The impact of Industry 4.0 on organizational performance: the case of Pakistan's retail industry

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Abstract

Purpose – The purpose of this paper was to assess and determine the impact of the five core technologies of Industry 4.0 (3D Printing, Big Data Analytics, Cloud Computing, Internet of Things (IoT) and Robotics) on the organizational performance of the retail industry in the context of Pakistan.

Design/methodology/approach – Pakistan's retail industry was chosen as the target sector, and the target population was composed of senior-level employees, including managers from first-level positions to top-level positions, as well as subordinate employees working under the supervision of first-level managers, possessing the technological know-how of Industry 4.0. The data were collected through a matrix-based survey questionnaire that was based on a five-point Likert scale, ranging from "strongly agree" to "strongly disagree." The process of data analysis was conducted using IBM SPSS Statistics.

Findings – The findings obtained by this research work showed a significant relationship among the five core pillars of Industry 4.0 and the organizational performance of Pakistan's retail industry. Besides, the obtained findings provided preliminary evidence that Industry 4.0's disruptive technologies, particularly, 3D printing, big data analytics, cloud computing, IoT and robotics, could help Pakistan's retail industry solve various problems and challenges, such as meager revenues, increased expenses and unorganized systems.

Originality/value – The present study extended the theoretical body of knowledge through studying and examining Industry 4.0's five crucial factors that significantly contribute to the service sector, particularly, the retail industry, of the big emerging markets (BEM) economies, including Pakistan.

Keywords Industry 4.0, Organizational performance, Service sector, Retail industry, Big emerging markets (BEM)

Paper type Research paper

1. Introduction

Industrial revolutions have entirely changed handicraft and agriculture-based economies into economies based on factories, mechanized manufacturing and large-scale industries (Rogers *et al.*, 1978). As a result, the new power sources and machines and the innovative ways of managing work significantly enhanced the existing industries' productivity and efficiency (Evans *et al.*, 2007). The review of the literature suggests that there are four phases of the

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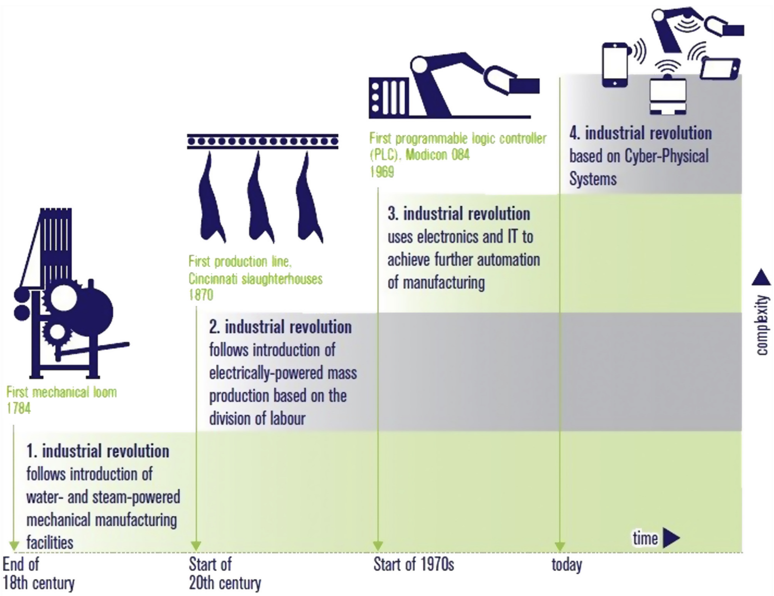
industrial revolution (Kagermann *et al.*, 2013). The first industrial revolution took place at the end of the 18th century, and was focused on mechanization, with both water and steam being used to power the factories. The second industrial revolution took place around the beginning of the 20th century and focused on mass production and electricity. Electronics, IT systems, and automation were the focus of the third industrial revolution, which refers to the period of the 1970s. The fourth and current industrial revolution (also known as Industry 4.0 – a term originally coined by the German government in 2011) took place at the beginning of the 21st and focuses on cyber-physical systems (CPS). Industry 4.0 is an umbrella term, which utilizes various pioneering technologies, ranging from cyber-physical systems (CPS) and big data analytics through to IoT, 3D printing, and cloud computing. Under the umbrella of Industry 4.0, these cutting-edge technologies result in the unique transformation of the value chain (Zhou *et al.*, 2015). Industry 4.0 refers to the evolution of automation, and the acquisition of data and technology, which, when combined, transforms multiple value chain activities, ranging from design to production and from marketing to distribution (Vaidya *et al.*, 2018). The advancement of technology was the primary focus of the first three industrial revolutions, whereas Industry 4.0 emphasizes how everyday lives are being impacted by the evolution and the advancement of technology. Figure 1 shows the four phases of the industrial revolution.

The last few years have seen an increased interest in Industry 4.0, due to its far-reaching influence (Lasi *et al.*, 2014; Lu, 2017). A number of studies have shown that the disruptive technologies of Industry 4.0 can blend breakthroughs in the industrial sector. Over the years, an enormous amount of research has been carried out to investigate the role of Industry 4.0 in the production sector, particularly the manufacturing industry (Frank *et al.*, 2019; Qi and Tao, 2018). However, the role of Industry 4.0 in the service sector, in particular the retail industry, is still poorly understood. Furthermore, no attempts have been made to explore the impact of Industry 4.0 on the organizational performance of the retail industry in developing countries, such as Pakistan, which has made an enormous contribution to Pakistan's total economic development.



Source(s): Kagermann *et al.*, 2013

Figure 1.
Four phases of the industrial revolution

Together with the wholesale industry, the retail industry consists of more than one-third of Pakistan's service sector, which itself accounts for over 53% of Pakistan's GDP (Imran, 2018).

Therefore, for the first time, this study took the unprecedented step to assess and determine the impact of the various disruptive technologies of Industry 4.0, such as 3D printing, big data analytics, cloud computing, the Internet of things (IoT) and robotics, on the organizational performance of Pakistan's retail industry, which is one of the world's fastest-growing retail markets.

This research work was carried-out in two ways. First, a thorough literature review was conducted on Industry 4.0, organizational performance and the retail industry of the BEM economies, such as Pakistan. This literature review served the purpose of: developing the problem statement, stating research questions, defining the variables relevant to the problem being investigated by this research work, proposing hypotheses for this research work, and developing a comprehensive research model for the study to be carried-out. For this purpose, a broad range of sources was examined, such as abstracting and indexing services, annual reviews, government documents, handbooks and encyclopedias, major public search engines, and review articles. Second, after completing the literature review, a quantitative approach was used to conduct the process of data analysis, which included the use of a matrix-based survey questionnaire to gather the participants' responses and verify the proposed hypotheses. IBM SPSS Statistics was used for this analysis. The participants of this research work included senior-level employees from Pakistan's retail industry, including first-level to top-level managers, as well as subordinate employees working under the supervision of first-level managers. Industry 4.0 was taken as the independent variable, and five core pillars of industry 4.0 were considered, which included 3D printing, big data analytics, cloud computing, IoT, and robotics. The organizational performance of the retail industry was taken as the dependent variable.

