexus of digital innovations and sustainable businesses produces strong synergies to enhance rapid urban sustainability. Digitalisation helps enterprises to redesign the business models towards sustainability, creating the opportunity to experiment with practices of a circular economy, transparency, and engagement of various stakeholders (Gil-Gomez et al., 2020). With the help of Blockchain and other such technologies the supply chain becomes more traceable and ethical sourcing is guaranteed along with declining potential environmental impact, meanwhile AI-driven analytics improve efficiency in production and utilize less waste.

In addition, urban environments assist in enabling collaborative innovation ecosystems through digital platforms, which involve enterprises, government agencies, research institutions and citizens that collaborate to generate sustainable solutions (Dana et al., 2022). Such partnership network is consistent with the smart city vision, in which integrated systems drive the sustainability agenda via various networks of actors and technologies (Zygiaris, 2013). Digital innovation eases business model innovation, and businesses can consider service-based models, including product-as-a-service, the sharing economy, and peer-to-peer networks that lead to fewer resources and environment impacts (Bocken et al., 2019). By way of example, urban mobility startups are delivering shared transportation services through the creation of a digital platform, which can reduce congestion and emissions.

There are many obstacles that make relations between digital innovation, sustainable enterprises and urban development complex despite the promising synergies. Digital divide still persists, refraining from the use of digital tools and infrastructure in deprived urban communities, which can increase the level of social inequality (Usmani & Mehmood, 2024). It is often the case that without equitable access, the benefits of digital transformation and sustainable business practices may become inequitably distributed, which jeopardizes sustainability on the urban scale. Digital finance and green innovation are also rather burdened by information asymmetry, as without openness or trust, investment and adoption may be difficult to achieve (Kong et al., 2022). In addition, quick technological developments leave one in a state of limbo as companies and urban planning agencies constantly have to change their tactics to new digital horizons (He et al., 2024). There is sectoral difference; as the effects of digital innovations differ across industries, not all industries are opposingly placed to take advantage of digital tools in achieving their sustainability. (Misiak-Kwit & Wiscicka-Fernando, 2024) The customized methods are required to adjust the digital transformation strategies to the definite urban sustainability objectives.

Empirical research can offer a good depiction of the interaction of digital innovation and sustainable enterprises in the context of urban development. The article by Rahajeng et al. (2024) discusses patterns of regional growth in Yogyakarta and how digital technology and sustainable firms can be used to provide sustainable urban regions with enhanced resources and community participation. In a similar vein, Sabiha and Saida (2024) trace the contribution of startups in Dubai smart city projects to sustainable development, as they incorporate innovative digital technologies and the need to pursue environmental and social sustainability interests. According to Vijaygopal, Bennett, and Savani (2023), the issue of marketing and branding of the smart city projects is discussed with the focus on decision-making process that combines smart sustainability principles and the application of digital innovation in order to enable citizen engagement and the success of the projects. All these studies point to the need to have an integrated approach, which is compatible with digital technologies, sustainable business models, and urban development policies to achieve resilient, inclusive, and sustainable cities.

Correlation between digital innovation, sustainable business and the city is by itself interdependent and symbiotic. Digital innovation is a driving force that transforms cities and allows enterprises to become more sustainable. Sustainable businesses mainly help to relieve the environmental issues in the city, such as pollution, and enhance social inclusivity among the communities living there. Collectively, they are stimulating the work of smart cities, that are aimed to achieve a sustainable economy by prioritizing the issues such as environmental protection, social rights and inclusivity. Nevertheless, in order to reach the potential of this relationship fully, we must overcome the obstacles connected with governance, access, and dynamics that characterize the industry. Sustainable urban environments in the future should focus on inclusive and supportive digital environments, derived policies, and communal ecosystems that support sustainable business operations and make use of digital innovations to the full benefit of society. (Patrascu, 2024).

2.4 Public opinion about urban development impacted by digital innovation and sustainable enterprises

The success and legitimacy of sustainable enterprise-driven urban development projects directly depends on the public opinion. Since cities have started to implement emerging technologies such as IoT, AI and data analytics in their infrastructure, the attitudes and expectations of citizens become the utmost significant criteria that determine whether these changes will occur with the backing from the public. Gaining knowledge of the attitude of citizens toward these changes and their perceptions is a key to adjusting the growth of technologies to the needs of society and maintaining a natural, equitable urban development.

The perceptions of the concept of smart cities differ very greatly among citizens. Although the promoters of smart cities make the promise of increased efficiency, sustainability and better urban livelihood, the perception of the general people is seen to be more workshopped and complicated. Zygiaris (2013) explains that the smart city concept uses technology as one of the foundations of resilience and environmental stewardship. Azmi and Rozman (2024) also note that the communities must be integrated and aligned with local cultures to become an accepted

part of an active contributor to smart city movements. Research indicates that the greater awareness to residents of how digital platforms make their lives easier, the more they will be willing to show support, say by way of streamlined transport, an enhanced garbage disposal system, or enhanced energy consumption. Yet this optimistic perspective is closely related to such subjective gains as convenience, cost savings, safety of society and environmental enhancement.

Trust between citizens and government transparency becomes the focal point of study in the public opinion polls. According to Safira et al. (2024), apprehensions about the collection, management, and execution of personal data may become the cause of mistrust. As long as information management remains opaque, the urban householders will see the digital infrastructure as controlling compared to the empowering aspect. According to the particular study conducted by Patrascu (2024), such concerns can be covered with the help of participatory governance models, which include the platform of community feedback, open data portals, and continuous consultation of citizens. Such interactive processes are democratic processes that engage residents in decision making thereby making smart city projects to be in line with local needs and promoting their legitimacy to the society.

The attitude of people about the environment also affects the general feeling. Majority of the world was pleased with the emergence of sustainability-based technologies, as urban populations face problems of pollution, climate change, and loss of green space. As soon as the benefits of environmental optimisation, like fresh air, lower emission and efficient utilisation of energy are obvious and can be observed with the naked eye, the approval of the population can be more effective. Rahajeng et al. (2024) found out that citizen support of the urban sustainability effort in Yogyakarta was much favoured when such interventions augmented the well-being of the community and when such initiatives were delivered in manners that were culturally acceptable. Immediately right after the issue of sustainability comes to the fore, digital innovations that promote the very same create engaged citizens who become ardent proponents of sustainability innovations.

Nonetheless, there is still a big obstacle to acceptance on terms of the digital divide. Usmani and Mehmood (2024) explain why both the lack of access to digital infrastructure and the lack of digital literacy may exclude people in enjoying the smart city services. In that scenario, the minorities, such as the lower-income settlers, older citizens, and immigrants, will feel threatened by these high-profile attempts and never see the opportunities in them. The failure of a community to reach Wi-Fi, mobile platforms, or digital services threatens to cause mistrust. This goes to show that Quadruple Bottom Line framework is crucial and incorporates economic, environmental, social and cultural inclusivity. Access to the smart city policies should thus focus on even access, online training, and outreach at individual levels to all urban citizens.

The second aspect of the relevant perception of the public is the discussion of entrepreneurial ecosystems and innovation reportable by start-ups. The study conducted by Sabiha and Saida (2024) analyses the success of the smart city startups in Dubai and the most popular among the residents were the startups working with the sustainable technologies such as ideas to make the city smarter including smart lighting and management of water quality. These projects are normally praised as creative and feasible methods to solve city problems. At the same time, Dana et al. (2022) also discover that urban entrepreneurship based on sustainability and supported by digital tools is a way to improve the perception of forward looking, community-oriented cities. However, this assertion can erode when the entrepreneurial projects are viewed as business-oriented projects that deny society justice or openness. Honesty in the pricing, fair business activities and observable effect on the community can define whether citizens identify with these enterprises or not.

The issue of privacy, security, and fairness also influences the opinion of people. The article by Safira et al. (2024) includes evidence of the nervousness of citizens towards systems of watchfulness, facial recognition, and monitoring equipment dependent on sensors in cities. Such cases as unlawful gathering of information or misusing the data about citizens might provoke dissimilarity and confidence jeopardy. In the same way, any investment in green can be an ethical issue when it involves the use of digital finance, blockchain, and more democratized access. According to Kong et al. (2022), the digital financial system may create inequality when

more wealthy users receive favoured access to data or are treated preferentially. The perceived morality of digital platforms may consequently be jeopardized by ethical issues unless strictly controlled and openly reported.

The issue of awareness and education is central to winning the support of the people. According to Gil Gomez et al. (2020), digital customer relationship management systems enable converging the benefits and applications of sustainability platforms in an effort to encourage engagement and generate trust. Societies made aware of the practical benefit, e.g. more intelligent traffic networks or locally deployed energy renewal systems, will be more willing to adopt them. The importance of outreach, education, and transparency in the Yogyakarta endeavours to improve its water and waste management infrastructure is also embraced by Rahajeng et al. (2024). Communication, especially the involvement of education programs, workshops, and interactive digital tools, enhances knowledge, minimizes resistance, and enables people to take part in urban sustainability to a greater degree.

Comparative research claims that cultural, political and institutional context influences the attitude of the masses towards digital urban development greatly. In a case study of Saudi Arabia, Alfehaid et al. (2024) indicate a strong correlation between ICT-led entrepreneurial activity and sustainability of the environment. However, it is the crucial issue of institutional authority and the government communication strategies that need to be issued and gain credibility to the masses in order to allow them to accept. Areas that have clear and transparent governance systems are likely to influence more positive response among people whereas lack of unity in administration will cause suspicion among people (Safira et al., 2024). The misperception of smart city projects in the eyes of the general populace also depends on the marketing and communication of these projects. The results presented by Vijaygopal, Bennett, and Savani (2023) indicate that branding that focuses on the benefits to the citizens, culture, and the sustainable objectives thereof can help to boost the citizens enthusiasm to a large extent. As the marketing discourses that associate city-change with palpable improvements in the standard of living, the acceptance increases. In the opposite case, when branding is done with only the technological novelty or the advantages of this approach in the private sector, citizens are likely

to feel alienated with the initiative. Another important factor appears, community co-creation. Azmi and Rozman (2024) state that to become popular, smart technologies of a smart city should be not only embedded culturally but also react to the values of the locals. The methods of co-creation including participatory design workshops, community idea platforms, and budgets giving input over institutional decision-making processes allow citizens to design solutions to meet their needs. This contributes to feeling of ownership which consequently enhances readiness to embrace and embrace digital urban systems.

