

The Impact of Digital Transformation on Business Performance

A Study of Pakistani SMEs

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Abstract—Business ecosystems are continuously evolving. In this hyper-competitive era, firms are increasingly transforming their business operations through advanced digital technologies. Gone are the days of mere testing and debating the influence of digital transformation and industry 4.0, yet the time has come for actionable steps. Therefore, this study has identified the role of industry 4.0 technologies including big data, cyber-physical systems, internet of things and interoperability, on the performance of Small and Medium-sized Enterprises (SMEs) in Pakistan. A relevant questionnaire was developed and distributed randomly in the cities of Karachi, Lahore, Peshawar, Islamabad, Gujrat, and Sialkot. After applying multiple regression techniques through SPSS, it was found that big data, cyber-physical systems, and interoperability have a significant positive impact to improve business performance, while the insignificant effect of internet of things was revealed. Since the research in the area of digital transformation and industry 4.0 is scant, the current study has contributed novel directions, insights and a framework for future researchers. Moreover, this study will help managers to justify the allocation of resources towards technological infrastructure development in the operations of their firms. Finally, policymakers will find it helpful in order to devise suitable strategies for developing human capital and to enhance their absorptive capacity.

Keywords—digital transformation; business performance; Pakistani SMEs; industry 4.0

I. INTRODUCTION

Digital advancement is forcing companies to rethink their organizational models. Some firms are showing a superior ability to exploit digital technologies to gain a competitive advantage over the market in many industries. Traditional companies, with their hierarchical, centralized, closed, top-down organizational structures, are unable to change and

evolve at the speed required by digital disruption [1]. In order to survive, traditional companies have to question their organizational models, learn from digital disruptors and shift their organizational models and mindset [2]. We are transitioning towards a digital economy and society. Although already underway for nearly half-a-century, the pace of change has quickened with the further deployment of digital infrastructure, the proliferation of smartphones which allows ubiquitous computing, and the generation of huge volumes of all kinds of data. These developments have turned data into an important strategic asset [3]. Many now compare the digital transformation with earlier industrial transformations propelled by general-purpose technologies like steam or electricity. Whether it is the Second Machine Age [4], the Third Wave [5], or Industry 4.0 [6], significant shifts are underway in the economy and in society more generally. With this transformation come rare opportunities to improve welfare and address pressing social issues from health care to education to the environment [7-9]. Yet such benefits come with new challenges as digital transformation changes the nature and structure of companies and markets, raises concerns around jobs and skills, privacy, security, social and economic interaction [10], the formation and composition of communities, and notions of equity and inclusion in the present era of industry 4.0. Researchers have endorsed the significant positive effects of digital transformation of businesses on productivity and performance on a macro level [11, 12].

The objective of Industry 4.0 is to attain an advanced level of operational effectiveness and productivity, as well as a higher level of automation [13, 14]. As Industry 4.0 has a significant role in the production and service sectors, it has a direct relationship with performance. Authors in [1, 15] have mentioned that various features of Industry 4.0 are highly connected with internet technologies and progressive

algorithms. However, they also specify that Industry 4.0 is one of the technical procedures of value addition and effective knowledge management practices. Despite the research on Industry 4.0, a comprehensive review of studies on Industry 4.0, is required [16]. Consequently, this study proposes a framework with the help of Industry 4.0 and presents the significance of this revolution in Small and Medium-sized Enterprises (SMEs). The current study aims to enlighten the role of Industry with respect of business performance.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

A. SMEs in Pakistan

In the industrial development of a country, the importance of the SME sector cannot be overlooked. The meaning of SMEs in Pakistan lies in the number of representatives (up to 250 individuals), paid-up capital (up to 25 million Rs.), and yearly deals (up to 250 million Rs.) [17]. SMEs constitute nearly 90% of all the enterprises in Pakistan. They employ 80% of the non-agricultural labor force and their share in the annual GDP is approximately 40%. However, unlike large enterprises in the formal sector, a small and medium enterprise is constrained by financial and other resources. This inherent characteristic of an SME makes imperative the existence of a mechanism through which it may get support in different functions of business including technical upgradation, marketing, financial, and human resource training and development [18]. Despite having economic importance, the SMEs of Pakistan are suffering many shortcomings, which seriously impede their performance. The major shortcomings include the ineffective business information structure, lack of strategic planning, and lack of human capital required in the modern era business [19]. Such inefficiencies can be resolved and the current state of SMEs can be uplifted by infusing the advanced digital technologies of industry 4.0 in their business operations [20, 21].

