

## Article

# Towards Sustainable Digital Innovation of SMEs from the Developing Countries in the Context of the Digital Economy and Frugal Environment

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**Abstract:** This study aims to explore the direct impact of the digital orientation, Internet of Things (IoT) and digital platforms on the sustainable digital innovation in the context of the digital economy and frugal environment. This study also investigated the mediating role of the digital platforms in these relations. The study was based on the quantitative research design and data were collected from the 397 CEOs and managing directors of Small and Medium Enterprises in Pakistan. Correlation and structural equation modeling approaches were applied for the analysis and testing of the hypotheses. Results revealed that the digital orientation, IoT and digital platform are major antecedents of the sustainable digital innovation. Results also show that the digital platforms mediate between both digital orientation-sustainable digital innovation link and IoT-sustainable digital innovation link. The rapid pace of change in the technology has forced the business organizations to think out of box and align their operational mechanism accordingly. The need for the sustainable digital innovation is a major need of the current decade for meeting the increasing demands of the society in a sustainable way. Organizations, especially SMEs, should be able to deal with these challenges and rapid technological transformations through cost effective frugal business models. The frugal innovation is an important element of sustainable digital innovation enables SMEs to reduce resources usage and waste and to enhance sustainable economic activities. In this way, they can develop and gain advantages in this highly competitive digital environment. This is the first study showing the bright harmony of the digital orientation, IoT and digital platforms for achieving the sustainable digital innovation in the rapid evolving digital economy.

**Keywords:** sustainable digital innovation; digital economy; digital orientation; Internet of Things (IoT); digital platform; SMEs; developing economies

## 1. Introduction

The emergence of digital innovation and technologies are able to drive social and economic development [1]. Digital innovation has shifted the traditional business economy into the digitalized one [2] and digital transformation of the economy is highly based upon big data and the advanced technologies [3]. Digital innovation is not a specific feature of the software organizations anymore and even the first most valuable business organizations in the world belong to the digital sectors [4].

Due to the complexity and technological dynamism, it is challenging to achieve the digital innovation in the digital economy [5]. All types of businesses and more specifically the Small and Medium Enterprises (SMEs) face these challenges. This technological progress can maximize the opportunities for SMEs [6]. The changes induced by the digital technologies in the organizations' business model represent a real challenge for all organizations in general and for SMEs more specifically [7]. If the digital transformations represent an opportunity or a challenge for SMEs, they depend on how these SMEs will strategically tackle it [8]. SMEs operating in the digital economy critically need the digital innovation for facing important challenges and for improving their technical expertise [9]. SMEs represent key participants on the market [10], especially during the structural change periods in the digital economy [11], thus it is important to analyze how they can manage in the digital economy in a sustainable way.

Digital innovation is referring to a product, process or business model that is new or requires significant changes and it is enabled by IT [12]. Sustainable digital innovation supports the digitalization process of the economy in a green, long-lasting and organic way. Thus, it serves the need of a sustainable future. The regular digital innovation addresses performances, costs, technology and attractiveness to customers and business, while the sustainable one also addresses to the environmental and social factors. Sustainable digital innovation tries to create value for all the stakeholders involved in the production and distribution process, it is inspired by nature, not only by technology, it reduces resources waste and targets the societal goals, not only the commercial and business goals.

Digitalization determines a significant shift in the business framework and it is a result of the 4th Industrial Revolution. The industrial revolution is a natural process due to technological achievements that took place in social and economic systems [13]. The 4th Industrial Revolution is characterized by the industrial implementation of inventions such as the Internet of Things, artificial intelligence, advanced robots, autonomous vehicles, cloud computing, big data, augmented/simulated reality, 3D printing, blockchain, etc. [14]. Its main innovations will reshape the economy structure towards service sectors, while the goods that can mainly benefit from the 4th Industrial Revolution will be those whose costs have so far been high in transport, logistics, information, regulation, and transaction [15].

Previous researchers highlighted various factors which predict digital innovation like: transformation and institutional perspective [16], digital innovation strategy [17], division of innovative labor and digital control [18], strategic transformation [19], digital workplace [20], big data [21], information technology [22], agility [23], organizational culture [24], innovation standards [25], organizational readiness [26] and organizational learning [27]. Still, they have overlooked some important and influential antecedents of sustainable digital innovation analyzed together, like, digital platform, digital orientation and Internet of Things (IoT), so far [28,29]. Hence, a comprehensive research study is required to fill this research gap. The current study overcomes this research gap and proves that SMEs can achieve the sustainable digital innovation through the nexus of the digital orientation, IoT and digital platforms. The current study explores how SMEs can reach the sustainable digital innovation in the digital economy, in the frugal framework specific to the developing markets.

The digital innovation is a powerful combination of the digital technology and digital management expertise for innovating the business processes and for reaching some creative solutions [30,31]. In the digital economy, SMEs mostly perform their operational mechanisms through adapting new technology, new software or digital platforms which support their transformation from analog-to-digital processes [32]. At the same time, digital orientation and IoT help to boost the process of the sustainable digital innovation in the digital economy prospect, in the frugal framework specific to the developing markets. Digital innovation differs among the used digital platforms according to their specific features, architecture and management practices; thus, the organizations can customize the digital platforms according to their specific needs and participate in creating the digital innovation [4]. Digital technology (such as IoT, social and cloud computing, big data

analytics) empowers the digital platforms and digital innovation [33]. The organizations can manage a major rapid sustainable digital innovation by adequately adapting and using of the digital technologies and digital platforms and by accumulating dynamic digital capabilities and embracing an overall digital orientation.

The digital orientation refers to the premeditated strategic placement of an enterprise to get the benefits of the bright opportunities smoked by the digital technologies [34]. The previous researchers have explored the multiple aspects of the digital orientation including its role in SME performance [8], intangible value drivers [35] and structuring and compensating top management teams [34]. The exact way an organization can benefit from a digital-oriented strategy is still very scarcely presented in the existing literature. So far, no comprehensive research has been carried out in order to explore the association of the digital orientation with the sustainable digital innovation [36]. Digital orientation allows organizations to rapidly adapt to customer demands [37] and to elaborate innovative products and services [38]. This represents a great advantage when customer needs rapidly develop [39], just like in the digital innovation case [40]. The digital orientation grants incentives for SMEs to adopt digital technologies, to overcome their rigid boundaries, to achieve digital innovation and to reach companies development and growth [8]. However, these effects differ among different types and sizes of SMEs, economic sectors and among countries. All the existing empirical studies have focused so far on case-studies.

The current study also highlights IoT as a major source of the sustainable digital innovation. IoT refers to the advancement of the technology in order to communicate and get connected constantly all around the world using internet and devices [41]. The major aim of IoT is to simplify processes in all domains, to increase the efficiency of systems and processes in order to achieve mainly the sustainability goals without negatively affecting the commercial viability and goals of the organisations and finally to improve life quality for all. IoT technologies are the basis of the 4th Industrial Revolution due to their relevance for the sustainable digital innovations and for the benefits gained by the population [42]. Internet of Things and digital platforms display a significant impact on the organizations' efficiency, costs and productivity. The use of the new technologies better meets the customers' demand, supports a better understanding of the customers' behavior, adjusts the existing products and services, innovates new ones, even at lower more affordable prices and, overall, supports the sustainable digital innovation.

Digital technologies impact all the social life areas, but they mainly determine the transformation of entrepreneurial and business models in different industries. The development of the digital platforms has significantly influenced the digital innovation in many sectors, such as health care (Patients Like Me), financial industry (PayPal), transportation (Uber), hospitality (Airbnb, TripAdvisor), education (Google Classroom) and software (Apple iOS, Google Android). Users' access to the Internet and to different products and services through digital platforms constitute the foundation and existence of these services and have transformed the classical business models into the new era of digitization [43].

Organizations that have used the digital platforms have achieved important growth in digital innovation. Thus, the digital platforms became a significant business model and a source for major economic growth for many domains [44]. Many recent studies, such as [45], have analyzed how digital platforms have reshaped business and organizational models and transformed the whole economy frame. One of the major outcomes of the digital technology (digital orientation and IoT) is represented by the digital platforms which play a pivotal role in reshaping the way that SMEs can gain a competitive advantage.