The findings obtained showed a significant relationship among the five core pillars of Industry 4.0 and the performance of Pakistan's retail industry's organizational, that is to say, the implementation of Industry 4.0 and its related cutting-edge technologies within the retail industry of Pakistan appear to help improve the overall organizational performance of the retail industry. The findings obtained by this study could be utilized by a wide range of audiences, such as business providers, Industry 4.0 experts, and academics and researchers related to the various fields of social sciences, to gain a comprehensive insight into the link between the five core Industry 4.0 technologies and the overall organizational performance of the retail industry. In addition, the study carried-out focused primarily on the managerial perspective of Industry 4.0, which could assist managers and policymakers from the service sector, in particular the retail industry, in making better and informed decisions, which would, in the long run, help not only improve the overall organizational performance, but also achieve a sustainable competitive advantage in the context of Industry 4.0.

1.1 Research questions

The research work carried-out intends to seek answers to the following research questions:

RQ1. Does Industry 4.0 have implications for the service sector, in particular the retail industry of Pakistan?

RQ2. To what extent does Industry 4.0 impact the organizational performance of the retail industry of Pakistan?

1.2 Research objectives

The objective of this research work is to assess and determine the impact of Industry 4.0 and its five core technologies, i.e. 3D printing, big data analytics, cloud computing, IoT and robotics, on the organizational performance of the retail industry in the context of Pakistan.

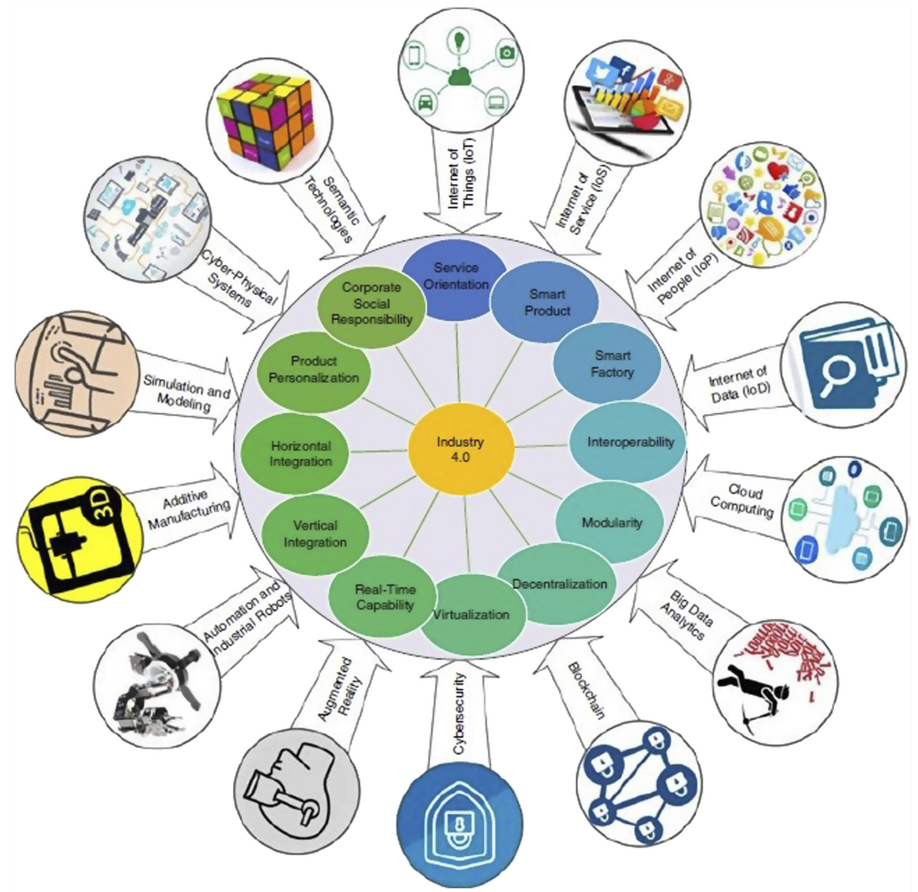
Industry 4.0's five innovative technologies of 3D printing, big data analytics, cloud computing, IoT and robotics are taken as independent variables, and the organizational performance of the retail industry is taken as the dependent variable.

2. Literature review

2.1 Industry 4.0

Industry 4.0 has significantly transformed the way businesses and organizations work in the 21st century (Iqbal *et al.*, 2020). It is an umbrella term, which utilizes various pioneering technologies, ranging from cyber-physical systems (CPS) and big data analytics through to IoT, 3D printing and cloud computing. Under the umbrella of Industry 4.0, these cutting-edge technologies result in the unique transformation of this value chain (Zhou *et al.*, 2015). Figure 2 shows several technology trends and design principles of Industry 4.0.

Numerous scholars have offered explanations for Industry 4.0 (Safar *et al.*, 2020). The study carried out by Xu *et al.* (2018) revealed that Industry 4.0 helps enhance the manufacturing efficiency and competency by adopting advanced information and communication technologies (ICT) in the manufacturing sector. There seems to be a general agreement in



Source(s): Ghobakhloo, 2018

Figure 2.
Technology trends and design principles of industry 4.0

the literature on Industry 4.0 that Industry 4.0 will improve customer experience, efficiency and productivity (Chen *et al.*, 2017; Imran, 2018). Furthermore, Industry 4.0 will provide better agility and flexibility and as a result, profitability will increase to a large extent.

Industry 4.0 enables both businesses and organizations to establish worldwide linkages that integrate their systems of warehousing, production facilities and CPS-based machinery (Singhal, 2020). As a result, several industrial processes involved in engineering, life cycle management, manufacturing, material usage and supply chain are significantly improved. Furthermore, with Industry 4.0, customers will be free to customize their products whenever required and this will help increase profits and reduce manufacturing waste. Furthermore, Industry 4.0 would allow engineering processes and businesses to make necessary changes at the eleventh hour and achieve end-to-end transparency over the whole manufacturing process – aiding in making optimized decisions (Hofmann and Rüsch, 2017). In addition, Industry 4.0 will help small businesses and startups develop and deliver downstream services. In sum, Industry 4.0 will eventually encourage novel ways of creating business models and values (Islam *et al.*, 2018).