Literature synthesis reveals that five intermixable themes are very much central to the public opinion on how to intersect digital innovation and sustainable enterprises with urban development. The first theme to discuss concerns the perceived benefits: convenience, ecological enhancement, open government and efficient economy are preferred by citizens. The second theme is about trust and governance: transparent participatory systems are capable of building trust, which decreases resistance. Third is the topic of digital equity: providing equal opportunities to access and make use of digital services by all residents irrespective of their difference in socio-economic/ demographic background. Fourth are ethics and security: the colony of privacy, level playing field, and protection of the data is a critical determinant in the adoption or abandonment of the smart city initiatives by the citizens. The fifth one is engagement: to create a favourable reaction in the mass media, one must educate, market, co-create, and engage the community. (Alerasoul, Tiberius & Bouncken, 2022)

These implications on policy and practice are evident. City makers should take into consideration fundamental infrastructure to ensure that there is access to broadband at affordable rates and accessible and open community platforms. Moreover, involving participatory governance processes like open data and constant feedback systems, helps in transparency, and guarantee citizen needs are reflected in the development. Effective targeted communication plans may also be used to raise awareness among the populace, as well as create trust through emphasizing the project objectives, performance, and ethical protection. Data protection policies and ethical frameworks such as privacy-by-design, data anonymisation, and fair equitable governing of the platforms are necessary to retain trust and avoid any social harm. Lastly, sustainable business

ventures, particularly the local start-ups that integrate the concept of digital innovation with societal or environmental welfare may help strengthen the overall image of smart cities. (Li & Xu, 2024).

2.5 Theoretical Overview

2.5.1 Diffusion of Innovation Theory

The Diffusion of Innovation Theory (DOI) as originally thought of by Rogers, offers a strong conceptualisation model on how innovations, especially that which foster sustainability get adopted over time by individuals as well as organisations and communities. This theory plays a key role in the investigation of the ways in which digital innovations can affect sustainable enterprises and urban systems. Employing the DOI theory, Khan et al. (2022) have discussed the role of sustainability innovations and environmental opinion leadership that has a central role in facilitating environmental behaviour and prioritized early adopters in shaping the environmental behaviour of the majority of the population. Also, in the episode of smart urban mobility, Bokolo (2023) examined sustainable e-mobility sharing in smart communities, and found that compatibility, relative advantage and observability are the important keys to adoption of innovation. On the same note, Ahn and Park (2022) combined the concept of DOI with the Technology Acceptance Model to discuss the adoption conditions linked to sustainable transportation that can support the notion that usefulness and ease are key when addressing urban sustainability innovations. All these findings indicate that digital innovations have better chances of adopting by society when they correlate with societal values, enhance the convenience of urban residents, and are promoted by trusted parties. Thus, the DOI theory can be utilized to understand all the spread of sustainability innovations in companies and their applicability in changing the path of urban development.

2.5.2 Stakeholder Theory

According to the Stakeholder Theory, there is need to include different groups of people (including government agencies, business organisations, individuals, and environmental

activists) into the processes of making decisions impacting the environment of sustainability and digital transformation. The emergence of the digital era provides Lock and Seele (2017) with the argument that nowadays stakeholder landscape has become more dynamic and complex, and digital platforms give the voices of these stakeholders more power and raise their transparency and accountability expectations. This point of view is particularly useful to the case of sustainable businesses who have to deal with the public opinion and pursue environmental and economic interests. Mhlanga and Moloi (2020) go further to argue that in the Fourth Industrial Revolution stakeholder involvement cannot be seen as purely ethical but rather strategic and has allowed organisations to develop collective intelligence when it comes to the design of digital systems designed to be more sustainable. Stawicka (2021) also discusses the role of digital entrepreneurship in ensuring sustainable development, with the cooperation between stakeholders as the central force in the creation of digital sustainability synergies. Using the Stakeholder Theory, the research reveals how the opinion of the public can be addressed using an inclusive dialogue and how the successful implementation of the urban development projects can be based upon the priorities of the individuals who are the stakeholders in the project. This theoretical perspective is therefore in a critical sense full of clues to the explanation of governance and legitimacy of sustainable innovation, particularly in the urban environment where activities of many stakeholders collide.

2.5.3 Triple Bottom Line (TBL) Framework

TBL presents a full assessment model on sustainability of companies' basis three pillars, namely economic viability, environmental stewardship, and social responsibility. In contemporary city development, this framework has been of especial service in examining the interface of digital innovation, sustainable enterprise, and inclusive urban development. An investigation on the role of metropolitan governance models in incorporating the TBL approach to reconcile the conflict of stakeholders and co-produce sustainable value was examined by Chen and Kamarudin (2024). According to them, sustainable urban development can be really attained only through the reconciliation of economic growth with environmental protection and social equity. The evolution of the TBL model into the so-called City 4.0 (Yigitcanlar et al., 2023) reflected the

idea of the involvement of digital infrastructure and smart governance in the plans to ensure sustainability. Their contribution proves that technological advancements should also be analysed based on efficiency only but also socially and the environmentally. In that regard, TBL acts as a guiding principle to not only businesses but also the planners of cities so that not only profit or convenience, but good for the people is pursued by the use of digital innovations. This very TBL framework increases the normative arguments towards such a connection between responsible urban development and the interaction with sustainable business practices.

Chapter 3 – Research Methodology

3.0 Introduction

The present research will examine the effects of digital innovation on sustainability performance of the enterprises with reference to four key aspects: adoption of green technologies, digital integration, data analytics, as well as digital supply chain management. The method used is quantitative research by the utilisation of a survey of 150 people from around the world, that have a broad range of demographics. The design incorporates statistical evaluation from the survey and literature information available from other research, making it unlikely to obtain a partial account of the impact of digital transformation on sustainable business practices.

3.1 Research Design

The research given is designed as the quantitative method research that will reflect on the influence of digital innovation on the sustainability performance of the enterprises. Combination of both the survey conducted and the literature information available from previous research enables the researcher to overcome sophisticated research questions which involve broad range of data (Ostlund et al., 2011). The quantitative component relies on the structured Likert-scale questionnaire, which is distributed among many people that have an age range of 18-60, coming from different backgrounds and that have different countries of origin. The sample group is selected to represent the possible effects of migration to other countries on the perception of digital innovation and urban development (150 respondents)

Such a combination of quantitative method with literature information available can be explained with the idea of complementing each other with their strengths. The quantitative approach also allows finding out the correlations and general trends, whereas the literature review helps to dive deeper into details and the process that supports certain patterns (Matovi and Ovesni, 2023). This combined plan makes the findings stronger via triangulation and minimizes the shortage that comes with application of a single approach (Pole, 2007). Such a mixture is especially suited

when it comes to investigating sustainability and digital innovation, which is defined by both quantitative markers and intricate social interactions (Sandelowski, 2000).

3.1.1 Research Philosophy

The philosophy of this research is pragmatism, which argues in favour of the combination of various research paradigms depending on the nature of the problem of the research study and not on the loyalty to the given philosophical tradition (Creswell, 1999). Pragmatism takes note that objective reality (which can be measured in quantitative data) and subjective experiences (that can be accessed through literature review inquiry) are the indispensability to know the phenomena of digital transformation and sustainability performance.

Pragmatism also enables scientists to focus on the resolution of a problem and practical applications more than following the traditions of positivists or interpretivists (Taherdoost, 2022). Within the frameworks of the present study, pragmatism involves combining rich narrative data with numeric Likert-scale data to obtain the overall picture of the impacts of digital tools (e.g., green technologies, data analytics, and digital supply chains) on business sustainability performance and the perceptions of these impacts developed by the community members.

This philosophy can justify why knowledge creation in both technology and sustainability is dynamic and so will suit the research purpose of the study to come up with actionable insight. In such a way, pragmatism contributes to the methodological variability and the utilisation of a variety of tools most appropriate to address the targeted research questions (Matovic & Ovesni, 2023).

3.1.2 Research Approach

In this research study, the deductive-inductive design is employed- usually associated with quantitative method research study, harmonized with literature review (Taherdoost, 2022). The quantitative component is deductive with its process starting with previously created theories and

hypotheses concerning the connection between digital innovation practices and the sustainability performance outcomes. It can then use statistical survey data of the businesses to test these hypotheses. Deduction logic provides systematic reasoning (hypothesis-based), which permits generalisation of outcomes.

On the other hand, the literature review component reflects the use of inductive methods according to which the themes are presented by virtue of the lived experience and the perception of the researchers and their respondents, based on previous research. Induction helps to investigate surprising themes and gives a deep insight into the experience of digital innovation in the community sense.

Converging deduction and induction provide a significant tool towards the construction and verification of knowledge (Sandelowski, 2000). This dual method enables feedback additional loop and triangulation, in that the literature information could explicate quantitative results and the contrary (Moffatt et al., 2006). This increases the internal and external validity of the research, and it is very applicable in the case of sustainability research where multiple variables interact at various levels of society and organisations (Chen et al., 2011).

3.1.3 Research Strategy

The research plan delivers the quantitative method design into parallel convergent approach by which the quantitative and qualitative data will be gathered and analysed simultaneously and independently but combined during interpretation, where qualitative data, which is not the method that is going to be used through this research, will only be gathered from previous literature review (Creswell, 1999). This will enable the researcher to answer various aspects of the research objectives at one go, making the research easy and covering depth and width of the topic.

The quantitative design is a cross-sectional survey, that is, questionnaires designed to reflect the level of adoption of the digital innovation practices base in the green technologies, digital integration, data analytics and supply chain management and their impact on sustainability

performance is to be captured. It is a valid strategy to test the associations between variables in a large sample and can be considered beneficial to this aspect of generalisability (Taherdoost, 2022).

