



The Effect of Digital Revolution in Business Operations: A Study of Small & Medium Enterprises in District Malakand and Swat, Khyber Pakhtunkhwa Pakistan

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ARTICLE INFO

Article History:

Received: January 14, 2025

Revised: February 09, 2025

Accepted: February 10, 2025

Available Online: February 11, 2025

Keywords:

Industry 4.0, Pakistani SMEs and Digital transformation

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ABSTRACT

In today's intensely competitive business world, companies need to adapt to stay relevant. When it comes to Industry 4.0 and digital transformation, there is currently no time for theoretical discussion or experimental initiatives. The results of this investigation into in what way Industry 4.0 technology disturbs the productivity of Pakistani SMEs are presented. The data was collected from district Malakand and Swat. SPSS multiple regression techniques have revealed that big data, cyber-physical systems & interoperability considerably improve business outcomes. Conversely, the internet of things had very little of an effect. This research offers helpful insights into the fields of Industry 4.0 and digital revolution, but it also suggests new areas of investigation and provides a foundation for further research. Since there hasn't been much research done in this field, the results will assist managers in defending their company's investments in IT infrastructure. Moreover, policymakers should make use of the current findings to create suitable plans for enhancing absorption capacities and building human capital in a digital environment that is always evolving. All things considered, this study broadens our knowledge of how businesses may leverage Industry 4.0 technology to attain sustained growth and competitiveness. By adopting these advancements, businesses in Pakistan can maintain an advantage over their rivals.

Introduction

Digital disruption is forcing businesses to reevaluate their management systems. The pace of digital disruption is too fast for conventional hierarchical and closed organizational structures to keep up with (Imran, Hameed, & Haque, 2018). If traditional businesses want to stay competitive, they must reevaluate their organizational structures, think like digital disruptors, and be flexible (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). This change presents a once-in-a-generation chance to solve fundamental issues with the environment, health care, and education (Chen, Preston, & Swink, 2015).

Slusarczyk (2018) and Thames & Schaefer (2016) stated that enhanced automation together with improved operational efficacy and productivity are among the objectives of Industry 4.0. According to Imran, Hameed, and Haque (2018) and Posada et al. (2015), advanced algorithms and web integration improve information management and increase value production. Still, additional research is needed to fully understand Industry 4.0's effects (Xu, Xu, & Li, 2018). In light of this, this paper examines a paradigm and the ways in which SMEs have been impacted by the Industry 4.0 revolution. The determination of the study is to clarify the elements that influence the operations of particular industries.

Review of Literature & Theory

Pakistani SMEs

Pakistan's small and medium-sized enterprises (SMEs) are dynamic to the country's economy (Qureshi & Herani, 2011) as SMEs make up around 90% of all enterprises, 80% of the labor force in non-agricultural sectors, and generate more than 40% of the nation's yearly GDP. Small and medium-sized organizations (SMEs) in Pakistan have several challenges in operating efficiently, including inadequate corporate information systems, absence of strategic planning, and a shortage of social capital.

According to (Zhang et al., 2018) The current period, commonly mentioned to as Industry 4.0, is the fourth industrial revolution and is distinguished by the manufacturing of CPS and the convergence of data and knowledge. According to (Van Holten & Hess, 2016) Germany's expanding economic system embraced the idea of "Industry 4.0," which built on the achievements of earlier industrial revolutions that used steam and water power in the 18th century and electrical energy for mass manufacturing in the 20th century.

These study emphases on four key features of Industry 4.0: cyber-physical systems, interoperability, big data (BD), the Internet of Things (IoT). It is clear that these components are necessary for improved performance, and SMEs' technology problems can be addressed by adopting them, which will have a big influence on services and production (Ismail, Bajwa, Zuraiz, Quresh, & Ahmad, 2023). Previous research has indicated an optimistic relationship between an enterprise's success and its embrace of technology (Brynjolfsson & Hitt, 2000). As well as how an organization's policies and procedures are impacted by IT deployment (Heracleous & Barrett, 2001). The acceptance and application of big data, IoT, and smart manufacturing technologies should be backed by suitable organizational structures and procedures for SMEs to achieve long-

term financial success (Ismail et al., 2023). All things considered, utilizing digital innovation to propel business success and promote economic progress in Pakistan and abroad requires an awareness of how Industry 4.0 affects SMEs.