Industry 4.0 also has vast potential to address pressing contemporary societal challenges, such as the efficient utilization of energy and other resources, population change, and urban production. With Industry 4.0, efficiency gains and nonstop productivity of the resources can be delivered across the complete value network. Additionally, working conditions will be uniquely transformed, resulting in more consideration of social factors and population change. Machines will perform routine tasks, whereas humans will be encouraged to perform novel value-added activities. Furthermore, the flexible nature of businesses and organizations will help their employees achieve a better personal and professional life balance.

While most of the research on Industry 4.0 has focused on how Industry 4.0 impacts the manufacturing sector, the influence of Industry 4.0 is far-reaching (Vaidya *et al.*, 2018; Zhong *et al.*, 2017). Industry 4.0 can blend breakthroughs in business as a whole (De Marchi and Di Maria, 2020; Maresova *et al.*, 2018; Shamim *et al.*, 2016). Although Industry 4.0 encompasses several enabling technologies, this research work focuses on the five core pillars of Industry 4.0 from the retail industry's perspective, which are: (1) 3D printing, (2) big data analytics, (3) cloud computing, (4) IoT and (5) robotics. According to the literature available on Industry 4.0, these five core pillars, play a vital role in the retail industry (Agnihotram *et al.*, 2017; Aktas and Meng, 2017; Caro and Sadr, 2019; Sun and Zhao, 2017; Zhao and Xu, 2017). Figure 3 shows the five core pillars of Industry 4.0.

These core pillars are briefly explained as follows:

2.1.1 3D printing. In the era of Industry 4.0, suppliers, digital enterprises, and customers all fall and work under the umbrella of industrial digital ecosystems. The existing Industry

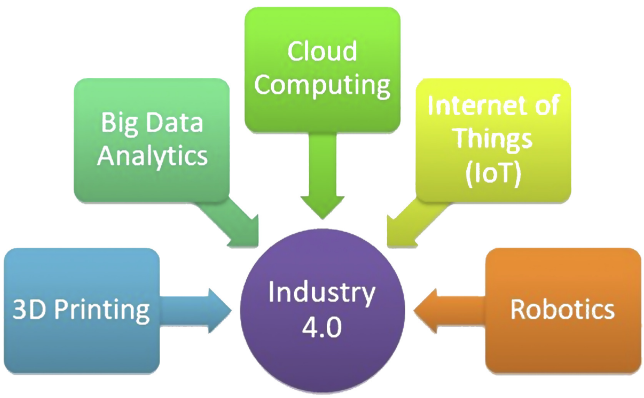


Figure 3.
Five core pillars of industry 4.0

4.0 related literature shows that 3D printing is one of the core pillars of Industry 4.0, and that it can blend breakthroughs in the industrial sector, particularly manufacturing (Almada-Lobo, 2015). Empirical evidence confirms that 3D printing can significantly disrupt the entire value chain. Furthermore, by using 3D printing, the customers is free to fully customize the products – thus enabling the enterprises to move from traditional bulk production to complete customization (Yin *et al.*, 2018). In addition, production will turn into distributed production instead of traditional centralized production. Indeed, 3D printing will completely reshape the way different products are manufactured, delivered and maintained.

Recent research shows that apart from the manufacturing industry, 3D printing will also positively impact the healthcare, defence equipment manufacturing and retail industry. The existing 3D printing-related literature shows that the retail industry can be disrupted by incorporating 3D printing in business models and different parts of the supply chain (Tjahjono *et al.*, 2017). 3D printing can help meet customer requirements and demands better, resulting in improved customer experience.

The current literature on the utilization of 3D printing in Industry 4.0 suggests that 3D printing plays a fundamental part in digitally transforming industries due to its quality, speed, reduced costs, safety, and reliability. It is generally agreed that the improved quality and the reduced costs of 3D printing will eventually take 3D printing up to the level of mass production. Furthermore, the range of the products produced will also increase with the further development of 3D printing (Horst *et al.*, 2018).

2.1.2 Big data analytics. Big data refers to an enormous amount of data that is generated by machines through blogs, comments, commercial transactions, documents, messages, photos, web forms, and weblogs (Weber, 2009). Based on the data generation sources, big data can be categorized into professional big data, personal big data and social big data (Li *et al.*, 2018). The current literature on Industry 4.0 suggests that big data analytics is one of the essential pillars of Industry 4.0, and that it helps effectively handling in smart factories (Wang *et al.*, 2016; Witkowski, 2017). To effectively manage smart factories, the latest tools and technologies are crucial for processing big data and to convert it into a form that can provide valuable insights to businesses and organizations. In Industry 4.0, the big data generated by industries is named as the industrial big data, whereby the industries generate it through utilizing cyber-based data, cloud-based data, data, which is obtained from IoT devices and surveillance cameras, human-computer interfaces, mobiles and smart sensors. This generated data can then be sent to the cloud for advanced level processing and analysis, or it can be directly stored in the industry's database for future utilization (Yan *et al.*, 2017). Accordingly, big data and Industry 4.0 can reshape the industrial processes in terms of resource consumption, process optimization and automation, and thus ultimately achieve sustainable development (Bettencourt, 2014; Oliveira, 2019; Wu *et al.*, 2016; Zhang *et al.*, 2020).

2.1.3 Cloud computing. The role of the cloud is groundbreaking in the convergence of various innovations in different fields (Almarabeh *et al.*, 2016; Schmidt *et al.*, 2015). It has helped dramatically evolve the market infrastructure and technological systems, transforming the correct range of services into an adaptive and flexible collection of applicants that have been continuously adapted to meet the needs of both companies and consumers (Foster *et al.*, 2008). In a continually shifting and highly competitive environment, the corporate world has to deliver superior versatility and efficiency to gain organizational performance in the context of consumer demand fulfilment (Sether, 2016). The incapacity to provide services at the pace needed can result in business failure. Such performance failures at the market level can be attributed to the absence of flexible technologies in the host systems, resulting in output reduction and customer loss (Putnik *et al.*, 2013). An incapable system will eventually fail, and the consumer base should predict similar outcomes if they do not adjust and prepare themselves with the requisite upgrades. A failure to fulfil this criterion will create problems for the whole industry. Cloud computing, however, can help fulfil the existing marketing objectives and meet emerging business needs. Furthermore, it can help both businesses and organizations effectively deal with operational and organizational challenges. The existing literature on cloud computing shows that cloud computing is now a critical component of contemporary society's technological development (Xue and Xin, 2016). Numerous businesses and organizations depend on it to undertake significant tasks (Aljabre, 2012; Saini *et al.*, 2019). In addition, with the expansion of digitalization and technology elevation throughout the entire globe, several industries have integrated the computerized and digital methods of job management and rely heavily on the latest technologies to maximize their productivity (Wu *et al.*, 2012; Zhang *et al.*, 2014).