At the same time, qualitative data derived from literature review is based on the use of semi-structured questionnaires, which are determined by the literature-based themes. The approach permits further examination of resident perceptions, which provides an in-depth perspective of the subtleties of social and environmental impact of digital innovation (Pole, 2007).

Through convergence strategy, the study exploits the merits of both methods to the maximum extent and takes into consideration the limitations of both methods to the bare minimum. It makes results strong, global and based both on empirical observation and situational awareness (Matovi & Ovesni, 2023).

3.1.4 Population and Sampling

Quantitative Sampling

The study population represents broad range of demographics. Age range of the respondents are from 18 to 60, where the highest level of education is PhD, where the lowest attained is high school degree. Half of the respondents are immigrants, mainly from less developed countries to highly developed countries, such as Turkey to Ireland. Majority of the respondents have an idea about digital innovation to some extent and use it regularly in their lives. The Cochran formula and the Morgan Table help to determine a sample size of 150 so that it is representative of its entire population with a margin of 5 percent error and 95 percent confidence level. The simple random method of sampling is implemented to prevent the possibility of a selection bias to assign every business an equal opportunity to be included in the process, which improves the ability of the results to be generalized (Taherdoost, 2022).

This sampling will make sure that the broad patterns found between all demographic groups are grasped, but also that the contextual accounts of the residents are also got. Nevertheless, when

purposive samples are used, they are more interested in depth despite the fact that simple random samples favour statistical rigor. The methodological implication is that whereas the quantitative results can be generalized, qualitative ones are bound more to a local place and are more interpretative because they have to be contextually framed in terms of the analysis (Matovic & Ovesni, 2023).

3.1.5 Data Collection

Quantitative Data Collection

Perceptions and level of adoption of the four independent variables namely, adoption of green technologies, the level of digital integration, the use of data analytics, and digital supply chain management are measured using a 5-point Likert scale based structured questionnaire. The measure of dependent variable is sustainability performance, which constitutes environmental, economic, and social aspects. Likert scales can be administered quickly and are statistically easy to analyse, as well as record the attitudes, behaviours and levels of agreement.

Information from Literature Review

Previous literature articles and studies are examined to illustrate a pattern based on the experiences in life and their perceptions on the aspects of sustainability of the digital transformation in the communities. The studies are mainly based on following themes, according to the literature review: the changes which take place in the environment, the availability of services and the participation of the people concerning digital projects.

The flexibility of the method, which is the semi-structured interview, gives the authors the opportunity to delve deeper into applicable answers hence resulting in deeper data. This however involves some skill of the interviewer, to create some consistency over sessions (Creswell, 1999). The twofold approach to data collection handles both statistical inquiry and richness of context and, therefore, the methodology is quite appropriate when it comes to investigating a

dynamic and complex phenomenon, such as sustainability and digital innovation (Östlund et al., 2011).

3.1.6 Data Analysis

Quantitative Analysis

The SPSS will be used to analyse the data collected using questionnaires. Mean, standard deviation will give an overall sketch of the sample and variable patterns. Hypothesis will be used to infer conclusions on how the four independent variables influence sustainability performance through the process of inferential statistics like correlation and regression analysis. The evaluation of reliability will be conducted through the alpha coefficient of Cronbach to provide the internal briefs of scales (Taherdoost, 2022).

Literature Review Analysis

Qualitative analysis will be based on the results derived from the literature review and studies based on the previous research and the conclusions found from these articles. Authors of these articles mainly conducted interviews and drew conclusions based on the answers of the respondents on the perception of their views of green technologies and sustainability.

Both analyses will be integrated at the interpretation stage when the results of both strands of the analysis are compared and contrasted to come up with overall conclusions. The analytical strategy is inevitable to guarantee that the breadth (quantitative) and depth (qualitative) of the research problem is successfully balanced (Matović & Ovesni, 2023).

3.1.7 Limitations of the Selected Methodology

Although quantitative methods have a lot of strengths, it has a few limitations. The lack of precision is typical of the Likert-scale responses in the quantitative part where the individual might give an answer that they would deem as being socially favourable instead of ones that

would represent their actual perceptions (Taherdoost, 2022). Also, using self-report may interfere with objectivity.

A qualitative component is constrained by the small sample size that might have been used which reduces the scope of generalisation and the second-hand usage of data from the literature review limits the quality and authenticity of the data. There is also the risk that purposive selection of residents will cause the selection bias since only residents with firm opinion or cognisance may participate (Sandelowski, 2000). Moreover, the combination of findings with quantitative models with qualitative data from literature review may be methodologically complicated. The opposite conclusions might be there, and it needs to be interpreted with a lot of care in order to arrive at the invalid conclusions (Moffatt et al., 2006).

The other constraint is provided by the geographical scope. Although as many people as can be addressed were tried to be connected with, concentrating in some regions such as Turkey and Ireland might restrict the generalisations to be made with respect to other regions. Lastly, as the field of digital technologies develops swiftly, the findings can soon be obsolete without reflecting on current patterns (Östlund et al., 2011).

In spite of all these shortcomings, the rather rigid methodology and thought-through analytical process of the research is expected to favour credibility, transferability, and reliability, which is an indicator of soundness of the results.

Chapter 4 - Findings & Analysis

4.1 Demographic Analysis

Here, the demographic feat of the respondents to the survey will be presented with respect to their distribution of age, level of education, location and size of their present company. These demographic issues are crucial to study as they are to be put in a context against certain perceptions and opinions on digital innovation, sustainable businesses, and their relation to city growth.

Age Distribution

As far as the age profile of the respondents is concerned, there is a high level of concentration among those in the 25-34 years bracket which is considered to be 68.7 percent (103 respondents) of the total number of respondents. This is the highest frequency recorded, which means that most of the participants will be young adults who may be either active professionals or those in the early to mid-career stage. The second position goes to the age bracket of 18-24 years holding 14.7% (22 respondents) followed by 35-44 age bracket accounting to 12.0% (18 respondents). The lowest showing is the under 55-64 age group, with 4.7 percent (7 of them). The prevalence of the low age categories points to the idea that the information is largely based on the views of a rather young, potentially tech-savvy, population that can affect their thoughts on issues of digital innovation and sustainability.

1. What is your age range?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	22	14.7	14.7	14.7
	25-34	103	68.7	68.7	83.3
	35-44	18	12.0	12.0	95.3
	55-64	7	4.7	4.7	100.0
	Total	150	100.0	100.0	

Table 1: Age

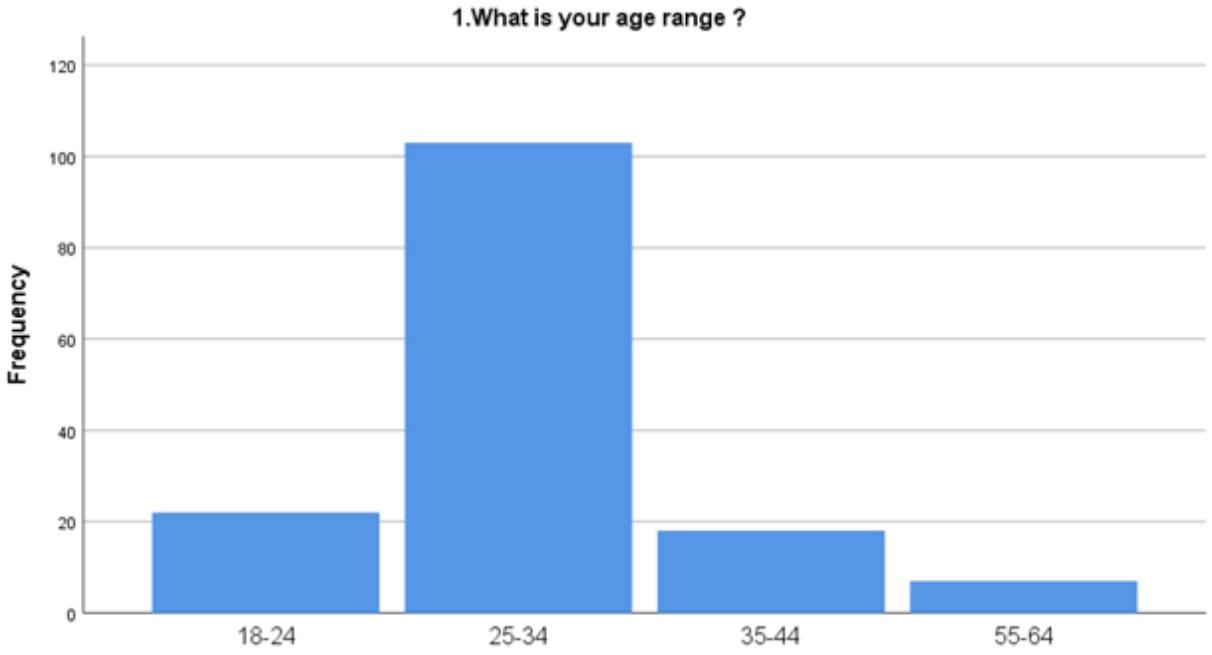

Figure 1: Age

Highest Level of Education

The respondents are highly learned and most of them are postgraduate level. The greatest percentage is that of people with a master's degree at 44.0 percent (66 respondents) followed by those having a degree in bachelor's at 40.7 percent (61 respondents). There are other educational

qualifications like PhD, or greater (4.7%, 7 outliers) and postgraduate diplomas (2.0%, 3 outliers) and also technical qualifications like in the machinery area (2.7%, 4 outliers). The rarest type is high school graduates, with 6.0% (9 also among the respondents). Such distribution indicates that the survey reached a well-educated sample, which may precondition (increase/decrease) the complexity and maturity of the responses related to their attitudes towards digital innovation and sustainability.