B. Business Performance and Industry 4.0

The industrial expansion has continued for many decades, and currently, it is in the age of Industry 4.0 [22]. The concept of Industry 4.0 was originally planned for an emerging German economic system in the year 2011 [23]. The first industrial revolution started in the last period of the 18th century [24]. This revolution was characterized by automatic production plants using water and steam power. The second industrial revolution began in the early 20th century, characterized by mass labor production grounded in electrical energy. The third industrial revolution started in the 70's with the distinctive features of programmed production grounded in new technology. Finally, the fourth industrial revolution, namely Industry 4.0, is continuing including the features of Cyber-Physical System (CPS) production, grounded in diverse data as well as knowledge combination [24]. Industry 4.0 has been described from various viewpoints. For instance, Industry 4.0 is "the integration of complex physical machinery and devices with networked sensors and software, used to predict, control and plan for better business and societal outcomes" [25]. Author in [26] defines Industry 4.0 as "a new level of value chain organization and management across the lifecycle of products". Author in [27] described Industry 4.0 as "a

collective term for technologies and concepts of value chain organization".

Four elements of Industry 4.0, namely big data (BD), IoT, interoperability, and cyber-physical systems are undertaken in this study. This collection has followed the notion of [1] which reported a significant connection of these factors with improved performance. These branches of Industry 4.0 can resolve technological challenges of SMEs, and may ultimately increase sustainable business performance. Moreover, they promote performance and exert significant effects on production and services. It is proven that Industry 4.0 has a positive influence on production and services, and it increases performance [1, 28, 29]. Various studies proved that technology adoption has a significant relationship with business performance [30, 31], and the structure and processes of an organization show a strong relationship with IT implementation [32]. There is an effect on strategy or technology implementation from Industry 4.0 that positively affects business performance among SMEs [28]. Organization structure and process should be supportive of accepting and implementing new technology related to big data, IoT and smart factory which will lead to better sustainable business performance among SMEs.

C. Digital Transformation and its Factors

In order to enable digital transformation and modernization of firms, advanced human capital is needed. Every area and department of a business should be open to being influenced by such technological makeover. Industry 4.0 can be defined as an umbrella term, denoting a variety of recent concepts, as well as numerous linked disciplines within the industry to transform the business operations [33]. The factors of digital transformation taken in this study include IoT, big data, cyber-physical systems (CPS) and interoperability [1] (Figure 1). Such technologies have the potential to enable a paradigm shift towards business settings [33, 34], and the very phenomenon can be further elucidated as a technology push.

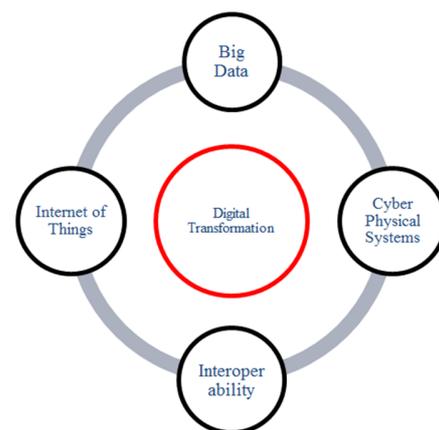


Fig. 1. Factors of digital transformation

1) Big Data

Big data is one of the umbrella terms for any method utilized to process a vast quantity of data, knowledge or

information, including capture, safety, transmission, storing, analysis, search, confidentiality, and data which is both structured and unstructured [16]. Big data is generally used to handle massive amounts of data [35]. The nature of big data encompasses extensive measures to identify and interpret the data into new ideas. Author in [36] mentioned that big data is a systematic visualization where the amount of data are just beyond technology's capability to store, manage, and process efficiently. Authors in [37] have categorized big data by volume, variety, and velocity. The term has a significant relationship with technology adoption [38]. The implementation of big data can overcome various technology-related challenges. It provides better technology, which helps to find better ways to store data efficiently [35]. Therefore, we hypothesize that big data positively affects business performance:

Hypothesis1: Big data has a positive impact on business performance

2) Cyber-Physical Systems(CPS)

Cyber-Physical Systems (CPS) refers to a new generation of systems with integrated computational and physical capabilities that can interact with humans through many new modalities [28]. The capability to interact with and enlarge the abilities of the physical world with the help of computation and communication, as well as control, is a significant enabler for future technological developments.