Some studies have been conducted regarding the digital platforms in relation with the ecosystem [46], the dynamic and integrative capabilities [47], the performance [32], the adoption of platform strategies [48], the impact of digital platforms on health and society [49] and the online transactions [50]. The information about the role of the digital platforms for achieving the sustainable digital innovation is very limited [51]. The direct role of the digital platforms has also been studied by several researchers [46], but the mediating role has not been analyzed so far. The digital platforms support cutting the

transaction costs [52], the technological development of new products and services by adequate governance structures [53] and offer new solutions for the business issues [54]. The role of the digital platforms in the sustainable digital innovations turned from classical products and services innovation to the innovation of the entire business models.

However, this research has studied the mediating role of the digital platforms. This study assumes that the digital platforms act as a driver of the digital orientation and IoT to reach the sustainable digital innovation in the digital economy in the frugal framework of the developing countries. There is a dire need among the SMEs to adapt further their investments in the digital innovation because the SMEs are in a continuous struggle to survive in a highly competitive market through the sustainable digital innovation [55]. To respond to this competitive pressure, the SMEs adopt the digital technologies and IoT for implementing their business strategy [56]. New software, devices and network standards have enabled the emergence of some new features.

This research aims to investigate both the direct and mediated impact of the digital orientation and IoT on the sustainable digital innovation in case of the developing markets. This research has also shown that the digital orientation and IoT significantly affect the digital platform. This study developed a sustainable digital innovation model through digital orientation, IoT and digital platforms. The mediating role of the digital platform has also been explored in this research. This study has tested the digital platforms as a mediator in both links between digital orientation-sustainable digital innovation and IoT-sustainable digital innovation.

SMEs display different features against large companies and this can also be seen in their digital transformation process. Thus, a deeper insight for analyzing the digital transformation and digital innovation of SMEs is necessary [57]. Some previous researchers have demonstrated the role of adopting digital technologies in triggering the chances in the business process of SMEs that play a crucial role in value creation of the countries or in achieving digital innovation for SMEs [58], but few studies have analyzed how digital transformation can re-design the whole business model of an organization [59]. Adopting and implementing digital transformation also demands specific resources, structures and skills that SMEs do not always possess and there is scarce knowledge on that issue. A more in-depth analysis is needed for finding an adequate resource configuration and business model that SMEs need for gaining advantages as a result of their technological development and what capabilities do SMEs need to develop for achieving sustainable digital innovation [60]. There is a deep need to understand how SMEs perform in a strategic way [61], because it has been observed that especially SMEs from developing countries pay less attention toward their strategic goals [62].

Many small firms develop products and services to fulfill the needs of the low-income customers from the developing countries, thereby contributing to sustainability [63]. Developing economies are considered adequate for low-cost innovation, it is called frugal innovation [64]. Frugal innovation is considered a catalyst for the sustainable innovation and for achieving the sustainable development in the developing economies [65,66]. Designing sustainable products and services for the low-income consumers in the developing countries is a major challenge for businesses [67]. Frugal innovation overcomes the resource constraints in the developing markets and supports the implementation of new business models for finding affordable solutions [68]. Frugal innovation is a new paradigm aiming to produce cheaper goods, through local cheaper inputs. As it saves materials and energy in the producing process, it contributes to a better use of the resources. Frugal innovation displays the ability to recycle the used components. It represents the engine of the technological change therefore it also supports the transition towards a greener economy and, in this sense, it is considered a big step towards achieving sustainability [69]. New technologies support frugal innovation because they allow cost cut, multiple use and recycle of these digital resources. Basu et al. [70] consider frugal innovation to be a significant way to create sustainable innovation and solutions for businesses.

The importance of building such a model for organizations in order to reach digital innovation is important in the sustainability frame. The current pandemic has demonstrated the role of digitalization and digital transformation and accelerated the digital transformation across all sectors. Without the digital transformation of the businesses, the economic and environmental challenges of the future cannot be addressed in a sustainable way [71]. Digital innovation has proven its major role for achieving long-term economic growth, reducing unemployment, improving life quality, granting a broader access to the public services and reducing the cost in many sectors of the economy [60]. Some recent papers have demonstrated the perspective of sustainability when the digital transformation takes place in the organization frame [72] and some authors have demonstrated the moderating role of digital transformation between digital readiness, digital technology, digital business models and a sustainable digital innovation [71]. An analysis of the World Economic Forum showed that 84% of existing IoT can address and support the achievements of the UN's Sustainable Development Goals (SDGs). Digitalization creates new opportunities to achieve Sustainable Development Goals. It is estimated that industrial IoT will provide major economic value to the world economy until 2030 and this can rise even more if consumer and public sector IoT (smart-city-related projects) are considered [72].

Sustainable businesses are those who aim both self-interests but also collective ones, targeting social, economic and ecological goals [73]. The convergence of the sustainability goals and use of the digital technologies became important both in the private and public sectors lately [74], but there is a research gap in the academic area on this specific topic.

Digital sustainability can be defined as the organizational activities that aim to address to the sustainable development goals through a creative use of the digital technologies [67]. For tackling sustainability goals, the organizations should aim digital innovation in a more complex way, namely by developing the whole business models focused on this specific purpose. The organizations can play a major role in how the global industrial system will manage the SDGs grand challenges [75].

Therefore, being and acting "digital" is a major condition for achieving the UN's SDGs [76]. By implementing new digital business models, the supply chains are enabled to cut the unnecessary consumptions, as well as to digitally transform the business model for reaching a sustainable value creation and for strengthening the relation with their customers. Businesses can develop without negatively impacting on environment [75,77].

This study was based on the quantitative research methods and standardized pre-tested questionnaires were used for data collection. Correlation and structural equation modeling (SEM) approaches were utilized for the analysis and testing of the hypotheses. Indirect effect for mediation analysis was conducted through Process, Sobel test. The objectives of study were achieved by conducting the analysis on the basis of live experience of 397 CEOs and MDs.

This paper has been arranged in the following structure: Section 2 is comprised of the theoretical background on the sustainable digital innovation, digital platform, digital orientation and IoT. Section 3 presents the research methodology. Next, results are presented, and the main finding, managerial implications, theoretical implications and future research suggestions have been discussed.

## 2. Literature Review

### 2.1. Digital Orientation and Sustainable Digital Innovation

The digital orientation is the adoption of the digital practices by utilizing advanced technologies like mobile applications, digitized processes, social networks and so on [8]. The digital orientation refers to an organization's strategic orientation towards using the advanced technologies and implementing the digitized processes in running its business in order to increase its value creation. This strategic orientation plays a supportive role for innovation considering the proper use of proactive innovation, market insight and candidness to new-fangled ideas [35]. For increasing the value business creation, the organizational strategy of the companies matters as much as the used technology. Thus,

a more in-depth analysis is necessary to see how the business models can be re-designed to respond successfully to the digital transformation for achieving sustainable digital innovation. This way, the created value can increase, the organization's performance can rise and the company can gain competitive advantages. This can be beneficial for the whole economy, as some previous studies have demonstrated so far [78]. Adopting digital technologies and practices by the companies can support their performance in a sustainable way and can respond to some fundamental questions about how the companies contribute to society well-being and what tools they need for responding to the demands of the society [78,79]. A digital-oriented business can avail of the value creation and persuade business to be an effective part of the digital economy [79]. The digital orientation suits business in this changing environment and ensures that businesses can only survive by adopting the latest and most innovative methods [34]. To differentiate the business from the competitors in order to benefit of the competitive advantage, the businesses are focused on managing the digital innovation by using the digital orientation [80]. The analysis of the role of the digital capabilities and internal resources through the digital orientation can provide an in-depth understanding of the digital innovation potential [81]. If the firms are capable of using the digital activities in their processes, they can potentially achieve the digital innovation according to the new technological ways [82].

Organizations need to adapt to the digital technologies and digital platforms, eventually adapting the products, work environments and the entire business context. This could be supported by designing new digital business models. The organizations displaying a high orientation towards optimization, customer interaction and utilization of the digital technologies are more susceptible to achieve a sustainable digital innovation and digital transformation [71]. Sustainable digital innovation is not only a result of the link between digital technologies and digital platforms, but is also influenced by the firms' digital orientation to speed-up the digital innovation. Thus, digital orientation is an enabler for achieving sustainable digital innovation. Activities have to be fitted to every individual business model so that the digitalization can be sustainable [83].