2. What is your highest level of education?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's degree	61	40.7	40.7	40.7
	High school	9	6.0	6.0	46.7
	Master's degree	66	44.0	44.0	90.7
	Mechanical techni	4	2.7	2.7	93.3
	PhD or higher	7	4.7	4.7	98.0
	Postgraduate Dipl	3	2.0	2.0	100.0
	Total	150	100.0	100.0	

Table 2: Highest level of Education

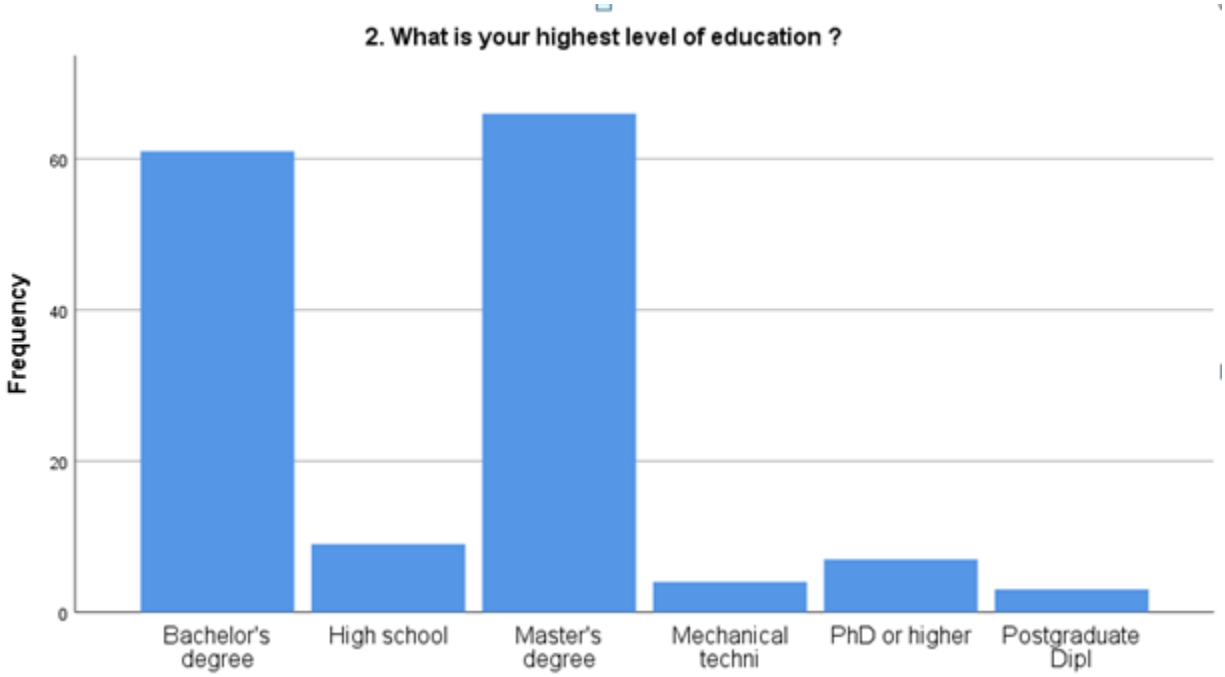

Figure 2: Highest level of Education

Current Place of Residence

Geographically, the current residence of half of the respondents (50.0%, 75 participants) is in Ireland which is the most represented site. With all the differences in the spelling (Turkey, Tyrkiye), Turkey has a total of 22.7 percent (34 respondents), which comes second as the most common residence. Other places like Istanbul, England, Malta, Moscow and other small groups all make up less than 5 percent of the sample. The low proportion of respondents in the countries like Canada (1.3 percent), Cyprus (1.3 percent) and Wales (1.3 percent) show that the respondents were not large representatives of the region. This geographical distribution shows an emphasis on European cities with a special reference to Plain of Ireland and Turkey which can be pertinent in the study of regional context of urban development and sustainability.

3c. I am currently living in					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Canada	2	1.3	1.3	1.3
	Cyprus	2	1.3	1.3	2.7
	Dublin	2	1.3	1.3	4.0
	ÉIRE	4	2.7	2.7	6.7
	England	3	2.0	2.0	8.7
	ireland	2	1.3	1.3	10.0
	Ireland	75	50.0	50.0	60.0
	İstanbu	2	1.3	1.3	61.3
	Istanbul	7	4.7	4.7	66.0
	izmir	2	1.3	1.3	67.3
	Malta	3	2.0	2.0	69.3
	Mersin	2	1.3	1.3	70.7
	Moscow	3	2.0	2.0	72.7
	Same	3	2.0	2.0	74.7
	Tukey	2	1.3	1.3	76.0
	Turkey	22	14.7	14.7	90.7
	Türkiye	12	8.0	8.0	98.7
	WALES	2	1.3	1.3	100.0
	Total	150	100.0	100.0	

Table 3: Current place of residence

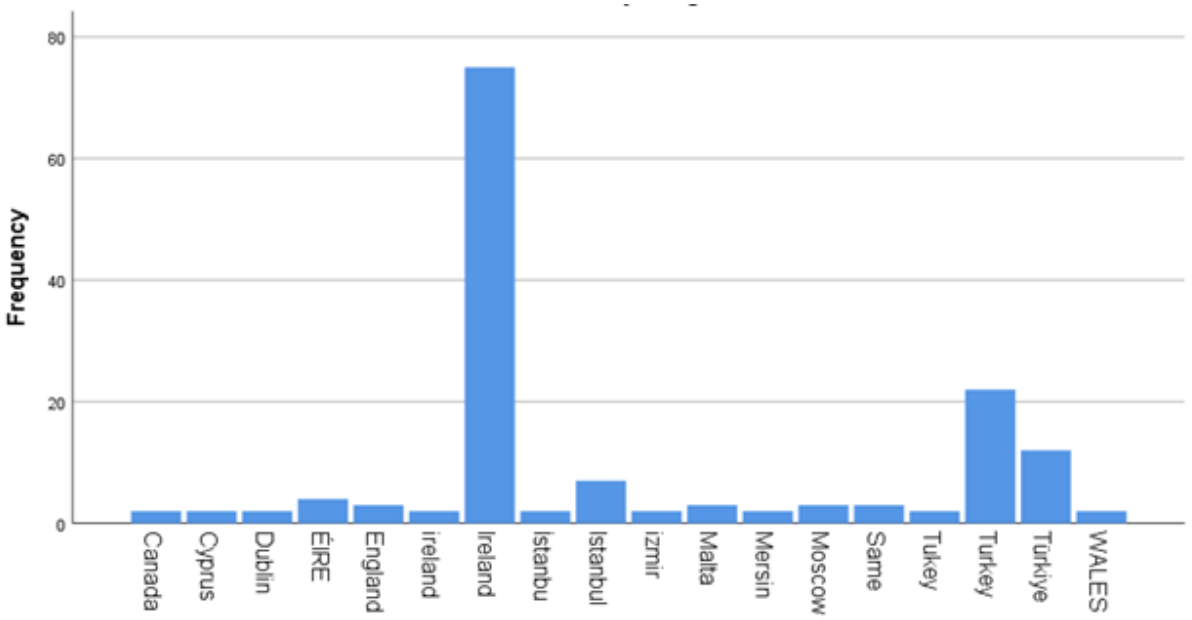

Figure 3: Current place of residence

Company Size

Concerning organisational context, the largest number of respondents hold employment in large companies (250+ employees), (43.3% / 65 respondents). Firms between 50 and 249 in the case of employees hold second position by 38.7 percent (58 Respondents). The lesser numbers of companies (10 to 49) make 12.0 percent of the total representation (18), and the smallest micro enterprises at (1 to 9) make 6.0 percent (9 respondents). It implies that most of the respondents work in either medium-sized or large companies, which can influence their experience and perspectives on the use of digital innovations and sustainability in an urban development system.

Company size					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Micro (1–9 employees)	9	6.0	6.0	6.0
	Small (10–49 employees)	18	12.0	12.0	18.0
	Medium (50–249 employees)	58	38.7	38.7	56.7
	Large (250+ employees)	65	43.3	43.3	100.0
	Total	150	100.0	100.0	

Table 4: Company Size

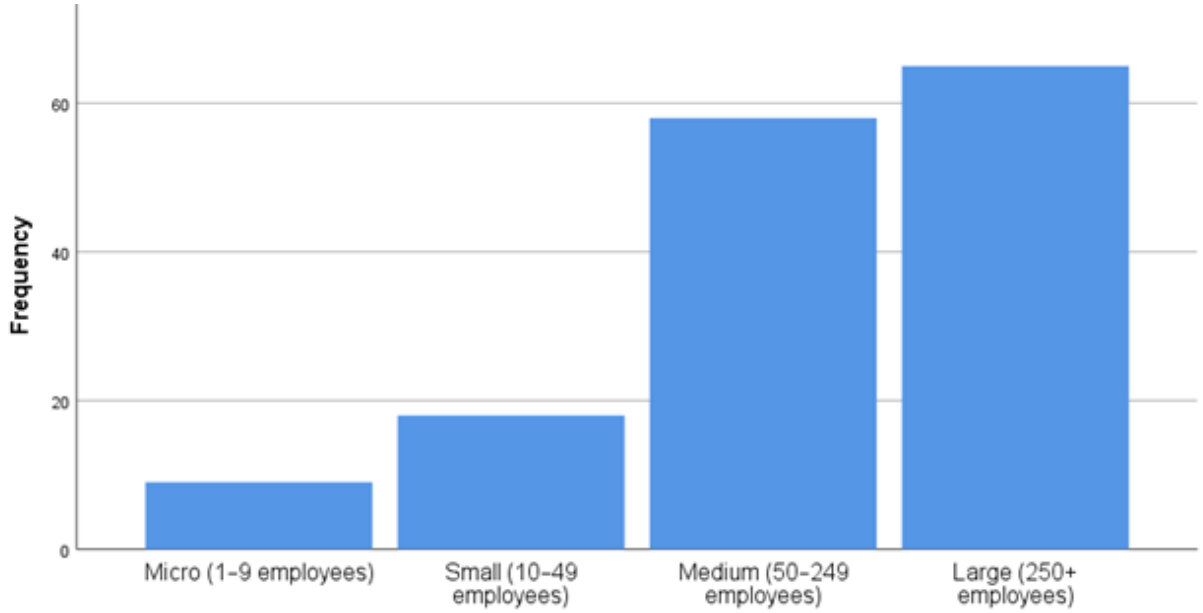

Figure 4: Company size

4.2 Descriptive Analysis

Descriptive analysis assists in knowing the distribution pattern and nature of the datasets since it looks at statistics like skewness and kurtosis (Bloomfield and Fisher, 2019). These two values of statistics give us an overview of the symmetry and form of the response's distribution. Skewness is a parameter that determines how symmetrical the distribution of data is, and Kurtosis measures

the tailedness of the distribution. Overall, values near 0 of skewness and kurtosis measure indicate a relatively symmetrical distribution and normal distribution, respectively. Negative skew means that most of the responses tend to be placed on the high side of the scale whereas negative kurtosis causes a flatter distribution with decreased extreme scores.