Hypothesis2: CPS has a positive impact on business performance

3) Interoperability

Interoperability is what happens when we bring the above elements together. It is the connection of cyber-physical systems, humans, and smart factories communicating with each other through IoT. In this direction, manufacturing partners can efficiently share various types of information error-free. Basically, interoperability enables error-free transmission as well as translation. It is one of the basic requirements of a modern technological system [20]. Therefore, it is assumed that interoperability improves performance.

Hypothesis3: Interoperability has a positive impact on business performance

4) Internet of Things (IoT)

In current years, IoT has been developed as the most significant subject in numerous industries. IoT is not only a major buzz word in businesses but also an emerging drift, an established plan, and a ground-breaking technology. Initially, author in [39] projected the idea of IoT and defined IoT as exclusively recognizable consistent objects with radio-frequency identification (RFID) expertise, which has the ability to alter the world. Authors in [40] specified IoT as network-connected tools. A few initial IoT applications have been previously industrialized in health sectors, transport, home utilization, and various self-propelled industries [14]. Industry 4.0 is based on these vital skills of IoT: RFID, cloud computing, middleware, and various software applications [41]. IoT technologies have been extensively used in numerous

industries, for instance, IoT can advance logistics and supply chain effectiveness by providing more comprehensive knowledge [38]. It is predicted that IoT would reach 26 billion parts in 2020, from 0.9 billion in 2009 [3]. Therefore, we can understand the strength of the persuading power that IoT skills can bring. Presently, various studies focused on IoT emphasizing on the expansion of IoT technologies and its applications, but no research has been conducted regarding the influence of IoT execution on the performance of Pakistani SMEs, therefore, this study aims to fill this gap.

Hypothesis4: IoT has a positive impact on business performance

D. Theoretical Framework

This study suffices the theoretical underpinnings of Resource-Based View (RBV). Concurrently, the RBV of IT recommends that the IT resources in the firm can be the competitive capability of the firm [42, 43]. It is further pointed out that the firm's human IT skills, IT infrastructure, and IT reconfigurability are the firm's unique resources [42]. Every single IT resource is unique and complex to acquire. The combination of the technological resources creates a firm's strong organizational capability which leads to superior performance [7, 42]. The current study focuses on the influence of industry 4.0 technologies including big data, IoT, interoperability, and CPS on business performance of SMEs as shown in Figure 2.

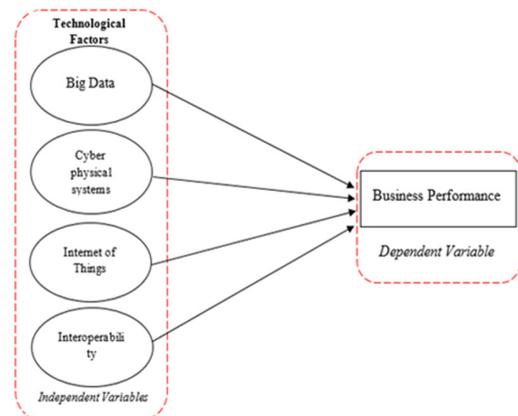


Fig. 2. Theoretical framework

III. METHODOLOGY

To evaluate the influence of digitalization of firms in industry 4.0 towards enhanced business performance in Pakistani SMEs, four major digitalization factors were considered, namely big data, IoT, interoperability, and CPS. The questionnaire was distributed physically, and through email to various SMEs in Karachi, Lahore, Islamabad, Peshawar, Sialkot, and Gujrat. Following the sampling table of [44], 390 questionnaires were distributed. The respondents of this study were employees of managerial level and above who have knowledge of industry 4.0 and digital transformation. Random sampling was used for respondents' selection. The

data were collected using the 5-point Likert scale from strongly disagree to strongly agree. The questionnaire was divided into two major parts. The first part included demographic items such as age, gender, marital status, and income and the second part regarded the key variables of this research which are big data, interoperability, CPS, and IoT. The questionnaire was adapted from [1] and [28]. This study applied multiple regression methods through SPSS to analyze the data.