The existing studies empirically validated three major approaches of the innovation: the Schumpeterian view, the Marshallian view and the technology pull view. According to the Schumpeterian view, the entrepreneurs cause the disturbance of the market equilibrium on a continuous basis and contribute to innovation. According to the Marshallian view, the innovation system is the original notion of the industrial districts, while the technology push view states that the innovation adoption of the firm can be determined by the capability of the firm to adopt the new and innovative technology. The digital technology is the most contemporary form of technology that can push the SMEs to adopt innovation by the digital inputs [84]. The SMEs need to adopt the digital orientation for speeding up the process of the sustainable digital innovation and this requires a huge investment [85]. The digitally-oriented firms are willing to bear the cost and risks for achieving the targets of the sustainable digital innovation and support the transformation of the traditional innovation process into the digital innovation [86]. Hence, the digital orientation is a major antecedent of the sustainable digital innovation. The technology acceptance model reflects that adopting attitude affects the innovation adoption decision [87]. If the organization has the capability to adopt the innovation through different means, it can achieve a high-level productivity from this [6]. From this model, it can be summarized that if the firm can adopt the digital technology, it can make its digital innovation productive [82]. Based on the above argument, it is justified to establish a positive link between the digital orientation and the sustainable digital innovation. Therefore, it leads to the following hypothesis:

**Hypothesis 1 (H1).** *The digital orientation has a positive relationship with the sustainable digital innovation.*

## 2.2. Internet of Things and Sustainable Digital Innovation

Information and operational technology play a significant role in changing the society, the economy, and industries worldwide. It plays four major roles in entrepreneurial operations: as a facilitator, as a mediator and as an outcome; it redesigns and becomes the business model itself. Business models consider the technological change as an opportunity from the business value side. Entrepreneurs search for business model that determine value creation and incorporating the new technologies for achieving sustainable innovation into their businesses. The Internet of Things, big data analytics and artificial intelligence, leads to the adoption of new technologies into the business model in a sustainable way, because the scarcity of the available resources [88].

Some well-known examples of high impact businesses (Facebook, Amazon, Google) have encouraged entrepreneurs to consider that Internet supported business ideas [89].

The advancement of the technology has provided an opportunity to communicate and get connected constantly all around the world with the use of the internet and devices connected to it [90]. These developments in the field of the technology and communication are the Internet of Things (IoT). Every device that is connected to the internet can be an example of the technological wonder and can assist the businesses in the digital economy [91]. The development and advancement of the internet have extended the scope of IT drastically and leads towards the digital innovation. Internet of Things (IoT) bring together so many devices and the results consist of “smart” houses or cities, transportation systems, electricity networks, that will develop economic activities by cutting down the transaction costs [92] and will increase wellbeing of the population. In this way, digital technologies significantly enable the sustainable digital innovation, their effects and results depending on the aim and framework [30].

IoT is involved in every task and activity of the business and influences the operational mechanism. The digital innovation rises through the constant communication and information sharing across borders and among organizations through network connectivity provided by IoT [93]. The information sharing offered by IoT generates the new ideas of doing business gathered from all over the world [94]. The business models that are successfully adapted in some other country can be utilized by gathering knowledge through IoT [90]. A large number of businesses are conducting new ways of reaching their customers or for marketing purposes by using the digital media [95]. These innovative methods of performance of business activities are possible through IoT [82]. The information availability on the internet can support the businesses to implement some new and innovative solutions to the old problems [96]. The Internet-related information and devices allow businesses to develop a new strategy in the old business context leading to the digital innovation [97]. New software and platforms that are the outcomes of IoT are available to the businesses to innovate the old processes [98].

These implications of IoT have been overlooked by previous researchers and there is hardly any evidence about the IoT-digital innovation link so far [99]. Both digital orientation and IoT can determine sustainable digital innovation but this stance is meager at best and hence we have linked these factors: digital orientation and IoT with sustainable digital innovation through digital platform.

Hence, we argue that IoT is a very important factor to enhance the sustainable digital innovation in the digital economy. The socio-economic growth and development of the digital economy are based on the advancement and growth of the IoT-based digital innovation [82]. Therefore, based on this, it is justified to establish that IoT positively affects the sustainable digital innovation in all sizes of business, generally, and in SMEs, specifically. Therefore, the following hypothesis is derived:

**Hypothesis 2 (H2).** *Internet of Things has a positive impact on the sustainable digital innovation.*

### 2.3. Digital Orientation and Digital Platform

The digital platforms include online businesses that regulate the commercial communication between two different parties for mutual benefits [32]. The digital platforms have become very important in the digital economy for the success of the businesses [100]. However, the literature has mostly discussed the outcomes of the digital platforms that are derived from the business. Less attention is given to the capabilities and resources upon which the success or failure of the digital platforms depends on. This study highlights that the digital platforms are initiated through the digital orientation. The firm's culture plays a very significant role in the adoption of the digital platforms. If the firm has the digital orientation, then it will support the transformation of its traditional business activities into the digitalized ones [101]. Adopting the digital orientation for business processes can take place at a large scale if the managerial decision supports it. The digital orientation helps to show that more assets are required to be invested in the development and advancement of the increasingly digital platforms to get benefits from it up to its full potential [102]. The readiness of the management to invest in purchasing and implementing the digital technology in the business organization allows the business to benefit of the online digital platforms for the businesses [103]. The digital orientation shows that the firms should be ready to transform their traditional ways of business processes and methodologies into the digital platforms. As it has been discussed above, the firms that are digitally-oriented firms are more inclined toward the adaptation of the digital platforms. Therefore, based on it, the following hypothesis is developed:

**Hypothesis 3 (H3).** *Digital orientation has a positive relationship with digital platforms.*

### 2.4. Internet of Things and Digital Platform

IoT has extended the productivity and functions of connecting people and organizations through different platforms such as social network service, email, live conferences and other online information sharing and feedback to a large extent [41]. The amount of information sharing and production by the connected devices is also increasing rapidly with the growth of technology and an increase of the number of devices used in this context [102]. IoT has very wide dimensions that include environmental, social and economic impacts that contribute to the growth and sustainability of the digital economy [93]. IoT not only provides communication and connection among millions of devices across the world, but it also provides new opportunities, service paradigms, architectures and new capabilities as well. Online platforms for instance are the most frequently used outcomes of the IoT [99]. The effects of the IoT-based network also influence the digital platforms; as things are growing, they become more influential and valuable to the people. IoT strategy of the platform can be analyzed by the success of connection, data flow, information, knowledge, and attractiveness. The IoT provides an opportunity to develop network globally that connects the things, data and people and create a digital platform [85]. This development provides the capability to the smart devices that are connected through the internet to transmit and share the data and information. IoT enables the services that require connectivity and intelligence regarding analytics and information management on the online platforms [98]. IoT-based mobile devices, things and cloud use the technology for the data transmission boost the development of the digital platforms. Everyone can create and share the content and information using the services of cloud-based platforms and infrastructures that provide access to the global users [41].

The most significant application areas of IoT are related to the industrial organizations where most implemented projects are [104]. The IoT is responsible for the digital transformations of the organizations. IoT speeds up the process of the business involvement in the digital platforms through the internet devices and technological advancements, mobile applications and social network.

Users have to be taught how to operate on the digital platform to capture value. By shaping the online customer-centric market, the ability of users to achieve value from interactions increases. Therefore, the simplicity of the digital platforms is crucial [89].

Therefore, this study argues that the digital platforms majorly depend on IoT. The things connected with networks maintain the online identity and global connection, which are requirements of the digital platform. IoT-based developed digital platforms are a globally approachable network. These digital platforms are conjunctions of the consumers, users, and things, who contribute to develop businesses, create content and participate in the business transactions online. Based on the above discussion it is justified to establish the argument that the IoT has a direct influence on the digital platforms. Therefore, it leads to the following hypothesis:

**Hypothesis 4 (H4).** *Internet of Things is positively related to the digital platforms.*

### 2.5. Digital Platform and Sustainable Digital Innovation

In a changing and competitive environment, one of the crucial determinants is innovation. The ability to achieve the innovation targets and objectives of the organization with digital technology is referred to as digital innovation [47]. Digital technology platforms currently support the innovation of the most products, processes or services within and across the organizations; thus, the digital innovation can be noticed at a large number of firms [105].

The digital platforms offer an online platform to communicate with other organizations that may be business partners, competitors, suppliers or consumers [32]. The digital platforms provide the opportunity to the business to enhance its performance using digital platforms and technological advancements [106]. The interaction between the client and the supplier, or any other parties that are involved in the commercial or business activities by using an online platform is known as a digital platform [107] and their major role in the economy was best emphasized during the current pandemic. Digital platforms gather together the customers, partners and developers and create large markets with significant scale economies and efficiency. They enable cooperation between organizations from many domains that can generate innovation of new products and services. The innovation phenomenon stresses that the digital platforms support innovation and the digital transformation of the organizations.