Descriptive Statistics					
	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
AGT	150	-.651	.198	-1.063	.394
LDI	150	-.796	.198	-.575	.394
DAS	150	-1.275	.198	.132	.394
DSCM	150	-.832	.198	-.313	.394
SPE	150	-.473	.198	-.305	.394
Valid N (listwise)	150				

Table 5: Descriptive statistics

Adoption of Green Technologies (AGT) has the skewness of -0.651 and kurtosis of -1.063. This denotes rather slight negative skew, or a larger number of people chose higher figures, implying an overall positive opinion concerning green technology usage. The low kurtosis shows a flat distribution, and it means that there are a variety of responses, and none is very clustered.

Level of Digital Integration (LDI) depicts skewness of -0.796 with Kurtosis of -0.575. It implies that the responses are also slightly skewed to the left, which means that generally shows greater tendency to elevated levels of digital integration, although there is lower variability in extremity in relation to AGT.

As indicated by the strongest skew (-1.275), the Use of Data Analytics in Sustainability (DAS) shows a highly skewed negative side of the scale or most preferably the higher scores. This implies that majority of the respondents are fully engaged in data analytics sustainability usage. The value of kurtosis 0.132 portrays that it is almost normal, in other words, although the data has a skewed distribution of the responses, they do not cluster on values at extreme ones.

Digital Supply Chain Management (DSCM) is skewed to the left to the extent of -0.832 and has a slight kurtosis of -0.313 meaning that it is very slightly flat. This means that many the respondents have a positive attitude towards digital supply chain practice albeit divided partially.

It has a minimum skewness of -0.473 and kurtosis of -0.305 that shows that it is a mildly left-skewed distribution with a normal kurtosis occurrence. This indicates that there are mixed reactions in terms of sustainability performance where on one hand the picture is viewed to be doing well, on the other hand the picture is neutral in terms of responses.

All in all, the skewness and kurtosis values show that the extent to which the respondents are positively disposed towards all the five constructs, particularly responding with digital and sustainable practices, and moderate to low variability in extreme answers.

4.3 Reliability Analysis

Reliability analysis comes in to measure the consistency of a set of items that are aimed at testing a particular construct (Östlund et al., 2011). The commonest figure of the coefficient used to measure reliability is Cronbach 2 Alpha where a high figure measures reliability at above 0.7 and above 0.8 or 0.9 constitutes a good to an excellent measure of reliability.

The reliability analysis findings on this study portray an excellent result of internal consistency amongst the observed variables. The Adoption of Green Technologies, the Cronbach's Alpha of this construct is 0.917 which shows that the items that are used to measure this construction are very consistent. Correspondingly, the Level of Digital Integration has obtained a high reliability score of 0.880, which comes to support that the items reliably measure digital integration in

enterprises. The alpha value is also good in the Use of Data Analytics for Sustainability, which is 0.851. In line with this, another construct is Digital Supply Chain Management with a value of 0.804 of Cronbach. This indicates a fair state of internal reliability. Lastly, the Sustainability Performance of Enterprises shows Cronbach's Alpha of 0.718, which is not the worst and was lower compared to the other variables. On the whole, all of the constructs used in the present study exhibit adequate reliability so that the measurement tools applied are consistent and reliable to proceed further statistical analysis.

Variable	Number of Items	Cronbach's Alpha
Adoption of Green Technologies	4	0.917
Level of Digital Integration	4	0.880
Use of Data Analytics for Sustainability	4	0.851
Digital Supply Chain Management	4	0.804
Sustainability Performance of Enterprises	5	0.718

Table 6: Reliability

4.4 Normality Analysis

Normal analysis is an essential pre-testing procedure in quantitative research especially when applying the statistical treatment of a parametric test related to the regression analysis, correlation or ANOVA. Assumption of normality denotes that the distribution of information is a bell-shaped form, and the researcher can be able to reliably infer about the population whose sample is extracted. Measure of centrals, dispersion, range of data of each variable, skew and kurtosis values are normally analysed by the researcher to test that data are normally distributed; it is also common to use graphical analysis in instruments such as histograms. In this study, descriptive statistics, which include the minimum, maximum, and mean and standard deviations were used in assessing normality of five core variables.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic
AGT	150	5.00	19.00	13.7333	4.81562
LDI	150	5.00	18.00	13.0733	4.32427
DAS	150	6.00	18.00	14.0733	3.99008
DSCM	150	7.00	18.00	14.2000	3.48149
SPE	150	10.00	20.00	15.5800	2.59910
Valid N (listwise)	150				

Table 7: Normality

Adoption of Green Technologies (AGT) had a response group of 5.00 to 19.00 with a mean of 13.73 and a standard deviation of 4.82. The far distribution and the somewhat flattish dispersion indicate that the means were widely spaced with an average mean that ran in the middle to upper coincidence side. This is a very slightly skewed, but balanced distribution which enforces the assumption of approximate normality.

The scale of the Level of Digital Integration (LDI) extended between 5.00 and 18.00 in the form of a mean of 13.07 and standard deviation of 4.32. The likeness of range and dispersion to AGT implies the standard assessment pattern, which implies moderate degree of digital assimilation among the respondents. Enterprises with relatively small minimums might be those far along in the digital transformation process and the aggregation around the mean might indicate a cluster towards convergence in digital practice.

Use of Data Analytics for Sustainability (DAS) had a smaller percentile range of 6.00 18.00 and mean of 14.07 with a standard deviation of 3.99. This distribution is inclined a bit to the upper side of the scale, which implies that a large proportion of enterprises are actively using data analytics to facilitate their sustainability objectives.

Digital Supply Chain Management (DSCM) had a least value of 7.00 and the greatest of 18.00 with a mean value of 14.20 and lowest standard deviation compared to the first four variables of 3.48. The lower value of spread indicates that the majority of respondents rated digital supply chain practices in a similar fashion, but they understand or are standardized.

Sustainability Performance of Enterprises (SPE) had a minimum score of 10.00 and a maximum score of 20.00 and the average value was 15.58 with the lowest standard deviation overall in 2.60. This shows a very strong cohesion in the perception of sustainability performance amongst the enterprises surveyed and the values are largely at the upper end which is in support of the conclusion that industries express a favourable judgment of their sustainability efforts.

4.5 Correlation Analysis

Correlation analysis is performed to determine the magnitude and direction of the linear associations among the variables of a data set (Fischer et al., 2023). Pearson correlation coefficient was employed in this study to analyse the relationship between five important variables that included Adoption of Green Technologies (AGT), Level of Digital Integration (LDI), Use of Data Analytics for Sustainability (DAS), Digital Supply Chain Management (DSCM) and Sustainability Performance of Enterprises (SPE). The values of Pearson r take values between -1 and +1 with higher (closer to +1) values showing a strong positive correlation. The statistical significance was determined via a 0.01 (2-tailed) level of significance.

Correlations						
		SPE	AGT	LDI	DAS	DSCM
SPE	Pearson Correlation	1	.378**	.710**	.646**	.682**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	150	150	150	150	150
AGT	Pearson Correlation	.378**	1	.818**	.768**	.662**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	150	150	150	150	150
LDI	Pearson Correlation	.710**	.818**	1	.837**	.728**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	150	150	150	150	150
DAS	Pearson Correlation	.646**	.768**	.837**	1	.840**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	150	150	150	150	150
DSCM	Pearson Correlation	.682**	.662**	.728**	.840**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	150	150	150	150	150
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 8: Correlation

Its result being a strong positive correlation, which is statistically significant, between all four independent variables and SPE. Correlation between SPE and LDI is the strongest, and it shows the Pearson r of 0.710 ($p < 0.01$). This is an implication that companies that integrate the level of digital higher would record better performance in terms of sustainability. The correlation between SPE and DSCM has a comparable strong relationship since $r = 0.682$, which indicates that the use of digital practices in supply chain management has a significant effect on sustainable results.

It can also be seen that there is a significant positive relationship between SPE and DAS as it produced the r= 0.646 statistic. This means that the more an organisation uses data analytics, the higher the probability of a better sustainability performance they achieve. Conversely, the relationship of SPE with AGT is the lowest of the relationships albeit statistically significant since the value of coefficient is $r = 0.378$. This finding implies that although using green

technologies is beneficial to sustainability, they might not have an immense effect when used alone in comparison to the expansion of digital and analytical changes.

Besides investigating the relation with the sustainability performance, the analysis reveals that there is a high intercorrelation among the four independent variables. The most correlated variables are LDI and DAS with the value of r = 0.837, which implies that the enterprises using digital technologies in their operations will also enter data analytics in the way they operate. The correlation between DAS and DSCM is also very high (r = 0.840) demonstrating that the link between analytical capabilities and application of digital supply chain practices is quite close. There is also a very strong correlation between AGT and LDI (0.818) and AGT and DAS (0.768) indicating the fact that in most cases, green technology adoption goes hand in hand with greater digital innovations.

4.6 Regression Analysis

Regression analysis is a very crucial statistical method of evaluating the relationship of a group of independent variables on a dependent variable (Watson, 2015). Multiple linear regressions were used in this study to determine the predictive connection between four independent variables, Adoption of Green Technologies (AGT), Level of Digital Integration (LDI), Use of Data Analytics on Sustainability (DAS), and Digital Supply Chain Management (DSCM), and dependent variable Sustainability Performance of Enterprises (SPE). This analysis will be conducted to determine the factors that influence the performance of sustainability and to evaluate the holistic capability of the model of explaining the performance of sustainability.