2.1.4 Internet of things (IoT). IoT has diverse uses, roles and facilities in day-to-day life and across various realms; it links the real world to the digital world and enables computers and humans to be linked ubiquitously (Vermesan *et al.*, 2011). In addition, IoT – specifically the industrial Internet of things (IIoT) – is the real ignition force behind Industry 4.0. Industry 4.0 blends conventional production and business processes with revolutionary innovations, such as CPS, machine-to-machine (M2M) communication and IoT (Zhou *et al.*, 2015). In turn, it transforms conventional businesses into smart enterprises by utilizing self-customization, self-management, self-optimization, and self-cognition into the industrial sector (Dlamini and Johnston, 2016). Furthermore, IoT can provide industries with a wide variety of solutions and numerous traditional and modern technologies and services that will improve the quality of life and contribute to the intimate, technical, and economic prospects and benefits (Li *et al.*, 2011; Nagy *et al.*, 2018).

IoT uses independent, reliable and stable communication, as well as the sharing of data between devices and technologies in the modern world, that thus leads to the accomplishment of M2M collaboration and interconnectedness and the incorporation of information into applications (Chowdhury and Raut, 2019). Accordingly, computers can process knowledge and data and render human-like independent instantaneous judgments, just like rational judgments, but without any human involvement. IoT will thus build a safer environment for people, where the things surrounding them know what they want, need, and like, and behave consequently without needing specific human orders (Kanagachidambaresan *et al.*, 2020).

2.1.5 Robotics. Competitiveness is on the increase every day in the current market climate, and is vital for making better decisions at the right moment, such that more intelligent systems can make intelligent decisions (Galin and Meshcheryakov, 2019). Machines in the shape of decades-old robots are used to execute designated roles in production processes (Albers *et al.*, 2016). Simultaneously, humans are allocated predetermined roles in partnership, such as checking commodity consistency and discarding those that have deficiencies. Robotics plays an essential function throughout modern manufacturing and can intelligently execute their assignments, emphasizing health, efficiency and teamwork (Bahrin *et al.*, 2016). The artificial intelligence and robotics industries are the primary innovations and they provide the technology to boost both demand and economy (Acemoglu and Restrepo, 2019).

The review of the literature shows that robotics is the cornerstone of Industry 4.0. Indeed, smart factories which incorporate robots will be wholly programmed and autonomous (Bayram and İnce, 2018; Dhanabalan and Sathish, 2018; Klincewicz, 2018). These factories will become a highly productive manufacturing environment, with computers being used at various production stages and transportation networks that share knowledge continuously without much human involvement (Bartodziej, 2017). Furthermore, adaptable automation solutions enable custom-made output, which, in turn, helps meet the increasingly complex needs of customers and consumers (Goel and Gupta, 2020).

2.2 Organizational performance

For both profit and non-profit purposes, organizations' performance is the most critical topic for any corporation. Understanding which factors influence organizational performance is crucial for managers. Nevertheless, it is not a particularly onerous job to describe, conceptualize, and evaluate performance. Therefore, organizational performance is defined as the extent to which a company can satisfy shareholders' needs and survival requirements. Consequently, performance is not reasonably associated with a certain amount of turnover, a significant market share, or providing the best goods. For it can also be achieved simultaneously through a performance description. Organizational performance can be affected by various factors combined in unusual forms which enhance efficiency or hinder output (Aluko, 2003; Ramayah *et al.*, 2011). To succeed in the digital era, companies can use performance assessment mechanisms extracted from their skills and approaches (Mushref and Ahmad, 2011).

According to Aluko (2003), organizational performance refers to the organization's ability to satisfy the needs of customers, employees and owners alike. Researchers usually focus on relative performance measurements, because these rely on quantitative measurements and are what are used to identify opponents (Uncles, 2011). Clarifying how a company interacts with its business peers when evaluating operational efficiency is essential. Therefore, it is necessary to use a comparative industry method when creating firm performance assessments tools for companies that are sampled from a broad range of industries (Allen and Helms, 2006). According to Narver and Slater (1990), organizational performance can be measured in subjective and objective ways. The subjective measures are focused on opinions or estimates provided by respondents who are typically asked to assess their organizational performance. However, the objective measures focus on information and can be tested objectively, either by requesting respondents to disclose absolute values, or by reviewing secondary sources (Gosselin, 2005). Accordingly, performance evaluation is the essential determining factor of performance improvement, and it ultimately impacts the organizational performance.

2.3 Pakistan's retail industry

Retailing includes a transparent interaction with clients and the end-to-end management of company operations (Ghani, 2005). In recent years, Pakistan has seen a shift from tiny supermarket clusters to huge wholesalers and shopping malls. It has witnessed a major retail transformation and has been host to various multinational brands and renowned foreign wholesale chains (Khan *et al.*, 2014).

Pakistan's retail sector is exceptional and has become the third-largest sector after agriculture and mining, however, it is still unorganized. During the last decade, the percentage of GDP of wholesale and retail trade has been around 17.5%, and that of utilities about 34%. Retail is also the second-largest employer in the world, recruiting around 16% of the world's total workforce. Since wholesale and retail trade occupies more than one-third of Pakistan's service market, representing more than 53% of Pakistan's GDP, there is a clear link between the three growths. Pakistan's wholesale and retail trade directs the country's overall economic development by having a significant impact on service contraction and expansion and the increase in GDP (Ahmed and Ahsan, 2011).

The retail market is one of Pakistan's primary sectors. However, it has faced numerous development-based challenges. Due to a decline in technical advancement, the retail industry is not producing optimum efficiency. In addition, Pakistan's online business industry is very competitive and volatile, and the retail sector is struggling to cope with numerous problems. Furthermore, relative to other neighbouring nations, including India, China and Malaysia, Pakistan's retail industry is lacking significantly. Therefore, in order to achieve a sustainable competitive advantage and improved overall organizational performance, the retail industry of Pakistan could follow the current technology trends by harnessing the true potential of Industry 4.0 and its various innovative technologies, such as 3D printing, big data analytics, cloud computing, IoT and robotics. The incorporation of these innovation technologies within the retail industry of Pakistan could help solve various organizational issues and challenges and thus result in an improvement in overall organizational performance.

3. Hypotheses development and research model

3.1 Hypotheses development

3.1.1 3D printing and organizational performance. Numerous scholars have carried out empirical studies on 3D printing to examine its potential benefits for businesses and organizations. According to Cohen (2014), 3D printing offers numerous compelling benefits, such as reduced time-to-market, increased geometrical complexity and reduced assembly and tooling costs. The work of Schniederjans (2017) demonstrates that 3D printing helps improve the performance of supply chain management and optimize operations. Furthermore, innovative designs can be significantly improved by implementing 3D printing in industries. Vanderploeg *et al.* (2017) claim that 3D printing helps businesses and organizations effectively develop prototypes and helps companies create customized products according to consumers' needs. In addition, 3D printing helps improve the quality of products and reduces overall lead time – leading to improved overall organizational efficiency and effectiveness.