Digital technologies have generated tools such as digital crowdfunding platforms, social media, 3D printers and digital imaging processors that reduce the barriers for inventions and enable innovation [108]. Increasing number of the entrepreneurial projects using digital crowdfunding platforms for financing reasons determines the development of these platforms [109].

Li et al. [110] presented the transformation of SMEs in a digital ecosystem. This paper described how SMEs have transformed from local to successful cross-border e-commerce players on the digital platforms. "This took place through dynamic managerial capability, organization capability, and strategic changes. The platforms motivate SMEs, providing training on the use of the platform, providing social networking and mutual learning among SMEs, building tools to overcome trading barriers, and motivating SMEs for a strategic transformation".

Facing the digital economy scenarios, the digital platforms are developing and advancing with the advancement in the technology, because this advancement allows the digital innovation. The digital innovation is rooted through the production of the new and latest technologies and majorly based on digital platforms [95]. The digital platforms allow people and firms to get connected through the digital technology and offer the newest digitalized innovation. The sharing of the new ideas and information has also increased and become easy through the digital platforms. This generates the availability of every kind of information and knowledge on the digital platforms [100]. The digital innovation is responsible for bringing the innovation and advancement through the digital platforms.

The digital innovation is based on the digital platforms as this helps to grant the opportunities of the innovation and new ideas for businesses that are now mostly based on by using the services of the digital platforms. The digital platforms provide the opportunities for businesses to get connected with their potential customers more effectively and efficiently in the newest ways. The digital platforms like Google search engine and other products and services of Google continuously derive digital innovation in order to create more opportunities and productivity for the businesses as well as for individuals [36]. The digital platforms have become the hub of the new business ideas and advertisements across the world [95]. The digital platforms develop technology, institutions and processes using 24/7 connections which turns to the digital innovation.

Achieving resource optimization for sustainable businesses can be reached using the digital technologies, that represent the pillar of the sustainable digital innovations in digital platforms and environments [111]. These digital innovations determine organizational digital transformation through digital technologies and new digital business models, which leads to sustainable implications for many business issues [112].

All the above-stated arguments about the digital platform in perspective of the sustainable digital innovation show that the digital platforms play a significant role in bringing sustainable digital innovation into the business. Therefore, the following hypothesis is derived:

**Hypothesis 5 (H5).** *Digital platform is positively related to the sustainable digital innovation.*

#### 2.6. Digital Platform as the Mediator between Digital Orientation and Sustainable Digital Innovation

The platform age is dominant in this era because of the development of powerful information and communication technologies that have decreased the cost and increased the reach of connecting platform sides, but the entrepreneurship research has ignored the role of the digital technologies in entrepreneurship [113].

This study argues that the digital platforms act as a mediator between the digital orientation and the sustainable digital innovation. Digital orientation leads towards the development of the digital platform for attaining the sustainable digital innovation. The previous studies have presented that the digital orientation predicts the digital platforms [32]. The digital platform provide opportunity to stay connected with top rated firms and can provide a competitive advantage for the businesses to develop the newest technology and creativity in the long run [55]. The digital platforms contribute as a driver for the digital orientation to achieve the sustainable digital innovation. The inclination of the digitally-oriented firms is toward the adoption of the digital technology for its processes (innovation); therefore, they do this through the online media and digital platforms. The willingness and desire of the firms to innovate their processes in a sustainable way can be fulfilled by the applications and information provided by the digital platforms. The digital orientation enables the firms to built-up their web-based business capabilities to go online and develop digital platforms for offering the latest products and services in a digitized innovative way [102].

Therefore, it is argued that the digital orientation initiates the process of the developing digital platform which in turn enhances the sustainable digital innovation.

**Hypothesis 6 (H6).** *Digital platform mediates the relationship between the digital orientation and the sustainable digital innovation.*

#### 2.7. Digital Platform as a Mediator between the Internet of Things and Sustainable Digital Innovation

IoT brings benefits for both businesses and individuals in the form of developing the connections with the latest technology and its applications with the continuous innovation [41]. Similarly, the creation of the digital platform majorly depends on IoT. This

research argues that the digital platforms mediate the IoT and sustainable digital innovation link. Different firms and organizations are taking advantage of IoT for achieving the digital platforms through the latest technology and advanced means of communication [32]. These digital platforms help to collect relevant data, information and knowledge to increase the efficiency of all functions of businesses for achieving the digital innovation [103]. The IoT has offered a wide variety of platforms that are present online to perform various functions of the business related to the digital innovation. These digital platforms are helping the businesses to gather the information for bringing the sustainable innovation. These platforms have also offered a wide range of innovative models for doing business in a sustainable way. By offering a wide range of business digital platform opportunities, IoT is deriving sustainable innovation into the business. By linking the IoT for bringing the sustainable digital innovation, the digital platforms may represent a strong connection bridge [99,100]. Therefore, based on it, the following hypothesis is derived:

**Hypothesis 7 (H7).** *Digital platform mediates between the Internet of Things and the sustainable digital innovation.*

### 2.8. Theoretical Framework

The theoretical underpinning of this study is linked with two major theories, i.e., (1) Theory of Innovation and (2) dynamic capability theory DCT.

Coenen and Lopez [114] reported that Theory of Innovation is based on three major elements, i.e., (1) Sectoral System, (2) Technological System and (3) Socio-Technical System. This study expanded the domain of these three dimensions with the respect of sustainable digital innovation. The Sectoral System highlights the directions sector-based synergies to improve innovation and performance, hence it is related to the sustainable digital innovation. Similarly, Technological System is advancement in technology using the latest knowledge and skills to enhance overall innovation. Finally, Socio-Technical System means radical innovations and transitional innovation based on technology and this innovation is in the best interest of society. The second basis of our theoretical framework is based on dynamic capability theory (DCT) that refers to firms' skills to be flexible and innovative for achieving sustainable performance [115]. It is timely adjustments in a firm's strategies and processes to adopt innovative methods in order to sustain its performance. Hence, sustainable digital innovation is the main concern for firms operating in the current dynamic world. Figure 1 show the theoretical framework of this study.

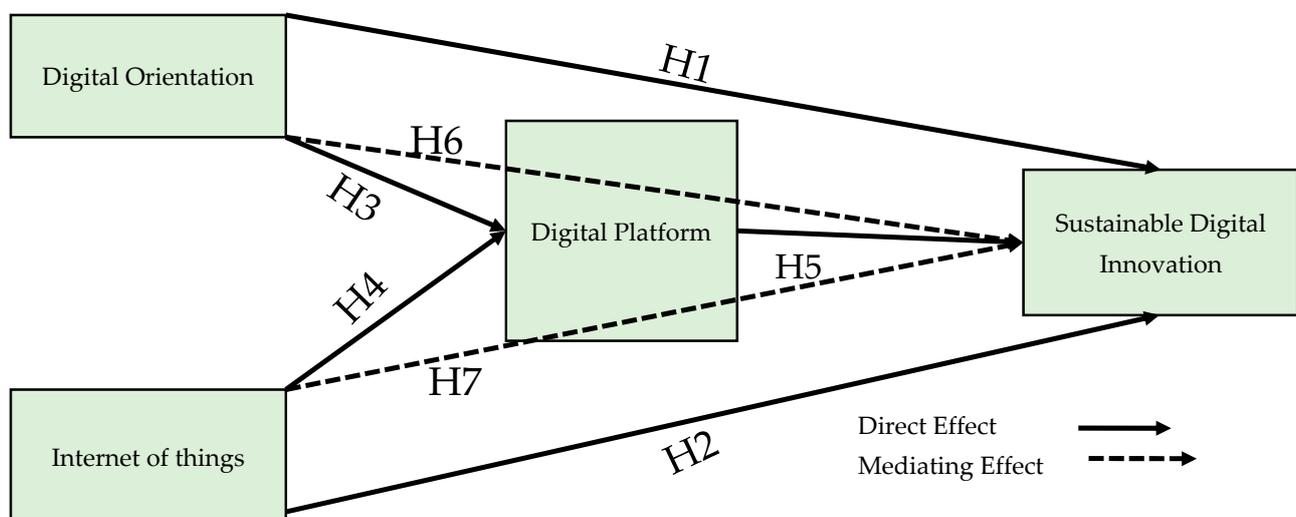


Figure 1. Theoretical framework.