According to the model summary, we find that there is a good relation between the independent variables and the SPE with the relation value of 0.850 which shows close positive relation between the observations and the predicted values. The R Square value indicates that the combined effect of the four predictors shows 72.2 percent of the variation in the performance of sustainability. The adjusted R Square of 0,714 that takes into consideration the number of the predictors as well as the sample size indicates that the model will be reliable even when applied to the population. The value of standard error of estimate is 1.38961, which is a small measure of

average variation between the predicted values of SPE and the observed values.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.850[a]	.722	.714	1.38961
a. Predictors: (Constant), DSCM, AGT, LDI, DAS				
b. Dependent Variable: SPE				

Table 9: Model Summary

To further prove the statistical significance of the model, ANOVA table shows a significance value of 0.0001. With a significant level equal to 0.000, the F-value of 94.062 indicates that the regression model fitted the given data quite well and that the predictors have joint significance in sustainability performance. This shows that where digital and technological factors are combined, the concern tends to have significant impact on the level of sustainability outcomes that enterprises will have.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	726.543	4	181.636	94.062	.000[b]
	Residual	279.997	145	1.931		
	Total	1006.540	149			
a. Dependent Variable: SPE						
b. Predictors: (Constant), DSCM, AGT, LDI, DAS						

Table 10: ANOVA

The coefficients table helps one get an elaborate idea about the role of individual independent variable. Its constant (intercept) is 8.490, so, when all the predictors assume a zero value, the base level of intercept is 8.49. Level of Digital Integration (LDI) is by far the most influential positive predictor in the study with an unstandardized B coefficient of 0.567 and standardized Beta of 0.944 (p= 0.000). This finding indicates that changes, which enhance digital integration,

affect sustainability performance significantly and directly. Digital Supply Chain Management (DSCM) is also a very strong indicator, and its Beta is 0.432 (p = 0.000) which means that supply chain digitalisation is closely connected with improved sustainability results.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.490	.479		17.728	.000
	AGT	-.384	.043	-.712	-9.005	.000
	LDI	.567	.056	.944	10.179	.000
	DAS	.026	.068	.040	.390	.697
	DSCM	.323	.060	.432	5.339	.000
a. Dependent Variable: SPE						

Table 11: Coefficients

On the other hand, Adoption of Green Technologies (AGT) is negatively related to SPE, and the Beta is associated with -0.712 (p = 0.000). Although such finding may appear counterintuitive, it may be assumed that in the surveyed enterprises, adopting green technologies is either expensive or way too recent and, therefore, implying the short-term inability to demonstrate the measurable sustainability rate, or it may imply the fact that without additional digital strategies, the green technologies are not going to immediately pay off. The factor of the Use of Data Analytics on Sustainability (DAS) cannot be considered considerably significant in this model as its p-value is 0.697 in which the Beta value is merely 0.040. This implies that data analytics can be of value, but it does not necessarily have a direct impact on sustainability performance unless incorporated into other information-based digital projects.

The residual statistics demonstrate that the mean of the predictions of the SPE is 15.58 deviating in a close range to that of the observed mean, 11.82 to 18.21. Residuals are distributed with -2.95 to 1.96 as the standard deviation is 1.37 with almost 0 mean, showing that there is no bias in the direction of the deviation in residuals around regression line.

Residuals Statistics[a]					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	11.8207	18.2127	15.5800	2.20819	150
Residual	-2.95264	1.96042	.00000	1.37083	150
Std. Predicted Value	-1.702	1.192	.000	1.000	150
Std. Residual	-2.125	1.411	.000	.986	150
a. Dependent Variable: SPE					

Table 12: Residuals Statistics

In order to confirm assumptions of regression, a residual histogram was checked. This was indicated by the histogram which pointed towards the approximate normal distribution, thereby indicating that the assumption of residual normality holds.

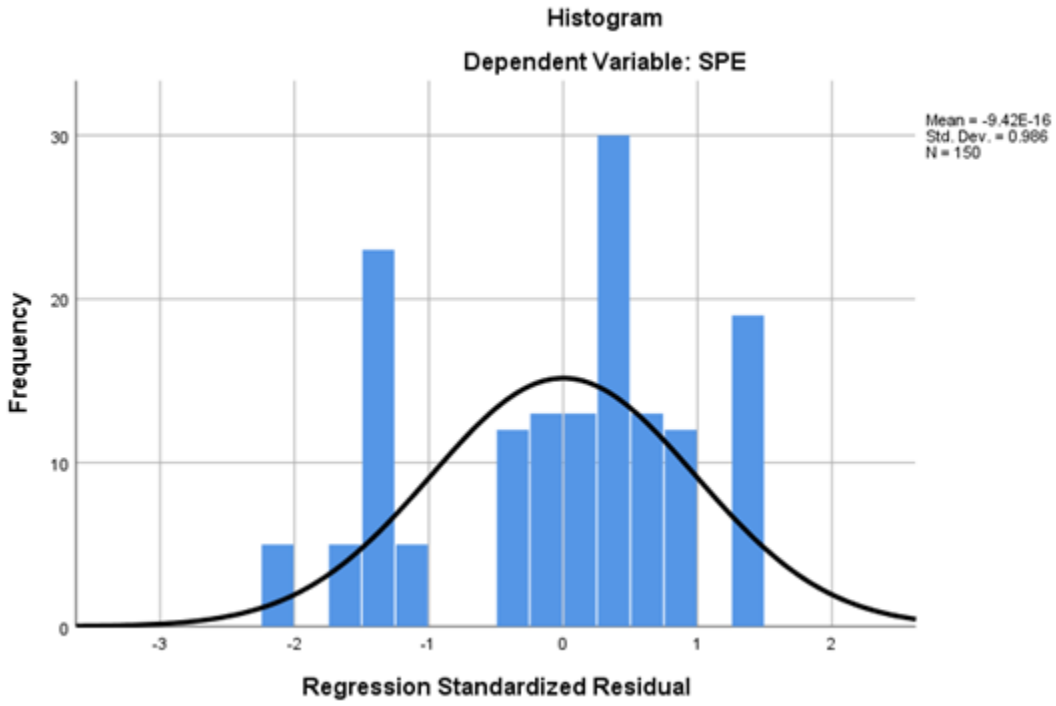

Figure 5: Histogram of Regression

Also, there was no trend in the scatter plot of the standardized residuals against the standardized predicted values and thus, suggested homoscedasticity, or equal variation of the residuals among

different predicted values. In combination, these diagnostics prove that the model is statistically valid, and it could be utilized to predict the sustainability performance through the use of digital and technological determinants.

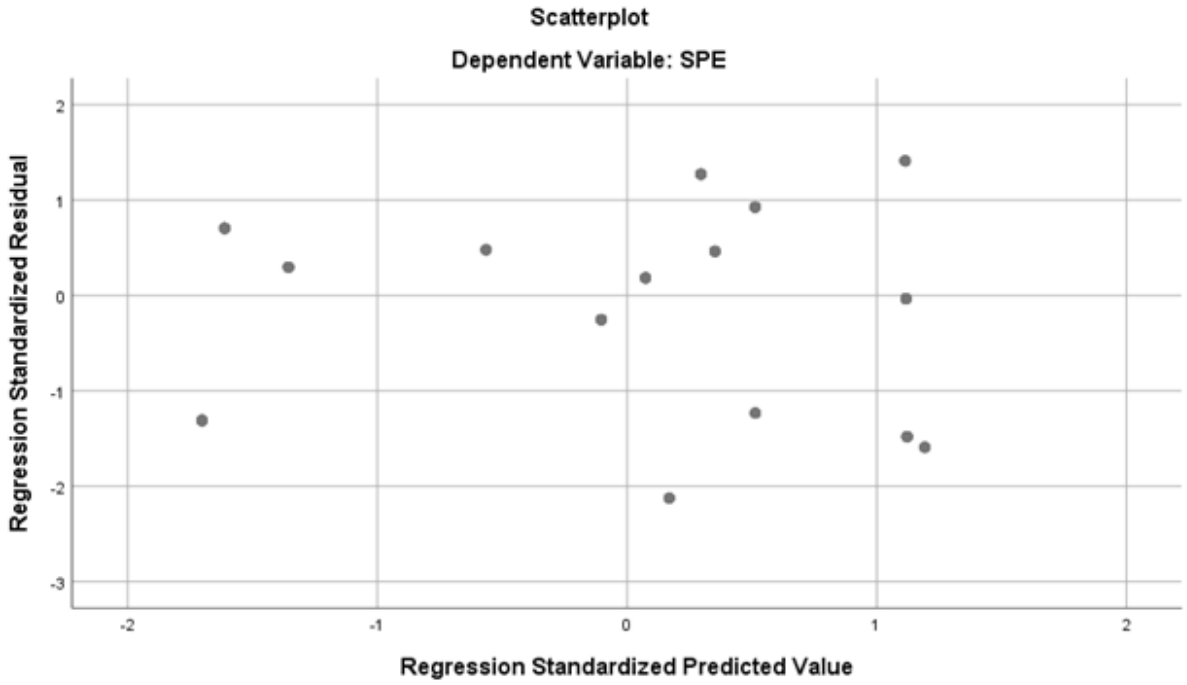

Figure 6: Scatterplot

4.7 Hypothesis Testing

Four hypotheses (H1-H4) have been conducted to assess how different digital and technological practices influence sustainability performance based on the analysis of regression and correlation analysis. Regression coefficients, significance level (p-value) and standardized Betas were analysed to find out whether or not each of the independent variables had significant effect on the dependent variable (SPE). A p-value below 0.05 was accepted as a hypothesis and rejected above 0.05 which gave us an idea of factors that are of significant influence on sustainability performance.

Hypothesis Testing Results and Interpretation

Hypothesis	**p-value**	**Beta**	**Decision**
H1: AGT → SPE	0.000	-0.712	**Accepted**
H2: LDI → SPE	0.000	0.944	**Accepted**
H3: DAS → SPE	0.697	0.040	**Rejected**
H4: DSCM → SPE	0.000	0.432	**Accepted**

Table 13: Summary of Hypothesis

These findings of the hypothesis testing indicate that LDI and DSCM have a significant and positive effect on sustainability performance whereas the effects of AGT are significant and negative, which might be caused by difficulty in implementation or costs. However, DAS does not exhibit any statistically significant effect.