Based on the findings of the literature, as mentioned above, this study proposes the following hypothesis:

H1. 3D Printing has a significant relationship with Organizational Performance.

3.1.2 Big data analytics and organizational performance. The existing literature on big data analytics shows that big data analytics helps businesses and organizations improve their overall organizational performance. In their study of big data analytics and organizational performance, Bogdan and Borza (2019) found that big data analytics plays a crucial part in the overall organizational performance. In addition, they claim that big data analytics increases the effectiveness of the decision-making process. Furthermore, big data analytics helps improve customer satisfaction due to better customer relationship management and the adoption of big data analytics results in increased sales and higher market share. Big data analytics helps achieve firm agility, resulting in the improvement of the capability of an organization to predict and respond to developments. Wamba *et al.* (2017) argue that firms' adoption of big data analytics can significantly help them achieve a sustainable competitive advantage over those that do not utilize the benefits of big data analytics. In their study of big data analytics and business performance, Popovič *et al.* (2018) found that big data analytics promotes cost savings, increases efficiency, encourages improved case management, and boosts customer satisfaction.

Based on the findings of the literature, as mentioned above, this study proposes the following hypothesis:

H2. Big Data Analytics has a significant relationship with Organizational Performance.

3.1.3 Cloud computing and organizational performance. Numerous scholars have sought to understand cloud computing. The study carried out by Gangwar (2017) reveals that the adoption of cloud computing by businesses and organizations can significantly help them achieve profitability and improve their overall organizational performance. The work of Ratten (2016) demonstrates that cloud computing provides companies with a more robust mechanism of knowledge management, enabling further correlation between systems of information and organizational standards. In their discussion of cloud computing and firm performance, Son *et al.* (2011) claim that cloud computing helps businesses and organizations increase their overall market value. Schniederjans and Hales (2016) support the notion that cloud computing can help businesses sustain good cooperation in the supply chain and align environmental and economic performance. Ooi *et al.* (2018) carried out an extensive study on cloud computing and found that the adoption of cloud computing by industries improves the organization's innovativeness, productivity, and performance.

Based on the findings of the literature, as mentioned above, this study proposes the following hypothesis:

H3. Cloud Computing has a significant relationship with Organizational Performance.

3.1.4 Internet of things (IoT) and organizational performance. Numerous scholars have examined the role of IoT in improving overall organizational performance. The study carried out by Li and Li (2017) reveals that IoT can help businesses and organizations sustain their strategic edge in the complex business ecosystem. In addition, the environments of modern businesses and technologies, aided by IoT, allow supply chain managers to address current and future issues dynamically and create more tactical and strategic procedures to improve supply chain growth, whilst finding ways to improve supply chain efficiency through the implementation of revolutionary supply chain management practices and techniques. In their discussion of IoT and firm performance, Tang *et al.* (2018) argue that IoT implementation supports businesses and organizations and significantly influences financial performance, profitability, and consumer demand. The work of Collymore (2017) demonstrates that IoT can help organizations boost their corporate strategic edge and their overall performance, and that IoT assists companies to compile, track, and evaluate the performance of their organizational processes. As a result, the improvement in a company's operational performance can have an enormous effect on the organizations' net revenues.

Based on the findings of the literature, as mentioned above, this study proposes the following hypothesis:

H4. Internet of Things (IoT) has a significant relationship with Organizational Performance.

3.1.5 Robotics and organizational performance. The review of the literature shows that robotics plays a crucial role in improving overall organizational performance. The work of Graetz and Michaels (2018) demonstrates that robotics helps businesses and organizations by not only increasing overall throughput but also by reducing output costs. In addition, they found that robotics substantially impacts and enhances overall labour productivity. The study carried out by Lichtenthaler (2019) reveals that artificial intelligence and robotics can help firms achieve a sustainable competitive advantage over those firms that do not benefit from these disruptive technologies. Fragapane *et al.* (2020) claimed that robotics boosts the flexibility of the production industry, which, in turn, increases the organization's capacity to respond to customers' requirements in a reasonable time frame and maximize the profitability of the production chain, without incurring unnecessary costs and or the need to commit additional resources. The work of Morikawa (2016) demonstrates that artificial intelligence and robotics significantly contribute to the improvement of the overall productivity performance of the manufacturing and the service industries.

Based on the findings of the literature, as mentioned above, this study proposes the following hypothesis:

H5. Robotics has a significant relationship with Organizational Performance.

3.2 Research model

Based on the formal systematic literature review and findings and interpretations of the literature, a comprehensive research model was proposed in this study, which is shown in Figure 4.