The Factors Affecting Digital Revolution

Modernizing an organization and embracing digital revolution demand superior human capital. Such technical advancements are expected to have an impact on every facet of a corporation. The word "Industry 4.0" defines a broad spectrum of cutting-edge ideas and methods that are being applied to drastically alter customary business processes. This investigation took into account several facets of digital transformation, including big data, cyber-physical systems, the internet of things, and interoperability. This phenomena can be explained as a technological push that could change the way that organizations operate (Ismail et al., 2023).

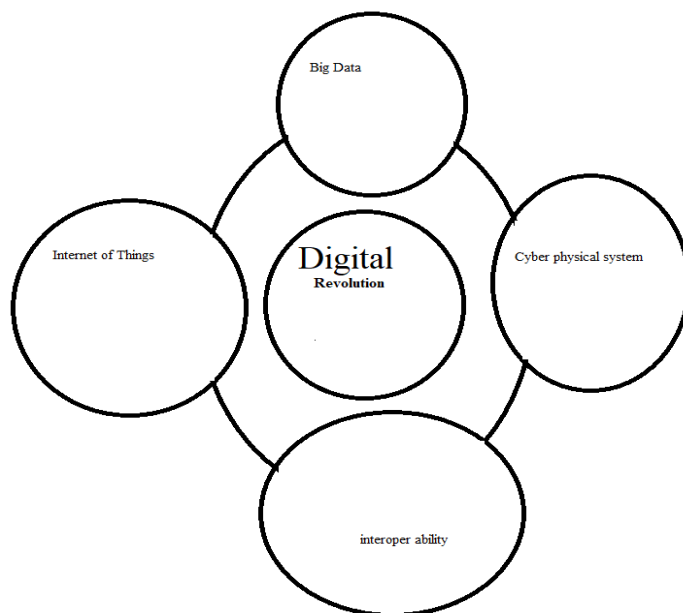


Figure 1: Digital Revolution

Big Data

The term "big data" describes a wide range of methods for analysing massive volumes of knowledge, information, or data, including both organized and unstructured data, and is used for confidentiality, collecting, transfer, storage, analysis, and search (Xu et al., 2018). Big data is often used in the processing of massive amounts of data (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014). Big data may be found and interpreted using a variety of techniques to generate novel ideas. There are several technological obstacles that can be addressed by using big data. Better technology is made available by it, and this aids in the discovery of more effective data storage methods (Erevelles, Fukawa, & Swayne, 2016).

Hypothesis 1: Utilizing big data enhances business operations.

Cyber-Physical Systems

Cyber-physical systems incorporate computer and physical competencies to engage with people in different ways. Future technological growth will be greatly aided by the capacity to use computing, communication, and control to interact with and augment the capabilities of the physical environment.

Hypothesis 2: CPS enhances business productivity.

Interoperability

Interoperability is the combination of the aforementioned elements. It is the information sharing between humans, intelligent manufacturing, and cyber-physical systems that occurs in both directions. This makes it possible for manufacturing partners to exchange a variety of data in an efficient and accurate manner. The capacity of systems to accurately translate and transfer data is known as interoperability. This is a necessary component of any cutting-edge technology setup in the present era (Homburg, Wielgos, & Kühnl, 2019). Therefore, more interoperability should lead to greater efficiency.

Hypothesis 3: Business operations are enhanced by interoperability.

Internet of Things

Numerous industries have shown increased interest in the Internet of Things in recent years. More than just a catchphrase, the Internet of Things (IoT) is a growing movement, a tried-and-true business tactic, and a revolutionary technological advancement. The author (Ashton, 2009) established and defined IoT as limited to standardized, acknowledged devices that are familiar with RFID technology, which has the power to alter the path of human history. IoT is defined by the authors of (Li, Chen, Tang, & Yan, 2018) as "network-connected tools." In the healthcare and transportation sectors, the commercialization of IoT applications has now progressed to the consumer market and the autonomous business sector (Thames & Schaefer, 2016). Industry 4.0 is based on a number of software applications, middleware, puff calculating, RFID & middleware (Belli, Davoli, Mediolini, Marchini, & Ferrari, 2019). Internet of Things (IoT) increase the effectiveness of supply chains and logistics by providing more precise data (Gunasekaran et al., 2017). According to Chen, Preston, and Swink (2015) the number of devices linked to the internet will rise from 0.9 billion in 2009 to 26 billion by 2020. We are thus in a better position to comprehend the Internet of Things' persuasive potential. Many studies have been conducted on the development of IoT technology and its applications, but not many have examined the relationship between IoT adoption and the prosperity of Pakistan's small and medium-sized enterprises (SMEs).