Chapter 5 - Conclusion and Recommendations

5.1 Summary of the Study

The aim of the research was to address the dynamic nexus between digital innovation and the make-up of sustainable enterprises and more so, the input of in the case of the innovations on the creation of urban growth. This research identified the rising theme of sustainability and digital transformation in the global arena, especially as pertaining to enterprise development and smart city strategies. As a methodology, the study used a structured quantitative method, where statistical instruments like descriptive analysis, correlation and regression analysis formed the means of verifying the hypothesis and accomplishing the set goals. (NCI, 2024)

The first aim was aimed at determining the role of digital innovation on sustainable enterprises. Through the analysis of the parts like adoption of green technologies (AGT), level of digital integration (LDI), data analytics for sustainability (DAS) and digital supply chain management (DSCM), the research was able to give concrete indications that digital innovation is a very crucial point in improving enterprise sustainability performance. The significant association of regression and correlation analysis was also confirmed, most importantly in the LDI and DSCM, in which it was found that digital transformation is a foundational process to sustainable business practices. (Alfehaid et al., 2024)

The second goal was aimed at assessing the interrelationship between urban development and digital innovation. It was revealed during the analysis that digital innovation does not only enhance performance in the enterprise but also augers well with the overall city development plan. The results indicate the available literature emphasizing that digital integration and sustainable operation of businesses are part of the objectives of intelligent cities and green urban development (Rahajeng et al., 2024). The synergy has been vital in increasing the pace of regional sustainability and economic growth.

Finally, the research covered the perception of people about the importance of digital innovation in sustainability. The findings indicated the overall favourable perspective with the stakeholders

who viewed the advantages of digital tools in encouraging both business development and city improvement. It was possible to trace similarity between business interests and community development, which underscores the growing importance of digital innovation in spheres of business and urban planning.

5.2 Conclusion of the Study

This study was conducted to estimate the part of digital innovation in facilitating sustainable enterprise development and its significance in the broadest sense of transformations in cities. The practical implications of the findings are that digital technologies contribute to enterprise sustainability performance greatly, which makes a strong argument in favour of business adoption of these innovations into their central strategy. Application of such digital solutions as green technologies, digital-based supply chain, etc. resulted in numerical improvements in their operational efficiency and environmental impact.

In terms of the first research objective, which was to determine the effect of digital innovation on achieving sustainable enterprises, the study was able to prove through its results findings that digital integration and supply chain digitisation technology relate well along with excellent sustainability performance. Worthy of note, one of the variables had the strongest positive correlation with the enterprise sustainability, and it had been level of digital integration (LDI). These results are in line with the opinion that digital innovation is one of the sources of competitive advantage and long-term environmental responsibility (Maningas & Matriano, 2024).

As far as the second objective, the study result was the idea that the businesses using sustainable digital innovations would affect the so-called smart city development positively. All parties are willing to participate because they are congruent with the vision of public infrastructure and smart cities, allowing them to achieve better results in urban sustainability (Patrascu, 2024). This congruence implies that online creativity in business is a key pillar in the town planning processes.

Lastly, the research paper covered the third research objective, which was the determination of the public opinion concerning the synergy between digital innovation and urban sustainability. The findings are presented as a positive attitude of the stakeholders towards digital transformation, as they recognize the importance of reducing emissions that will make the businesses and cities smarter. These knowledge points reaffirm the realisation of digital innovation by both the private and the public sectors as a reciprocal opportunity towards business expansion and ultimate progress in cities as espoused in the models of sustainable development of urban areas by Rahajeng et al. (2024).

5.3 Recommendations

According to the results of this study, several suggestions can be offered that can enhance the prevalence and success of digital innovation in the development of sustainable enterprises and urban expansion.

To begin with, business entities are supposed to focus on digital strategy integration of all functional departments. The researchers found out that the term level of digital integration (LDI) affected sustainability performance potentially the most. and sustainability and the alignment of firm-based business operations with the sustainability objective should invest in digital infrastructure and platforms that enable automation, energy efficiency and real-time data management (Maningas & Matriano, 2024).

Secondly, organisations should improve green technologies in their comprehension and practice. Despite AGT having a significant relationship with sustainability performance, its negative coefficient of Beta implies the difficulty of implementing it. To beat this, companies need to be given more assistance either in the form of training, policy strategy and financing encouragements. This corresponds with what Misiak-Kwit & Wiscicka-Fernando (2024) report on their findings by indicating the knowledge gap and resources access between smaller firms that are trying to practise smart city or green enterprise practice.

Thirdly, the low level of impact of data analytics of the sustainability (DAS) that has been identified in the research indicates the necessity of improved analytics utilisation in the decision-making process. Companies ought to implement high-tech data analytics to track their emissions, energy use and other sustainability indices. These tools may have more significant input to sustainability when they are coupled with strategic objectives (Rahajeng et al., 2024).

Besides, the role of collaboration between the private and the public is crucial. Enterprises and the municipalities and local governments should also collaborate to ensure alignment of digital enterprise transformation with the objectives of urban development. The synergistic policy structures that foster digital innovation and sustainability in combination will enable collaborative effort towards the realisation of smart cities (Patrascu, 2024).

Lastly, there should be educational and capacity-building efforts concerning digital sustainability in the different industries. The social, economic, environmental advantages of digital innovation need to be taught to the stakeholders. The promotion of community support will help enterprises and urban environments shift toward a sustainable change more quickly. This have been given to the publisher by the author on the conditions set forth by this permit, which permit the publisher to

To round off, the recommendations can serve as a sort of guideline to policymakers, business leaders, and planners who want to harness the power of digital innovation to fulfil two purposes (which are one purpose) one is the goal of enterprise sustainability, and the other is the goal of smart urban development.

5.4 Suggestions for Further Research

As much as this study will provide meaningful research suggestions in digital innovation, enterprise sustainability, and urban development, the research is also an avenue to broader research.

The longitudinal effect of digital innovation on sustainability is one of the questions on which to carry out future research. The current study was only a glimpse of the current practice and perceptions, but over time these variables could demonstrate the long-term impact of digital innovation process on the enterprise performance and transforming the city. Response: It would be useful to learn how early adopters of green technologies and digital tools perform better than others in the long term and what influences a long-term adoption.

The other suggested move is to scale it to various industries or geography. Although this study was concerned with enterprises in a generic sense, subsequent researchers can examine the differences that enterprises have in a particular industry using digital sustainability tools, e.g., differences between manufacturing, construction industries, and service industries. In the same vein, the author suggests that regional variations in the values of urban and rural businesses or advancement and developing states might appear with significant policy implications (Rahajeng et al., 2024).

More so, the extent to which government policies and government regulations help or stifle the digital innovation in sustainable enterprise practice should be analysed. Future researchers can investigate whether there could be any impact of regulatory frameworks, subsidies on the level of enterprise-level digital sustainability or PPPs on the level of enterprise-level digital sustainability.

Finally, it is worth going into more detail on behavioural and cultural aspects of the adoption of digital innovations. Misiak-Kwit & Wiiscicka-Fernando (2024) points to the significance of the size of the firm and the level of knowledge in developing the attitude to smart city integration. Their future study may focus on the way the organisational culture, internal leadership, and employee digital literacy influence sustainability performance.

These channels have the capacity of strengthening the knowledge at the academic front and enlightening the leaders of businesses and urban planners to make more informed decisions towards integrating enterprise innovation with the visions of sustainability and urban development.

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Appendix

Appendix A-Questionnaire

Instructions

Please tick (√) the appropriate box.

Part 1: Personal information

1. **What is your age group?**
    - 18 – 24
    - 25 – 34
    - 35 - 44
    - 45 – 54
    - 55 and above
2. **What is your gender?**
    - Male
    - Female
3. **What is the size of your business?**
    - Micro (1–9 employees)
    - Small (10–49 employees)
    - Medium (50–249 employees)

- Large (250+ employees)

Part 2: Specific Information

1. Statement	2. Strongly Disagree	3. Disagree	4. Neutral	5. Agree	6. Strongly Agree
Adoption of Green Technologies					
1. I use energy-efficient equipment to reduce energy consumption in my business.	7.	8.	9.	10.	11.
1. I invest in renewable energy sources for my business operations.	12.	13.	14.	15.	16.
1. I apply technologies to monitor and reduce carbon emissions.	17.	18.	19.	20.	21.
1. I focus on minimizing waste generation in my production processes.	22.	23.	24.	25.	26.
Level of Digital Integration					
1. I apply digital technologies to manage business operations.	27.	28.	29.	30.	31.
1. I use cloud-based systems to store and manage my business data.	32.	33.	34.	35.	36.
1. I have integrated digital tools across departments in my business.	37.	38.	39.	40.	41.
1. I adopt new digital solutions regularly to improve business efficiency.	42.	43.	44.	45.	46.
47. Use of Data Analytics for Sustainability					

I use real-time data to monitor the sustainability performance of my business.	48.	49.	50.	51.	52.
I rely on data analytics to support decision-making in my business.	53.	54.	55.	56.	57.
I track key environmental performance indicators using analytics tools.	58.	59.	60.	61.	62.
I apply predictive analytics to plan future sustainability improvements.	63.	64.	65.	66.	67.
68. Digital Supply Chain Management					
1. I use digital tracking systems in my supply chain operations.	69.	70.	71.	72.	73.
1. I maintain real-time visibility of my supply chain through digital tools.	74.	75.	76.	77.	78.
1. I automate supply chain processes where possible.	79.	80.	81.	82.	83.
1. I collaborate with suppliers through digital platforms to enhance sustainability.	84.	85.	86.	87.	88.
89. Sustainability Performance of Enterprises					
1. I have reduced the environmental impact of my business in recent years.	90.	91.	92.	93.	94.
1. I have improved operational efficiency through digital innovation.	95.	96.	97.	98.	99.
1. I manage resources more effectively because of sustainable practices.	100.	101.	102.	103.	104.
1. I believe sustainability efforts have improved my business reputation and	105.	106.	107.	108.	109.

stakeholder trust.					