### 3. Methodology

#### 3.1. Data Collection

A cross-sectional plan was used for the investigation of association among the constructs of the hypothesized model. To identify a representative sample, a list of SMEs was obtained from small and medium enterprises development authority (SMEDA) and small industrial development board of Khyber Pakhtunkhwa (SIDB-KP). Data were collected from CEOs and managing directors of SMEs in Pakistan using convenient sampling. Sampling refers to the method which allows the researcher to draw inference regarding a population on the basis of results obtained from a smaller portion of the population [116]. Majority of the empirical studies use both probability and non-probability for getting observation keeping in view the nature of population [117]. As the characteristics of population for the current study were unknown, therefore, a non-probability sampling method was used to select the sample from the requisite population. Resultantly, the data obtained from Pakistan will not restrict application of this study to the other developing economies [62].

The structure of the SMEs is different from large scale enterprises and demonstrates dissimilar features. SMEs play a critical role for the development of economies of both developed and developing countries [62]. SMEs in Pakistan also have a major role for improving the living standard of country citizens by contributing more than 70% in GDP. Almost 80% of the labor force in Pakistan is employed by SMEs which represent almost 90% of the total economic organizations in Pakistan [61]. Due to the transformation of economy from traditional to digitalization economy, there is a dire need to update the structure of the SMEs in order to respond the emerging economies [57]. Therefore, the current study selected IT-based SMEs and empirically related the digital orientation of these SMEs with sustainable digital innovation. The selection of SMEs related to IT was evaluated through their business websites, Internet-based Buying/Selling links, E-Commerce and other digital-based operating activities.

The SMEs were selected for the data collection purpose and the data have been collected from those SMEs which are located in KPK and Punjab province of Pakistan. Four different criteria were confirmed for the data collection. First, SMEs should have been involved in online businesses activities, so they can have the complete set of digital operation from last 6 years. Second, SMEs have their own websites. Third, SMEs should have more than 100 employees. Finally, SMEs must have an IT Department which deals with upgrading its digitalized mechanism.

Data were collected with the help of 4 professional research assistants. These research assistants could collect 397 usable responses. The questionnaire was comprised of 2 sections; Section 1 asked 3 questions; respondent age, education and experience. Section 2 asked questions about the digital orientation, Internet of Things, digital platforms and sustainable digital innovation. All scales were measured using a 5-point Likert-scale "SD = 1 to SA = 5". Likert scale is widely used in quantitative research because it is used as a universal mode for the collection of data and is easy to understand by the respondents. It is a form of ordered scale through which respondents can easily choose a given option that best aligns with their view and attitudes about a particular statement or question. However, we used the Likert scale in the current study as it is quantitative research design in nature.

#### 3.2. Measures

To be sure about the reliability and validity of scales used in this research, we used pre-tested constructs of previous research (see Table A1 in Appendix A).

##### 3.2.1. Digital Orientation

Digital orientation helps an organization to adopt digital practices and utilize latest technologies through proper orientation [8]. The use of digital technologies enables SMEs to attain the benefits of first mover in the operational industry. Digital orientation was measured through 4 items scales adapted from the work of Khin and Ho [82].

### 3.2.2. Internet of Things

IoT is the technological advancement which provides a world-wide platform for constant communication and connection all around the world using internet and devices connected to it [90]. IoT is one of the best tools to perform all business activities. IoT was measured through a 9 item scale adapted from the work of De Vass et al. [90]. Most of the IoT-related items used in the applied questionnaire are the best related with the sustainable digital innovation concept.

### 3.2.3. Digital Platform

Digital platforms refer to the online platforms that connect different organizations and help businesses to regulate the communication processes for mutual benefits [32]. Digital platform was measured through an 8 item scale adapted from the work of Cenamor et al. [32].

### 3.2.4. Sustainable Digital Innovation

Sustainable digital innovation helps to implement the newest digital technology for achieving creative solutions that will address the social, economic and environmental business issues in the long-run [82]. It is a dominant combination of the digitalized technologies and digitalized management system for innovating the business processes in a sustainable way [31] and it is also based on the frugal innovation concept. Digital innovation was measured through 8 items, i.e., 6 items were adapted from the work of Khin and Ho [82] and 2 items were newly developed. The items of the sustainable digital innovation were adapted, given the focus on cutting the SMEs' costs and reducing the waste, considering the scarcity of resources that are specific to the developing countries.

## 4. Analysis

We used descriptive, correlation and SEM to test the hypotheses. To analyze the mediating role of digital platform, we used a 'Process' developed by Preacher and Hayes [118]. For the purpose of the data analysis, the current study has used the descriptive statistics, correlation, multiple hierarchical regressions techniques and structural equation modeling. Moreover, the discriminant validity was examined by using AMOS 7.0 software with the help of the confirmatory factor analysis (CFA). The aim of current study was to find out the linear relationships between variables used in hypothesized model. In order to examine the linear relationships, we employed a covariance approach. A covariance-based approach measures how two random variables change at the same time. On the other hand, variance-based approaches tell us that how the data set is spread around its mean value, while the covariance-based approach is used to determine the directional relationship between study variables. Discriminate validity was checked through Fornell and Lacker's approach [119]. The reliability of the construct was checked by using the value of Cronbach's  $\alpha$ . CFA results show that our model is fitted to the data. Discriminate validity was checked through Fornell and Lacker's approach [119]. The reliability of the construct was checked by using the value of Cronbach's  $\alpha$ . CFA results show that our model is fitted to the data.

### 4.1. Measurement

CFA was utilized to test construct validity and model fitness. The reliability, discriminant validity and convergent validity were satisfactory (see Table 1). The reliability was confirmed and it ranges from 0.73 to 0.86, showing that the construct used in this research is reliable. The discriminant validity and constructs validity were confirmed through CFA and factor loading is greater than 0.70. We have also applied Fornell and Larcker's approach [119] to measure the average variance extracted (AVE) and results show value of AVE is above than 0.50, whereas Cronbach's  $\alpha$  value is greater than 0.70.

**Table 1.** Results of alpha, CR and AVE.

Variables Details	F-L	t-Value	Alpha	CR	AVE
Digital Orientation			0.89	0.85	0.74
DO1	0.75	15.41			
DO2	0.71	13.22			
DO3	0.73	14.56			
DO4	0.74	13.44			
Internet of Things			0.88	0.96	0.73
IoT1	0.78	15.44			
IoT2	0.79	13.32			
IoT3	0.75	14.55			
IoT4	0.77	13.44			
IoT5	0.71	14.56			
IoT6	0.74	13.54			
IoT7	0.73	15.74			
IoT8	0.74	14.32			
IoT9	0.77	15.64			
Digital Platform			0.87	0.94	0.75
DP1	0.73	13.96			
DP2	0.77	14.66			
DP3	0.79	13.32			
DP4	0.8	15.11			
DP5	0.75	14.21			
DP6	0.78	15.77			
DP7	0.72	13.74			
DP8	0.74	14.55			
Sustainable Digital Innovation			0.86	0.93	0.78
DI1	0.76	14.22			
DI2	0.78	15.32			
DI3	0.77	13.55			
DI4	0.80	14.74			
DI5	0.76	15.21			
DI6	0.80	15.22			
DI7	0.71	15.21			
DI8	0.74	15.22			

We have tested four different models to access the model fitness. The results are presented in Table 2. This shows that the results of our 4-factor model were fitted to the data (RMSEA = 0.06,  $\chi^2 = 1021.34$ ,  $df = 390$ ;  $\chi^2/df = 2.619$ ; CFI = 0.92; GFI = 0.91).