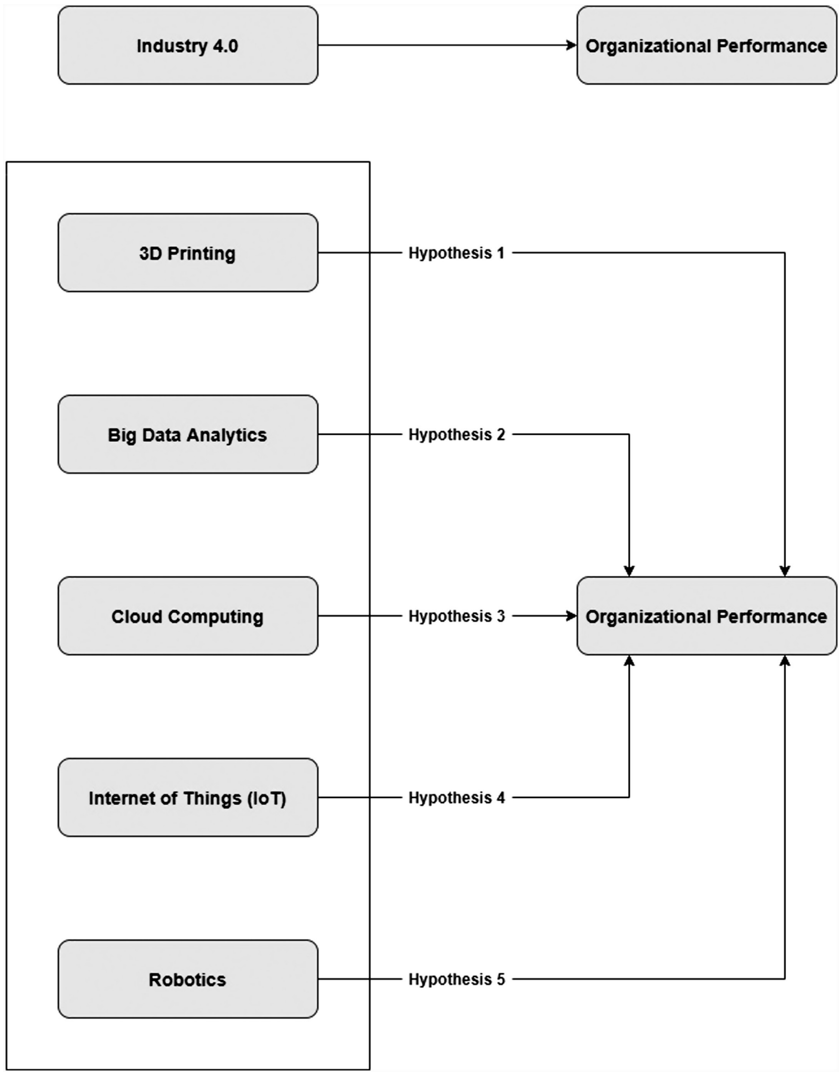


Figure 4.
Research model

4. Materials and methods

4.1 Sampling and data collection

Pakistan's retail industry was chosen as the target sector, with the target population being composed of senior-level employees from Pakistan's retail industry, including managers ranging from first-level positions to top-level positions, as well as subordinate employees working under the supervision of first-level managers who possess the technological know-how of Industry 4.0. In order ensure whether the participants possessed the technological know-how of Industry 4.0, short informal interviews related to Industry 4.0 and its related technologies were carried out prior to the distribution of the survey questionnaire, which helped shortlist the most suitable participants for the subsequent research work, by excluding those who were not aware of Industry 4.0 and its related technologies. The data were collected through a matrix-based survey questionnaire. The work by Comrey and Lee (2013) demonstrates that the acceptable size of a sample should be more than 200 respondents. Drawing on their work, Haque *et al.* (2017) highlight that any sample size of more than 200 is adequate in social science research to reach a reasonable inference. Accordingly, 630 survey questionnaires were sent out both online and offline to the respondents, with adequate instructions on how to fill out the survey questionnaires properly, as well as the purpose of the research, which proved to be efficient. The online methods of questionnaire distribution included Google forms, e-mail and social media platforms, whereby the offline methods of questionnaire distribution included visiting the participants in person and mailing the hard copies of the survey questionnaires to those who were not available for an in-person meeting, due to personal reasons. After sending out the survey questionnaires both online and offline, 477 responses were collected, with a 75.71% response rate. Out of these 477 responses, 8 responses were found invalid. 469 survey questionnaires were thus used finally, which is an acceptable sample size for drawing conclusions. The sampling method used for the subsequent research work was representative sampling, in order to ensure that only those participants are targeted who truly represent the larger population, which, as a result, helps improve the overall accuracy of the research work to be carried out.

4.2 Research instruments

A quantitative approach was employed to gather the participants' responses, involving the use of a matrix-based survey questionnaire – based on a five-point Likert scale, ranging from "strongly agree" to "strongly disagree". The survey questionnaire was designed and then divided into two main segmentations: (1) the demographic segmentation and (2) the attitudinal and behavioural segmentation. The demographic segmentation part of the survey questionnaire was based on respondents' demographic profiles, comprising four items: (1) gender, (2) age, (3) level of education and (4) work experience. Table 1 shows respondents' demographic profiles in terms of their gender, age, level of education, and work experience.

The attitudinal and behavioural segmentation part of the survey questionnaire was based on the attitudinal and behavioural research items – based on the key independent and dependent variables of this study, i.e. 3D printing, big data analytics, cloud computing, IoT, robotics and organizational performance.

The 3D printing section was comprised of five items, which were taken from the study by Schniederjans (2017). The participants were asked to answer a variety of questions on 3D printing, such as "3D printing increases our organization's productivity."

The big data analytics section contained eight items, from which six items were taken from the study of NewVantage Partners (2012), whereas two items were newly developed. The participants were asked to answer a variety of questions on big data analytics, such as "using big data analytics enables our organization to make better, fact-based decisions."

The cloud computing section was comprised of seven items, which were newly developed. The participants were asked to answer various questions on cloud computing, such as "cloud computing helps our organization achieve better collaboration across teams."

The IoT section contained seven items, out of which three items were taken from the study of Imran (2018), whereas four items were newly developed. The participants were asked to answer various questions on IoT, such as "using IoT helps our organization provide better communication between employees."

The robotics section was comprised of six items, which were all newly developed. The participants were asked to answer various questions on robotics, such as "using robotics enables our organization to reduce risks."

Variables		Frequencies	Percentages (%)
Gender	Male	316	67.4
	Female	153	32.6
	Total	469	100
Age	18–25 Years	128	27.3
	26–35 Years	191	40.7
	36–45 Years	107	22.8
	46–55 Years	43	9.2
	56 Years or above	0	0
	Total	469	100
Level of education	SSC/HSSC/Diploma	7	1.5
	BA/BS/BE	290	61.8
	MA/MS/ME	145	30.9
	MPhil	27	5.8
	PhD	0	0
	Total	469	100
Work experience	1–2 Years	128	27.3
	3–5 Years	85	18.1
	6–8 Years	58	12.4
	9–12 Years	71	15.1
	13–16 Years	60	12.8
	17–20 Years	32	6.8
	21 Years or above	35	7.5
	Total	469	100

Table 1. The demographic profiles of the respondents ($N = 469$)

The organizational performance section contained five items, which were taken from the study of Powell (1995). The participants were asked to answer a variety of questions on the organizational performance, such as "over the past three years, our financial performance has been outstanding."

5. Results and discussion

5.1 Results

5.1.1 Reliability and validity analysis. IBM SPSS Statistics was used for the data analysis. The reliability of the research instrument was tested using Cronbach's alpha, whereas the KMO measure of sampling adequacy and Bartlett's test of sphericity were used to test the research instrument's validity. Table 2 shows the results of the reliability and validity analysis.

The existing literature on Cronbach's alpha shows that to pass the reliability test, each variable of the research instrument needs to have a Cronbach's alpha value greater than or

Variable	No. of items	Cronbach's alpha (α)	KMO measure of sampling adequacy	Bartlett's test of sphericity Approx. Chi-square	df	Sig
3D printing	5	0.930	0.883	1888.292	10	0.000
Big data analytics	8	0.951	0.947	3598.760	28	0.000
Cloud computing	7	0.943	0.931	3187.108	21	0.000
Internet of Things (IoT)	7	0.950	0.945	3475.500262	21	0.000
Robotics	6	0.935	0.922	2529.185	15	0.000
Organizational performance	5	0.953	0.899	2806.951	10	0.000

Table 2. Reliability and validity analysis

equal to 0.7. Table 2 shows that each variable of the research instrument had a Cronbach's alpha value greater than 0.7. Therefore, the reliability test was successfully passed by the research instrument. For passing the validity test, it is generally agreed that each variable of the research instrument should have a KMO value of greater than or equal to 0.5. Furthermore, each variable of the research instrument should also have a p-value (Sig.) of less than 0.05. Table 2 shows that each variable of the research instrument had a KMO value of greater than 0.5. Additionally, each variable of the research instrument had a p-value of 0.000. The validity test was accordingly also successfully passed by the research instrument. It can therefore be concluded that the research instrument was proved to be both reliable and valid.