Thank you for taking your valuable time to fill the questionnaire based on your opinions.

Appendix B

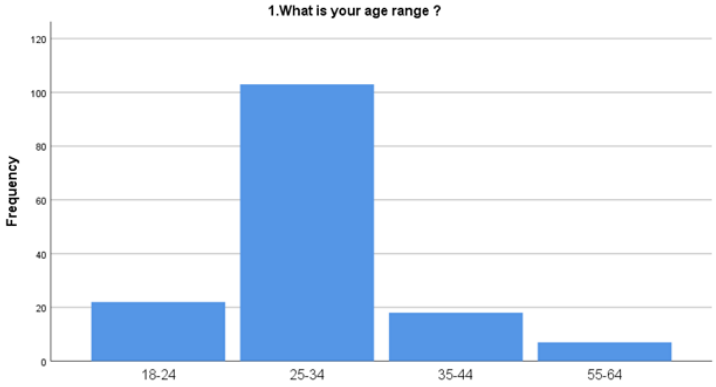
Demographic Analysis

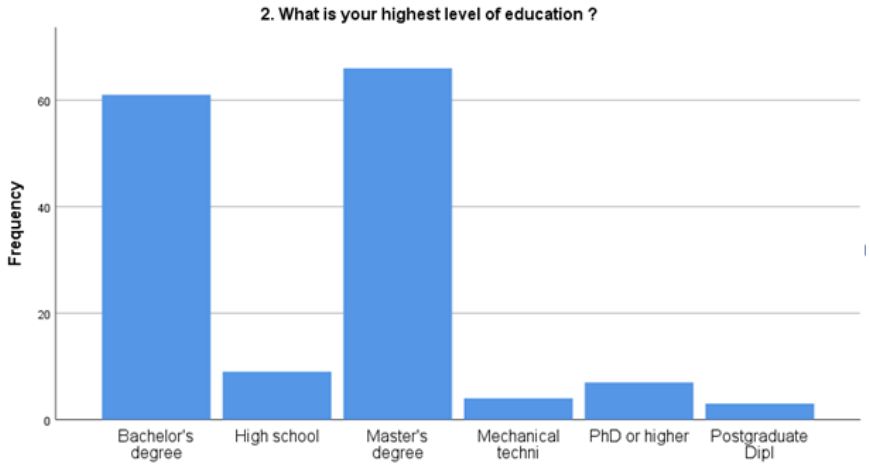
1. What is your age range?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	22	14.7	14.7	14.7
	25-34	103	68.7	68.7	83.3
	35-44	18	12.0	12.0	95.3
	55-64	7	4.7	4.7	100.0
	Total	150	100.0	100.0	

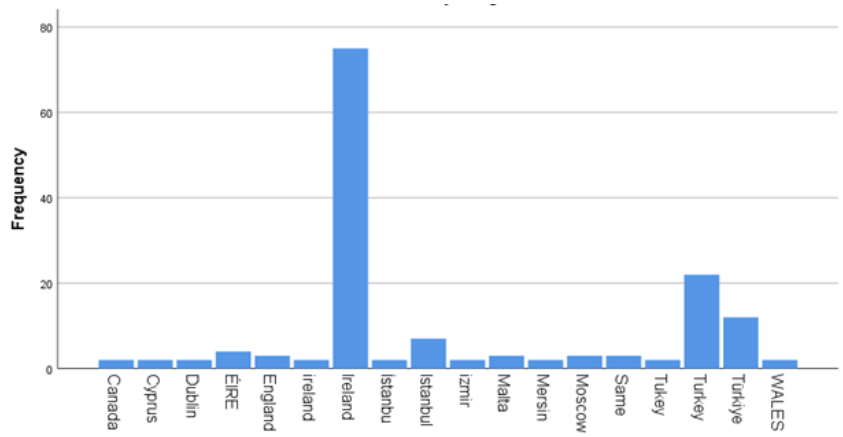
2. What is your highest level of education?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's degree	61	40.7	40.7	40.7
	High school	9	6.0	6.0	46.7
	Master's degree	66	44.0	44.0	90.7
	Mechanical techni	4	2.7	2.7	93.3
	PhD or higher	7	4.7	4.7	98.0
	Postgraduate Dipl	3	2.0	2.0	100.0
	Total	150	100.0	100.0	

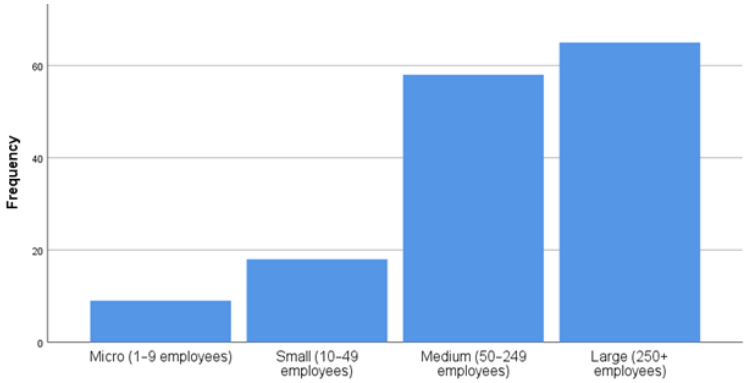
3c. I am currently living in					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Canada	2	1.3	1.3	1.3
	Cyprus	2	1.3	1.3	2.7
	Dublin	2	1.3	1.3	4.0
	ÉIRE	4	2.7	2.7	6.7
	England	3	2.0	2.0	8.7
	ireland	2	1.3	1.3	10.0
	Ireland	75	50.0	50.0	60.0
	İstanbu	2	1.3	1.3	61.3
	Istanbul	7	4.7	4.7	66.0
	izmir	2	1.3	1.3	67.3
	Malta	3	2.0	2.0	69.3
	Mersin	2	1.3	1.3	70.7
	Moscow	3	2.0	2.0	72.7
	Same	3	2.0	2.0	74.7
	Tukey	2	1.3	1.3	76.0
	Turkey	22	14.7	14.7	90.7
	Türkiye	12	8.0	8.0	98.7
	WALES	2	1.3	1.3	100.0
	Total	150	100.0	100.0	

Company size					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Micro (1–9 employees)	9	6.0	6.0	6.0
	Small (10–49 employees)	18	12.0	12.0	18.0
	Medium (50–249 employees)	58	38.7	38.7	56.7
	Large (250+ employees)	65	43.3	43.3	100.0
	Total	150	100.0	100.0	


1.What is your age range ?
Frequency
120
100
80
60
40
20
0
18-24
25-34
35-44
55-64


2. What is your highest level of education ?
Frequency
60
40
20
0
Bachelor's degree
High school
Master's degree
Mechanical techni
PhD or higher
Postgraduate Dipl


Frequency
80
60
40
20
0
Canada
Cyprus
Dublin
EIRE
England
ireland
Ireland
Istanbu
Istanbul
izmir
Malta
Mersin
Moscow
Same
Tukey
Turkey
Turkiye
WALES



Descriptive statistics

Descriptive Statistics					
	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
AGT	150	-.651	.198	-1.063	.394
LDI	150	-.796	.198	-.575	.394
DAS	150	-1.275	.198	.132	.394
DSCM	150	-.832	.198	-.313	.394
SPE	150	-.473	.198	-.305	.394
Valid N (listwise)	150				

Reliability

Reliability Statistics	
Cronbach's Alpha	N of Items
.917	4

Reliability Statistics	
Cronbach's Alpha	N of Items
.880	4

Reliability Statistics	
Cronbach's Alpha	N of Items
.851	4

Reliability Statistics	
Cronbach's Alpha	N of Items
.804	4

Reliability Statistics	
Cronbach's Alpha	N of Items
.718	4

Normality

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic
AGT	150	5.00	19.00	13.7333	4.81562
LDI	150	5.00	18.00	13.0733	4.32427
DAS	150	6.00	18.00	14.0733	3.99008
DSCM	150	7.00	18.00	14.2000	3.48149
SPE	150	10.00	20.00	15.5800	2.59910
Valid N (listwise)	150				

Correlation

Correlations						
		SPE	AGT	LDI	DAS	DSCM
SPE	Pearson Correlation	1	.378**	.710**	.646**	.682**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	150	150	150	150	150
AGT	Pearson Correlation	.378**	1	.818**	.768**	.662**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	150	150	150	150	150
LDI	Pearson Correlation	.710**	.818**	1	.837**	.728**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	150	150	150	150	150
DAS	Pearson Correlation	.646**	.768**	.837**	1	.840**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	150	150	150	150	150
DSCM	Pearson Correlation	.682**	.662**	.728**	.840**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	150	150	150	150	150
**. Correlation is significant at the 0.01 level (2-tailed).						

Regression

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.850[a]	.722	.714	1.38961
a. Predictors: (Constant), DSCM, AGT, LDI, DAS				
b. Dependent Variable: SPE				

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	726.543	4	181.636	94.062	.000[b]
	Residual	279.997	145	1.931		
	Total	1006.540	149			
a. Dependent Variable: SPE						
b. Predictors: (Constant), DSCM, AGT, LDI, DAS						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.490	.479		17.728	.000
	AGT	-.384	.043	-.712	-9.005	.000
	LDI	.567	.056	.944	10.179	.000
	DAS	.026	.068	.040	.390	.697
	DSCM	.323	.060	.432	5.339	.000
a. Dependent Variable: SPE						

Appendix C

This survey is **solely** prepared for research purposes, and your responses will be **anonymous completely.** This survey was created to examine the public perception on sustainable enterprises and their usage of digital innovation and effect on urban development. By answering these questions, you confirm that you are **over the age of 18.** Your participation is voluntary completely and you can exit anytime you desire, without any consequences. If any questions arise while answering the survey, please feel free to contact the researcher. The information collected will be completely confidential and will not be shared with a third party. The answers will be stored in a secure and password protected computer, and the information gathered will be

solely used for the purpose of this research, which is just to get data for the dissertation. There are no ethical or physical risks arising from answering these survey questions.