**Table 2.** CFA results.

Model Detail	$\chi^2$	Df	$\chi^2/df$	RMSEA	GFI	CFI
Hypothesized four-factor model	1021.34	390	2.619	0.06	0.91	0.92
Three-factor model	1174.65	360	3.263	0.15	0.88	0.89
Two-factor model	1244.58	310	4.015	0.22	0.71	0.72
Single-factor model	1236.21	290	4.263	0.26	0.64	0.65

#### 4.2. Correlation Results

Quantitative analysis is helpful for understanding the relationship among variables and the correlation shows level of association. In this study, the dependent variable is sustainable digital innovation (SDI) and major independent variables are IoT and digital orientation. To test the effect of independent variables on digital innovation, it is necessary to test correlation. Hence, this study conducted a correlation analysis which is presented in Table 3. Results proved that digital orientation is positively associated with the sustainable digital innovation ( $r = 0.16^{**}$ ,  $p < 0.0001$ ). Our findings extended the work of a previous

theory [35] who acknowledged that digital orientation determines intangible values. Our research hypothesized the IoT relates to SDI and results of correlation proved that IoT is positively associated with the sustainable digital innovation ( $r = 0.17^{**}$ ,  $p < 0.0001$ ). These findings are supported by the work of Xiaocong et al. [41] and Nižetić [38] who proved that IoT develops platforms and improves digital innovation. Similarly, the digital platform is positively associated with the sustainable digital innovation ( $r = 0.36^{**}$ ,  $p < 0.00001$ ). Digital platform builds eco-system [46] and digital platform is the key determinant of digital innovation [47]. To eliminate the risk of multi-collinearity, we used variance inflation factors (VIF). The value of VIF scores was less than 10.0, i.e., cut-off value. Hence, multicollinearity is not an issue in this analysis.

**Table 3.** Correlation and descriptive values.

Variable	Mean	SD	1	2	3	4	5	6	7	8
1 Age	3.5	0.75	1							
2 Size	2.6	0.69	0.105 **	1						
3 Respondent Education	2.8	0.59	−0.28	0.24	1					
4 Respondent Experience	2.9	0.56	0.66	0.33	−0.2	1				
5 Digital Orientation	3.6	0.71	0.59	−0.2	−0.3	1	1			
6 Internet of things	3.3	0.78	0.49	−0.6	−0.3	−0.2	0.834 **	1		
7 Digital Platform	3.4	0.73	−0.82	0.53	0.90 *	−0.1	0.255 **	0.348 **	1	
8 Sustainable Digital Innovation	3.7	0.75	−0.29	−0.3	−0.9	−0.7	0.164 **	0.175 **	0.364 **	1

Note: \*  $p < 0.5$ , \*\*  $p < 0.1$ .

#### 4.3. Hypothesis Testing

Structural equation modeling (SEM) was used for testing the hypotheses of this study. The results of the hypotheses show that all paths were significant and positively associated with each other (see Table 4). The digital orientation positively and significantly predicted the sustainable digital innovation ( $B = 0.27^{**}$ ,  $p < 0.0001$ ); thus, H1 is accepted. IoT is positively and significantly linked with the sustainable digital innovation ( $B = 0.17^{**}$ ,  $p < 0.000$ ); H2 is accepted. The digital orientation is positively and significantly connected with the digital platform ( $B = 0.39^{**}$ ,  $p < 0.0001$ ); thus, H3 is accepted. Internet of Things is positively and significantly linked with the digital platform ( $B = 0.34^{**}$ ,  $p < 0.0001$ ); so, H4 is accepted. The digital platform is positively and significantly linked with the sustainable digital innovation ( $B = 0.25^{**}$ ,  $p < 0.0001$ ). Thus, H5 is accepted.

**Table 4.** Hypothesis testing.

Hypothesis Detail	Effects	Coefficient	Remarks
(H1) DO→DI	+	0.27 **	Accepted
(H2) IoT→DI	+	0.17 **	Accepted
(H3) DO→DP	+	0.39 **	Accepted
(H4) IoT→DP	+	0.34 **	Accepted
(H5) DP→DI	+	0.25 **	Accepted

Note: \*\*  $p < 0.1$ .

#### 4.4. Mediating Role of the Digital Platform between the Digital Orientation and Sustainable Digital Innovation

Table 5 shows the mediating role of the digital platform between the digital orientation and sustainable digital innovation. To conduct mediation tests, we have followed the instructions of Preacher and Hayes's approach [118]. According to their approach, the mediating role is confirmed with significant value of the indirect effect. The results show that the digital platform acts as a mediator between the digital orientation and sustainable digital innovation. (Beta = 0.1471, lower value = 0.1894, upper value = 0.2222). We have

also used the Sobel test analysis “Z score” and the results proved that Z score = 5.74 \*\* value was significant. Hence, H6 was accepted.

**Table 5.** Results of indirect H6.

Model Detail	Data	Boot	Bias	SE	Lower	Upper
DO→DP→DI	0.1471	0.1463	−0.0008	0.329	0.1894	0.2222
Sobel Test Z Score = 5.74 **						

Note: \*\*  $p < 0.1$ .

#### 4.5. Mediating Role of the Digital Platform between IoT and the Sustainable Digital Innovation

Table 6 shows the mediating role of the digital platform between IoT and the sustainable digital innovation. The results show that the digital platform acts as a mediator between IoT and the sustainable digital innovation. (Beta = 0.1886, lower value = 0.1247, upper value = 0.2701). We have also used the Sobel test analysis “Z score” and results proved that the Z score = 6.85 \*\* value was significant. Hence, H7 was accepted.

**Table 6.** Results of indirect H7.

Model Detail	Data	Boot	Bias	SE	Lower	Upper
IOT→DP→DI	0.1886	0.1871	−0.0014	0.0357	0.1247	0.2701
Sobel Test Z Score = 6.85 **						

Note: \*\*  $p < 0.1$ .

## 5. Discussion of the Results

Digital technologies enable new businesses that incorporate new technology as a vital part of their business models and operations and this rapid development has significantly changed the competitive environment and redesigned traditional business strategies, models and processes [108,111].

This study was conducted to explore how SMEs can achieve the sustainable digital innovation in the digital economy. To achieve this purpose this study has investigated the direct impact of the digital orientation and IoT on the sustainable digital innovation and has also investigated the mediating role of the digital platform. H1 has proposed that the digital orientation predicts the sustainable digital innovation in SMEs. The results of H1 testing show there is a positive relationship between the digital orientation and the sustainable digital innovation. These findings have extended the research work of Linton and Solomon [85]. In the current digital-based economy, the digitalization has become the top priority of a large number of SMEs. The business transformation process into the digital form has made the digital orientation an evolving research stream that has the potential to efficiently meet innovation thrusts. The digital economy is based on the utilization of the information and communication technology in all the business activities. The SMEs that are operational in the digital economy are also involved in adopting the digital technology. This study uplifted the present understanding of the sustainable digital innovation by the digital orientation and ensured that digitalization efforts of many firms can lead to innovation. H2 of this study was also supported by the achieved results; thus, we can state that IoT determines the sustainable digital innovation. IoT in terms of Web technology including its hardware and software derives a large amount of information useful to develop the sustainable digital innovation into the business. Thus, the SMEs can attain new and innovative ideas. By testing the second hypothesis H2, it has been derived that the IoT has a positive influence on the sustainable digital innovation. This has extended the previous research work and findings of Kraus et al. [102]. These findings for H2 are supported by the work of Xiaocong et al. [41] and Nižetić [42] who proved that IoT develops platforms and improves digital innovation.

The effect of the digital orientation on the digital platform was also tested by H3. The results have disclosed that the digital orientation can play a pivotal role in the utilization of the digital platforms. This supports the results of the previous research of Kraus et al. [102] or Jones-Evans and Klofsten [103] that proved the positive relationship between the digital orientation and the business platforms. The digital orientation helps to invest more in the development of the digital platforms to get benefits from it up to its full potential. The readiness of the management to invest in digital technology in the business organization allows the business to benefit from the online digital platforms for the businesses.

The link between the IoT and digital platforms is also tested by H4 and the results have shown that the relationship is a positive one. This has extended the previous work of Kirchner and Schußler [97] who have demonstrated the link between the internet and the digital platforms. Internet-related information and related platforms allow businesses to develop a new strategy in the old business context leading to the digital innovation. The results of H5 have also confirmed the relationship between the digital platform and the sustainable digital innovation. This result is according to the findings of Nambisan et al. [30]. Digital platform builds an eco-system [46] and digital platform is a key determinant of digital innovation [47].

Nambisan [120] has shown that digital technologies, in conjunction with an important characteristic of the digital platforms, contribute to the evolving emergence and evolution of entrepreneurial opportunities and to digital innovation.

H6 has shown that the digital platform positively mediates the relationship between the digital orientation and the sustainable digital innovation. This has extended the previous research findings of Esposito De Falco et al. [28]. More precisely, being digitally-oriented, the SMEs can achieve the sustainable digital innovation, but when this relationship is mediated by the digital platforms, the achievement of the sustainable digital innovation is certain. Hence, the SMEs cannot automatically achieve the sustainable digital innovation advancement except creating the digital platforms. Nevertheless, insights into the impact of the digital orientation on the digital innovation through the digital platforms are scarce in the existing literature. This study contributes to fill this research gap by examining the mediating effect of the digital platform capability between the digital orientation and sustainable digital innovation.