5.1.2 Correlation and regression analysis. A correlation analysis was carried out to evaluate the co-relationship among all the variables of the research instrument. Table 3 shows the results of the correlation analysis for all the variables of the research instrument, and Table 4 shows the correlation analysis results between Industry 4.0 (a single variable computed by adding the five variables of Industry 4.0) and organizational performance.

Table 3 shows that positive and statistically significant correlations were obtained for 3D printing, big data analytics, cloud computing, IoT, robotics, and organizational performance. Furthermore, when Industry 4.0 was taken as a single variable, a correlation between Industry 4.0 and organizational performance was obtained, which was also positive and statistically significant (as shown in Table 4). Figure 5 shows the research model with the obtained correlations.

All variables of the research instrument were positive and significantly correlated with each other. Therefore, the obtained findings were found suitable for carrying out the regression analysis.

The regression analysis was carried out in two ways: (1) a regression analysis among each variable of Industry 4.0 and organizational performance, and (2) a regression analysis between Industry 4.0 (a single variable computed by adding the five variables of Industry 4.0) and organizational performance. For carrying out a regression analysis for all the variables of

Table 3.
Correlations among all variables of the research instrument

Correlations

	3D printing	Big data analytics	Cloud computing	Internet of Things (IoT)	Robotics	Organizational performance
3D printing	1					
Big data analytics	0.642**	1				
Cloud computing	0.529**	0.669**	1			
Internet of Things (IoT)	0.472**	0.567**	0.708**	1		
Robotics	0.527**	0.471**	0.518**	0.611**	1	
Organizational performance	0.421**	0.433**	0.438**	0.427**	0.489**	1

Note(s): **Correlation is significant at the 0.01 level (2-tailed)

Table 4.
Correlations between industry 4.0 and organizational performance

Correlations

	Industry 4.0	Organizational performance
Industry 4.0	1	
Organizational performance	0.540**	1

Note(s): **Correlation is significant at the 0.01 level (2-tailed)

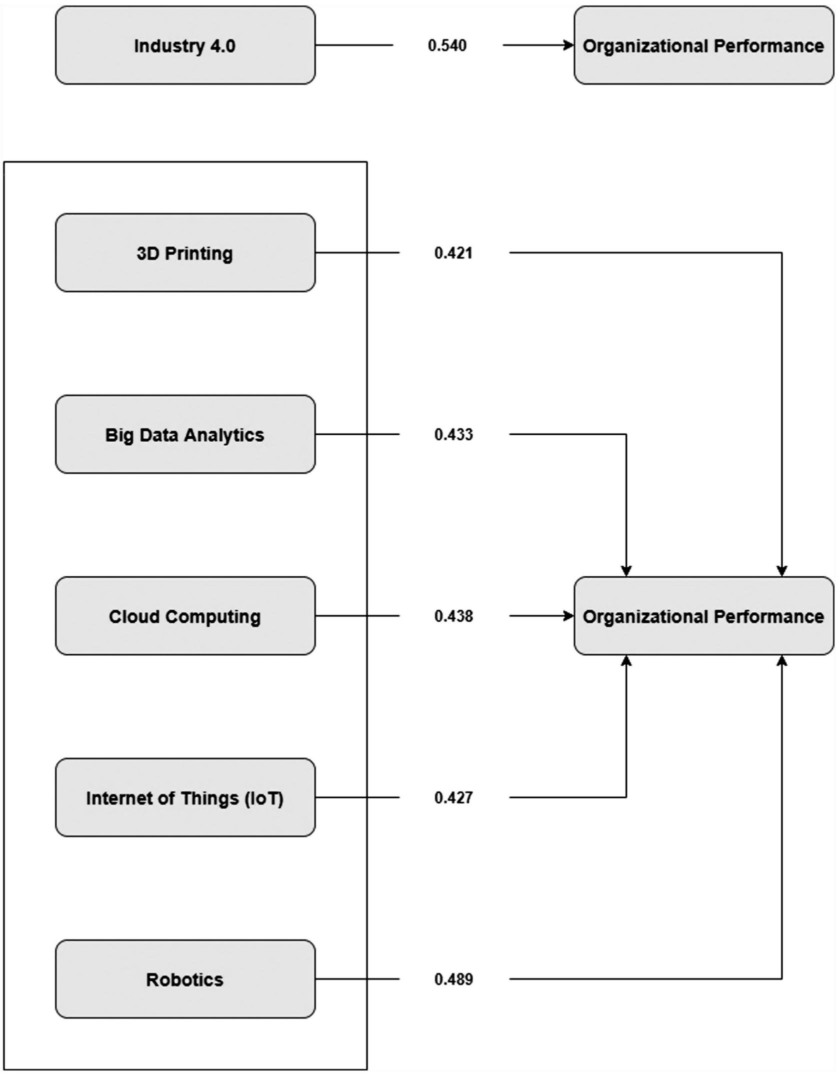


Figure 5.
Research model with obtained correlations

Industry 4.0 and organizational performance, 3D printing, big data analytics, cloud computing, IoT and robotics were taken as the independent variables, and organizational performance was taken as the dependent variable. Table 5 shows the results of the regression analysis for the five variables of Industry 4.0 and organizational performance.

It is generally agreed that a hypothesis with a *t*-value of greater than or equal to 1.96 is considered as an accepted hypothesis, whereas a hypothesis with a *t*-value of less than 1.96 is considered as a rejected hypothesis. Table 5 shows that the results yielded a statistically significant relationship between 3D printing and organizational performance. Hypothesis 1 was therefore accepted. Similarly, a statistically significant relationship was obtained between big data analytics and organizational performance and thus Hypothesis 2 was not rejected. Additionally, the relationship between cloud computing and organizational performance was statistically significant. Thus, Hypothesis 3 was accepted. Furthermore, the results yielded a statistically significant relationship between IoT and organizational performance and therefore Hypothesis 4 was not rejected. It was also found that the relationship between robotics and organizational performance was statistically significant and Hypothesis 5 was thus accepted. In addition, the β-values, shown in Table 5, indicate that all of the obtained relationships were positive. The hypotheses along with their statistical indicators of relevance are shown in Table 6.

In addition, we also carried out the regression analysis between Industry 4.0 (a single variable computed by adding the five variables of Industry 4.0) and organizational performance, where Industry 4.0 was taken as the independent variable, and organizational performance was taken as the dependent variable. Table 7 shows the results of the regression analysis between Industry 4.0 and organizational performance.

Table 7 shows that the results also yielded a statistically significant relationship between Industry 4.0 and organizational performance. Furthermore, the β-value, shown in Table 7, indicates that the relationship obtained was positive.