Hypothesis 4: The operations of corporation's benefits from IoT.

Theoretical Foundations

This paper provides a basic overview of the theoretical foundations of the Reserve-Based View. Simultaneously, the Reserve-based view of I.T implies that the company's I.T assets could

potentially provide a competitive edge (Nwankpa & Roumani, 2016) and (M. S. Shahbaz, Chandio, Oad, Ahmed, & Ullah, 2018). The company's distinctive assets—its IT infrastructure, IT configurability, and human IT capabilities—are further highlighted (Nwankpa & Roumani, 2016). Each IT resource is unique and tough to obtain. Increasing organizational competency is the outcome of integrating a company's technological resources (Nwankpa & Roumani, 2016). The main objective of this study is to determine how industry 4.0 technologies, such as big data, IoT, interoperability, and CPS, affect the financial conditions of small and medium-sized businesses (SMEs).

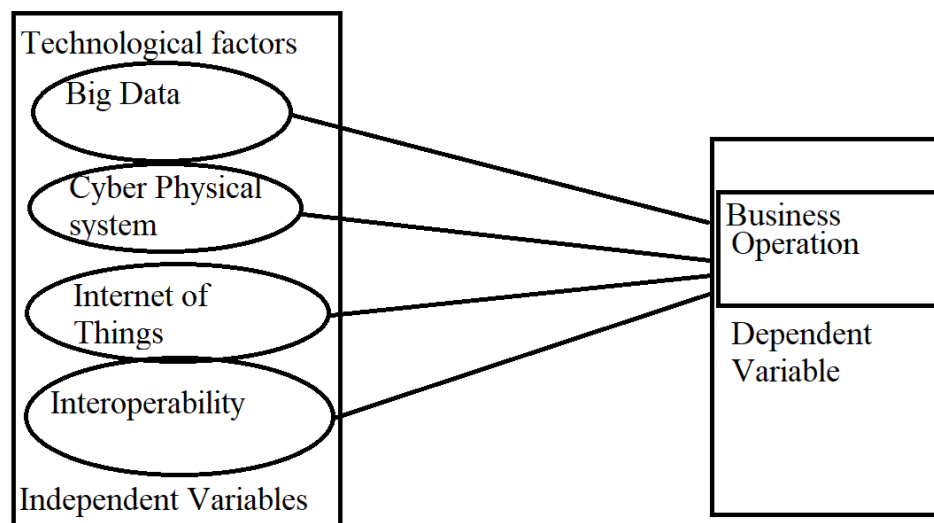


Figure 2: Theoretical Framework

Methodology

The four primary digitalization components that were considered to ascertain how industry 4.0-related corporate digitalization effected improved business performance in Pakistani SMEs were big data, IoT, interoperability, and CPS. The survey forms was physically circulated to a number of SMEs in District Malakand & District Swat. This survey was taken among managers and professionals who are familiar with industry 4.0 and the digital revolution. A process of random selection was employed to pick the participants. The data was gathered on a 5-point Likert scale, which extended from "strongly disagree" to "strongly agree." There are two important sections in the questionnaire. Age, sexual characteristics, marital position, and revenue were among the variables studied in the first part of the study. The primary research determinants of big data, interoperability, CPS, and the Internet of Things were the emphasis of the second half of the study. In this work, SPSS was used to analyse data using multiple regression techniques.

Outcomes & Data Analysis

300 questionnaires that were distributed, 238 were selected due to their sincere answers. 39 respondents did not answer more than 60% of the survey's questions, their responses were deemed invalid. 40 questionnaires were filled from the pharmaceutical industry, 85 are from the textile industry, 25 are from the cutlery company, 60 are from beverages, 15 are from fans, and 13 are

from the surgical equipment manufacturing industry. The demographic data of the respondents is presented in Table 1.

Table 1: Participants Demographic

Title	Number of defendants	(%age)
Businesspersons	36	14
Executives	124	55
Admins	78	31
Total	238	100
Experience (years)		
1-7	79	32
8-12	43	19
13-17	80	36
18-22	22	7
23 and more	14	6
Total	238	100

Cronbach's alpha was employed to measure the consistency of the data. For the sample sizes that were employed, Table II displays the mean, standard deviation, and Cronbach's alpha. Every item's Cronbach's alpha is larger than or equal to 0.80, placing them inside the acceptable range (Sarstedt, Ringle, & Hair, 2017). Independent mean values for big data (3.37), CPS (3.35), Internet of Things (2.97), and interoperability (3.28).