Furthermore, this study has also examined the mediation effect of the digital platform in the relationship between IoT and the sustainable digital innovation (H7). Thus, the results support the present understanding of the role played by the digital platform in the relationship between IoT and the sustainable digital innovation. The findings are according to those of the previous studies [41,103]. These studies showed that IoT brings benefits for both businesses and individuals and determines a continuous innovation and digital platforms help to collect relevant data, information and knowledge to increase the efficiency of all functions of businesses for achieving the digital innovation. It was proved that those SMEs, which are involved in the digital platforms initiated through IoT, and its peripherals can achieve the sustainable digital innovation. The results of testing each hypothesis are presented in Figure 2.

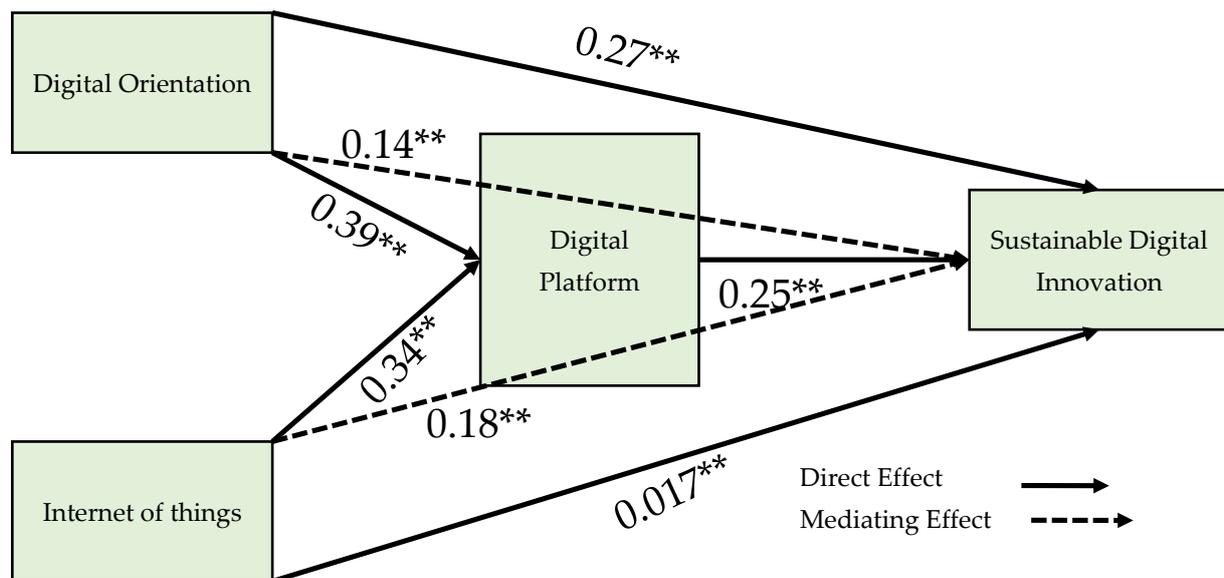


Figure 2. Results of hypotheses. Note: \*\*  $p < 0.1$ .

## 6. Conclusions

Frugal sustainable innovation addresses the ecological issues, due to the high quality of products and long-lifetime, to social issues, because it solves some social problems by transferring the technology and innovations to the developing markets, and to economic issues because it addresses lower income markets with a high potential. All these goals can be reached by reducing functionality of the products and services to what is really necessary, being of high quality, durable, eco-friendly and sustainable at the same time.

Albert [65] in his study stated that the interest for frugal innovation is quite recent and this topic requires further research. He analyzed a wide literature on frugal innovation and concluded that most of the studies found a positive relation between the frugal innovation and social or economic dimensions of sustainability and only a high potential of frugal innovation in addressing environmental issues of sustainability by spill-over effects [121] or by side-effects, when it is targeting social or economic issues [122]. The existing literature, however, focused mainly on one specific dimension of sustainability (out of three dimensions) in relation with frugal innovation. Only few studies aimed at all three pillars of sustainability, but these were not empirical analyses [121–123]. Hence, ecological sustainable frugal innovation is normative, a more appropriate empirical research relates to the impact of ecological sustainable frugal innovation, how to design more ecological sustainable frugal innovation processes and outcomes, and how the results are different in developed vs. developing countries. Tiwari et al. [124] demonstrated that frugality is motivated by choice in developed countries, comparing to the lack of resources in the developing countries, but it can represent a sustainable solution also for the poor people from the developed countries. However, in their study, they proved that the diffusion of the frugal innovation is larger in the developing markets that lack large resources.

Le Bas [125] has proved that diffusion of the frugal innovation can be more often met into the business models based on services, because they combine product innovation with service innovation. The services sectors may be intensively using information technology for saving energy and resources, for reducing the waste. Although, the frugal innovation does not address mainly the environmental aims, it exhibits three important environmental properties: the ability to repair, to reuse and recycle the used components. In brief, it is linked to sustainability [125]. Frugal innovation minimizes resource use and supports the environmental sustainability [126] and therefore this requires a more in-depth approach.

The digital technologies allow this type of innovation which can make a huge contribution for achieving the SDGs up to 2030. Thus, the resources waste can be reduced

and the products and services become more affordable and accessible. This can represent the best solution for the developing countries, but also the developed countries have their need for reducing the waste in relation with the environment. This study was conducted for a developing country, for the IT service sector, with the specific aim to analyze frugal digital innovation (its economic and environmental dimensions) in relation with some of its major determinant, digital orientation, digital technologies and digital platforms.

There is a gap in the existing studies on sustainable digital innovation that requires a further connected research to the digital technologies [30]. A major gap exists in defining the entrepreneurship in the digital age and in the digital economy frame [113].

Many countries consider digital entrepreneurship as a major determinant of the digital economic development. Thus, it is necessary to further research the digital entrepreneurship in relation to its major features and determinants [127].

This research has aimed to investigate both the direct and mediated impact of the digital orientation and IoT on the sustainable digital innovation in the developing countries. In this respect, seven hypotheses were built and tested. All of the hypotheses were validated by the applied statistical tests. This research has shown that the digital orientation and IoT significantly affect the digital platform. This study has developed a sustainable digital innovation model through digital orientation, IoT and digital platforms. It has also explored the relation between the digital platform and sustainable digital innovation and has tested the digital platforms as a mediator in both links between digital orientation-sustainable digital innovation and IoT-sustainable digital innovation and has proved that the digital platforms enhance the impact of the digital orientation and IoT on the sustainable digital innovation of SMEs in the context of their lack of large resources on the developing markets. These represent important findings for SMEs that are key participants on the markets [10], because they need to achieve the sustainable digital innovation for facing important challenges of the transforming digital economy and for improving their technical expertise in this frame [9].

### 6.1. Theoretical Implications

This research has several theoretical implications and provides an understanding of the sustainable digital innovation in the SMEs in different ways. Firstly, it shows that the digital orientation capability of the firm has a positive significant effect on the sustainable digital innovation. These findings have extended the existing knowledge in the current literature by expressing the interdependency of the SMEs on the digital technology that may induce enrichment in the digital innovation [128]. The major emphasis of this research is on the utilization of the digital platforms for achieving the sustainable digital innovation. Based on the recent research, which reflect the other advantages of the digital platforms, the findings of this study stress that the digital platform capability can significantly affect the sustainable digital innovation of SMEs. The results also suggest that successful SMEs can improve their digital innovativeness if the firm is digital-oriented via the digital platforms. Therefore, it is a major contribution in the existing literature of SMEs that these can achieve the latest form of innovation that is digitalized.

The findings of this research add to the theory by complementing the role of IoT on the sustainable digital innovation through the mediating role of the digital platforms [116,117]. This adds new findings to the existing literature because less work has been done so far on the digital platforms in relation to the improvement of the sustainable digital innovation for the SMEs. This study has suggested new ways for the adoption of the sustainable digital innovation in the case of SMEs, therefore it has extended the current knowledge related to the impact of the digital platforms in internet technology in the case of the emerging digital economies [41]. This research has also added new dimensions of knowledge in the technology acceptance model of the Rogers's theory [129]. It has linked the theories with the model of the sustainable digital innovation which is the new and latest concept. According to the Rogers's theory, the capability of innovation adoption affects the entrepreneurial decision [129]. SMEs have limited resources; therefore, the finding of this research can help

the entrepreneurs of SMEs to allocate the capabilities and resources more effectively by bringing improvement in the entrepreneurial SMEs' planning for cutting the costs and reducing the waste.