5.2 Discussions

This study was carried out to assess and determine the impact of the five disruptive technologies of Industry 4.0 on the organizational performance of Pakistan's retail industry, which is among the world's fastest-growing retail markets. The findings obtained provided convincing evidence of a strong association among the five core pillars of Industry 4.0 and Pakistan's retail industry's organizational performance, that is to say, the implementation of

Table 5. Regressions among five variables of Industry 4.0 and Organizational Performance

Regressions (organizational performance)	β	t	Sig
3D printing	0.421	10.040	0.000
Big data analytics	0.433	10.375	0.000
Cloud computing	0.438	10.527	0.000
Internet of Things (IoT)	0.427	10.194	0.000
Robotics	0.489	12.112	0.000

Table 6. Hypotheses along with their statistical indicators of relevance

	Statistical indicators of relevance			
Hypotheses	t	Correlations	Sig	End result
Hypothesis 1	10.040	0.421	0.000	Accepted
Hypothesis 2	10.375	0.433	0.000	Accepted
Hypothesis 3	10.527	0.438	0.000	Accepted
Hypothesis 4	10.194	0.427	0.000	Accepted
Hypothesis 5	12.112	0.489	0.000	Accepted

Table 7. Regressions between industry 4.0 and organizational performance

Regressions (organizational performance)	β	t	Sig
Industry 4.0	0.540	13.877	0.000

Industry 4.0 and its related cutting-edge technologies in the retail industry of Pakistan could help improve the overall organizational performance of retail.

The findings obtained demonstrate that there was a statistically significant relationship between 3D printing and organizational performance. A *t*-value of 10.040 and a β-value of 0.421 indicate that 3D printing had a positive and direct relationship with organizational performance. The obtained results provided preliminary evidence that 3D printing can help accomplish tasks and activities more quickly and that 3D printing can increase organizational productivity. Thus, the implementation of 3D printing leads to an increase in the overall organizational performance of Pakistan's retail industry. Our findings are consistent with the results obtained by Cohen (2014) and Schniederjans (2017).

The results yielded a statistically significant relationship between big data analytics and organizational performance. A *t*-value of 10.375 and a β-value of 0.433 indicate a positive and direct relationship between big data analytics and organizational performance. The findings obtained provided preliminary evidence that big data analytics can improve customer experience and lead to the making of better, fact-based decisions, and achieve more efficient organizational operations. In addition, big data analytics can enable an increase in sales and reduce risks. Accordingly, the implementation of big data analytics would increase the overall organizational performance of Pakistan's retail industry. Furthermore, our findings are in line with the studies carried out by Bogdan and Borza (2019), Wamba *et al.* (2017), and Popovič *et al.* (2018).

The findings obtained also show that there was a statistically significant relationship between cloud computing and organizational performance. A *t*-value of 10.527 and a β-value of 0.438 indicate that cloud computing had a positive and direct relationship with organizational performance. The results obtained provided preliminary evidence that cloud computing can help increase organizational agility and that cloud computing also helps achieve better collaboration across teams. Thus, the implementation of cloud computing would increase the overall organizational performance of Pakistan's retail industry. In addition, our findings are consistent with the results obtained by Gangwar (2017), Son *et al.* (2011), and Ooi *et al.* (2018).

The findings obtained yielded a statistically significant relationship between IoT and organizational performance. A *t*-value of 10.194 and a β-value of 0.427 indicate that the relationship between IoT and organizational performance was positive and direct. The results obtained provided preliminary evidence that IoT could provide better communication between employees. Additionally, IoT can increase organizational efficiency and customer satisfaction. Therefore, the implementation of IoT would increase the overall organizational performance of Pakistan's retail industry. Our findings are in line with the studies carried out by Collymore (2017) and Tang *et al.* (2018).

The results obtained demonstrate that there was a statistically significant relationship between robotics and organizational performance. A *t*-value of 12.112 and a β-value of 0.489 indicate that robotics had a positive and direct relationship with organizational performance. The findings obtained provided preliminary evidence that robotics can help reduce risks. Furthermore, robotics can increase customer experience and customer satisfaction. Accordingly, the implementation of robotics would increase the overall organizational performance of Pakistan's retail industry. Furthermore, our findings are consistent with the results obtained by Fragapane *et al.* (2020) and Morikawa (2016).

The findings obtained show that there was also a statistically significant relationship between Industry 4.0 (a single variable computed by adding the five variables of Industry 4.0) and organizational performance. A *t*-value of 13.877 and a β-value of 0.540 indicate a positive and direct relationship between Industry 4.0 and organizational performance; this means that the implementation of Industry 4.0 would increase the overall organizational performance of Pakistan's retail industry.

6. Conclusions and recommendations for further research

6.1 Conclusions

This study took the unprecedented step to assess and determine the impact of the five key technologies of Industry 4.0, i.e. 3D printing, big data analytics, cloud computing, IoT, and robotics, on the organizational performance of Pakistan's retail industry. The target population was composed of senior-level employees from Pakistan's retail industry, including managers ranging from first-level positions to top-level positions, as well as subordinate employees working under the supervision of first-level managers, who possess the technological know-how of Industry 4.0. The data were collected through a matrix-based survey questionnaire. The findings obtained yielded some interesting findings and provided convincing evidence of a strong association among the five core pillars of Industry 4.0 and the organizational performance of Pakistan's retail industry. In addition, the results obtained provide preliminary evidence that the disruptive technologies of Industry 4.0, in particular, 3D printing, big data analytics, cloud computing, IoT and robotics, could help Pakistan's retail industry in solving various problems and challenges, such as meager revenues, increased expenses and unorganized systems. It can therefore be concluded that the implementation of Industry 4.0 in Pakistan's retail industry would increase the overall organizational performance of Pakistan's retail industry. Accordingly, Pakistan's retail industry should introduce Industry 4.0 through a comprehensive strategy, covering the aforementioned five disruptive technologies of Industry 4.0.

6.2 Research limitations and recommendations for further research

The findings obtained are not generalizable to the entire service sector. Future research should therefore explore the impact of the various disruptive technologies of Industry 4.0 on the organizational performance of the other industries of the service sector. Furthermore, our findings are not generalizable beyond the population studied and thus future studies should take other countries into account. Future scholars and researchers from both developed and developing countries are encouraged to investigate and clarify the relationship between Industry 4.0 and the organizational performance of the production and service sectors of their respective countries, as this would help further the understanding of Industry 4.0 in the context of the production and service sectors of both developed and developing countries. In addition, future research should also compare and contrast organizations' overall performance, both before and after the implementation of the various disruptive technologies of Industry 4.0, as this would help assess the extent to which the implementation of Industry 4.0 impacts the overall performance of businesses and organizations.

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