Table 2: Cronbach's Alpha, Mean & S.D

Independent Variable	quantity of substances	Cronbach's alpha	Mean	S.D.
Big data	4	0.816	3.37	0.673
CPS	4	0.834	3.35	0.570
IoT	5	0.851	3.39	0.569
Interoperability	3	0.880	2.97	0.681
Business operation	10	0.827	3.36	0.522

The study employed multiple regression investigation to ascertain the direction and magnitude of the linear correlation between the independent variables under investigation. The correlations between the independent and dependent variables discovered by regression analysis are displayed in Table 3. Regression research of these parameters against business operation and variance shows that big data, CPS, IoT, and interoperability can return 36.6%, 34.6%, 32.2%, and 33.8% of profits to small and medium-sized firms (SMEs) in Pakistan. At a significance level of 0.634, it is concluded that the impact of IoT on corporate operation is at most marginal. Big data has a beta of 0.307, CPS of 0.314, IoT of 0.170, and interoperability of 0.227. Table III shows the positive effect of large data on performance at the 0.05 level of significance. At the same P-value threshold, CPS and interoperability are found to have a substantial effect on business results. These findings imply that a 1% increase in big data can result in a 30.7% increase in business operations.

Moreover, for every 1% rise in CPS, operation improved by 31.4%. The Internet of Things (IoT) and interoperability improve SMB operation by 17% and 28.3%, respectively, for every 1% increase in spending. The data recommends that hypotheses H1–H4 are true, but H3 is false.

Table 3: Regression Exploration Coefficients

Model	Unstandardized Numbers	Standardized Numbers	t	Sign.
	B	Sd Error	Beta	
(Persistent)	0.894		0.124	4.6 0.000
				83
Big data	0.307		0.513 - 0.309	5.4 0.000
				06
CPS	0.314		4.972 - 0.314	4.6 0.001
				29
IoT	0.169		0.807 - 0.189	0.3 0.624
				77
Interoperability	0.273		4.804 - 0.279	4.7 0.000
				22
Dependent variable: Business operations				

Discussion

The advancement of companies employing industry 4.0 approaches is currently the top goal for strategic leadership. In reality, the majority of policymakers in developed countries think that ecosystems will play a significant strategic role. These outcomes align with those found in (Waschneck, Altenmüller, Bauernhansl, & Kyek, 2016), (Nawanir, 2016) and (Imran et al., 2018) where it was observed that these factors positively impacted the operations of SMEs in Indonesia and Thailand. As opposed to the results of (Imran et al., 2018) The recent study discovered that the impact of IoT on operations was minimal for SMEs in Thailand. These contradicting results could have their roots in the different technological and business contexts in Thailand and Pakistan. According to reports, Thailand, a well-liked travel destination, was first to adopt modern technology, which has slightly increased Pakistan's SME sector's ability to assimilate new technology. Despite their establishment and growth, Pakistan's small and medium-sized businesses are developing and growing at a slow rate. The moment has come to put them into practice in order to gain a competitive edge and endure in a cutthroat market, rather than relying on historical innovation discourses to verify the existence of such technologies (Keawphang, 2014) and (M. Shahbaz, Kazi, Bhatti, Abbasi, & Rasi, 2019). In order to modernize corporate environments, managers need to develop agility, which requires them to find a balance between investigating and exploiting their businesses (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). Thus, Industry 4.0 technologies like big data, CPS, and interoperability are required to overcome this problem, enhance operations and efficiency, and obtain a competitive edge.

Conclusion

The use of industry 4.0 technologies, such as big data, CPS, IoT, and interoperability, by small and medium-sized enterprises (SMEs) in Pakistan, it was discovered that these technologies could be highly advantageous for SMEs. Businesses are affected by innovation and make a concerted effort to integrate and employ new technologies. The growth of technology has rendered traditional

corporate structures outdated. The Pakistani government ought to support and motivate SMEs to fully integrate these technologies into their operations. They would be able to achieve objectives like cost reduction, output growth, and product value enhancement that are currently unattainable for Pakistani SMEs. Businesses must meet the demanding requirements of Industry 4.0, and this can only be done with the right kind of human capital that possesses cutting-edge capabilities.

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