Moreover, given the important role of R&D in achieving sustainable innovations in the private sector, and in supporting the economic growth and development [130], a true partnership between public authorities and private organizations should be more and more implemented and should become very efficient in supporting R&D in the private area. Suci et al. [131] demonstrated in their study that a high-skilled labor force supports the digitalization of the economy, while R&D and innovation have a significant impact on economic growth and wellbeing.

### 6.2. Managerial Implications

This research has different practical implications. Due to the limitation of the resources and capabilities, the small and medium enterprises have a lack of data that is collected from stakeholders to achieve innovation. The management of the SMEs should adopt the digital platforms for the collection of big data as it is efficient to gather data through online platforms. The digital orientation and platforms-based approach present a model that enables the SMEs to gain benefits of the digital platforms. For instance, marketplaces, big data and crowd funding platforms offer some valuable opportunities to the management in terms of gaining new marketing ideas, new ways of accessing the markets and new value approach [132]. However, the achievement of the sustainable digital innovation is a complex approach, but this study provides insights to understand the multiple aspects of the digital platform and innovation. The results have also shown that the IoT has also a significant effect on the sustainable digital innovation, through digital platforms, because previous studies have showed that internet-based capabilities can affect the performance of the firm and the welfare of the entire society, as we mentioned in the previous sections of this study. In practice, the management should focus on achieving the sustainable digital innovation through implementing the digital platform-enhanced network capability initiated by the digital orientation and IoT. It is also suggested to the managers of entrepreneurial SMEs that they should get benefits of the digital economy by improving their digital innovativeness and by using the digital platforms and technologies. The results of the mediating effect of the digital platforms can help the managers of SMEs to focus on improving their digital platform capabilities [103]. By making this improvement, the firm can collect the digital innovative benefits. It can enable the small firms to achieve long-run sustainability and a high level of performance based on reducing the costs and the waste of resources. It is also suggested to the managers of the SMEs to enhance their capacities for the utilization of technology in their business.

### 6.3. Limitations and Directions for Future Research

This research also bears several limitations from the perspective of the model, findings and scope. This study focuses only on the sustainable digital innovation through the digital technologies. However, the digital platform capabilities and digital orientation can also affect the overall performance of the firms [133]. Therefore, a future research can be elaborated by considering the strategic business performance (other than digital innovation) through the digital technologies and platforms. Another interesting further research would be represented by the analysis between big data analytics capabilities or the governance of big data analytics infrastructure and the sustainable digital innovation achieved by SMEs because according to Bertello et al. there is a positive relation between those variables and the SMEs' expansion and growth [134]. An interesting further research can be elaborated based on a new methodological approach, by applying new criterion for testing the validity of the measurement scale [135], namely Heterotrait-Monotrait (HTMT) relationship instead of Fornell and Lacker criterion that was considered a lax one by some authors [136]. Another limitation of this research is that it has taken the sample of SMEs [137]. It has not considered a broader view of large businesses. In addition,

we have not discussed the case of any special sector. In the future, this research can be extended in any specific large sector. For instance, future research can also be done by checking the effect of the digital orientation, platforms and internet on the sustainable digital innovation in the case of the hospitality sector [138]. Finally, the context of this current research was Pakistan in which the market scenarios for SMEs are different from other countries where the digital economy is in the developed phase. In the future, this topic can be explored more for other countries that do not rely on frugal innovation, but a classical innovation, based on top technologies. Moreover, a cross country analysis can be elaborated for comparison. This way, the effectiveness of adopting the different sustainable digital innovation scenarios in different countries can be checked. Furthermore, nexus of a direct or mediated relationship between the digital orientation and sustainable digital innovation can also be empirically tested in the future, by adding some mediating variables like customer feedback in the framework of a future research. Another major direction for a further research would be to analyze the negative effects determined by the digital innovation. In addition to the technical, organizational, and economic benefits brought by the 4th Industrial Revolution, many researchers consider that it will also cause some negative effects such as rising unemployment, social stratification, threats to cyber security, violations of privacy and an increasing gap between the developed and poor countries [14]. This requires a further research to investigate also the negative effects in the social and economic area of using the digital technologies. We have also investigated here only the economic and environmental dimension of frugal digital innovation in the developing countries. It is necessary to extend the analysis by adding the social dimension of the frugal innovation in a further study.

Orientation is related with learning and the outcomes of learning always develop an understanding with existing stream of knowledge, i.e., develops a platform. Hence, this study used the digital orientation as independent and digital platform as mediator and sustainable digital innovation as dependent variables. Moreover, the targets of this study were to build a sustainable digital innovation model for SMEs which are operating in Hi Tech digital arena. Therefore, an explicit research study was required to investigate the impact of IoT and digital orientation on sustainable digital innovation directly and through a mediator digital platform. Moreover, World Economic Forum has demonstrated that IoT can support the SDGs achievement. It is estimated that industrial IoT will provide major economic value to the world economy until 2030 [72].

However, further research can analyze these multifaceted dimensions separately. There are a number of previous studies which considered the multifaceted dimensions into a single research framework. Yousaf and Majid [62] analyzed the independent variable based on four dimensions into a single construct and their dependent variable strategic business performance (SBP) was also a combination of different dimensions. However, as for future research, these variables could be studied more in-depth.

This study focused on IoT and digital orientation which are only some of the many digital enablers which can be considered to study digital/smart transformation or sustainable digital innovation. Hence, future research should consider AI or cognitive robotics, advanced analytics or virtual reality for finding a specific technology paradigm into a research framework.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

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## Appendix A

**Table A1.** Details of the applied questionnaire and the relation between its questions and the variables used in the analysis.

No.	Items	Source
Digital Orientation		
1	We are committed to use digital technologies in developing our new solutions (for managing our social, economic and ecological business issues)	(Khin and Ho, 2019)
2	Our solutions are supported by the digital technology	
3	New digital technology is readily accepted in our organization	
4	We always look out for opportunities to use digital technology in our innovation	
IoT		
1	Using IoT our firms can provide individual item level identification (thus it reduces paper work)	(De Vass et al., 2018)
2	Our firm provide unit level (e.g., container/box/pallet) identification with the help of IoT (instead of banners that damage environment)	
3	Our firm can auto-captures data to monitor, track and trace operational activities and people.	
4	We can measure business activities, processes and its environmental conditions	
5	Using IoT, we can control business processes remotely (thus better protecting the environment).	
6	IoT enables us to provide real-time information to optimize business activities (hence reducing paper work)	
7	IoT enables us to provide real-time intelligence of business operations (including managing environmental issues)	
8	We can provide large volumes and variety of data to apply data analytics for tactical and strategic decision making (including diminishing the resources waste and cutting down the costs).	
9	IoT helps us to strengthen communication and coordination between operators (improving the overall efficiency)	

Table A1. Cont.

No.	Items	Source
Digital Platforms		
1	Our platform easily accesses data from our partners' IT systems Our platform is easily adapted to include new partners	(Cenamor et al., 2019).
2	Our platform provides seamless connection between our partners' IT systems and our IT systems (e.g., forecasting, production, manufacturing, shipment etc.)	
3	Our platform has the capability to exchange real-time information with our partners	
4	Our platform easily aggregates relevant information from our partners' databases (e.g., operating information, business customer performance, cost information etc.) (thus it addresses to the social and economic goals of the firms and their partners)	
5	Our platform is easily adapted to include new partners	
6	Our platform can be easily extended to accommodate new IT applications or functions	
7	Our platform employs standards that are accepted by most current and potential partners	
8	Our platform consists of modular software components, most of which can be reused in other business application	
Sustainable Digital Innovation		
1	The quality-price ratio of our digital solutions is superior compared to our competitors'	(Khin and Ho, 2019)
2	The features of our digital solutions are superior compared to our competitors'	
3	The applications of our digital solutions are totally different from our competitors'	
4	Our digital solutions are different from our competitors' in terms of product platform	
5	Our new digital solutions are minor improvements of existing products, at lower costs	
6	Some of our digital solutions are new to the market at the time of launching (and they address to social, economic and ecological business issues)	
7	Our digital innovations/solutions are based on cutting the costs and reducing the waste when we launch products	Newly developed
8	Our digital innovations/solutions is cost saving and we aim to rely on the frugal innovation when entering in new markets	Newly developed

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