IV. RESULTS AND DATA ANALYSIS

From the total 390 questionnaires distributed 237 were usable responses selected out of the received 278. Forty one questionnaires were excluded because they did not respond more than 60% of the questions of the survey. The selected questionnaires include 45 respondents from pharmaceutical firms, 83 from textile firms, 27 from cutlery firms, 68 from beverage companies, 32 from fan manufacturers, and 23 from surgical instruments manufacturing firms. The demographics of respondents are given in Table I. The demographic details of targeted SMEs are shown in Figure 3.

TABLE I. RESPONDENTS PROFILE

Designation	Number of respondents	(%)
Entrepreneurs	34	14
Managers	129	55
Administrators	74	31
Total	237	100
Experience (years)		
1-5	75	32
6-10	46	19
11-15	82	36
16-20	18	7
21 and more	16	6
Total	237	100

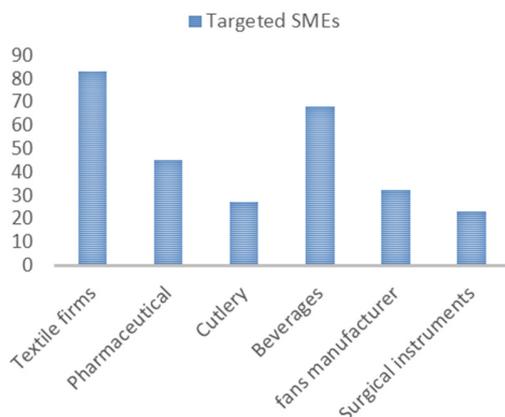


Fig. 3. Number of targeted SMEs

Data analysis was performed in two phases. In the first phase, responses with higher missing values and outliers were eliminated manually and 278 responses were retained. The reliability of the data was checked using Cronbach's alpha. Table II shows Cronbach's alpha, mean and standard deviation values. Cronbach's alpha values of all items are higher than 0.80 which are within the acceptable range [45, 46]. The mean values of the independent variables including big data, CPS,

IoT, and interoperability are 3.37, 3.35, 2.97 and 3.28 respectively.

TABLE II. CRONBACH'S ALPHA, MEAN, AND STANDARD DEVIATION

Variable	Number of items	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 performance	10	0.827	3.36	0.522

In the second phase, multiple regression was applied which determines the degree of strength and direction of the linear relationship among research variables [47]. The regression analysis results exhibited in Table III indicate the relationships between the independent and dependent variables. Big data, CPS, IoT, and interoperability were regressed against the business performance and variance accounted for, R2=36.6, R2=34.6, R2=32.2 and R2=33.8 correspondingly, which means that infusion of 36.6% in big data, 34.6% in CPS, 32.2% in IoT and 33.8% in interoperability can enhance the performance of SMEs in Pakistan. It can also be seen in Table III that the impact of big data at P<0.05, with significance level of 0.000 is positively affecting performance. Similarly, CPS and interoperability are also found as effectively significantly to performance of business at P<0.05. However, the effect of IoT is found as insignificant towards business performance, at significance level of 0.634. The beta values for big data, CPS, IoT, and interoperability are 0.307, 0.314, 0.170, and 0.283 respectively. These values denote that when 1% increase in big data will be made, the business performance will be improved by 30.7%. Furthermore, 1% increase in CPS leads to 31.4% increase in performance. Also when 1% increase will be devoted to IoT and interoperability, the performance of SMEs will be upgraded by 17% and 28.3% respectively. Thus, in the light of these results H1, H2 and H4 are accepted, and H3 is rejected.

TABLE III. REGRESSION ANALYSIS COEFFICIENTS

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	
	B	Std. Error	Beta			
1	(Constant)	0.884	0.124		4.683	0.000
	Big data	0.307	0.513	0.309	5.406	0.000
	CPS	0.314	4.972	0.314	4.629	0.001
	IoT	0.170	0.806	0.190	-0.477	0.634
	Interoperability	0.283	4.904	0.280	4.722	0.000

Dependent variable: Business performance

V. DISCUSSION

Advancement of businesses through industry 4.0 means is currently one of the foremost concerns of strategic leadership. As a matter of fact, the majority of policymakers of developed countries are anticipating a significant strategic contribution of

advanced technologies of industry 4.0 in the whole business ecosystem [2, 7]. These findings are in alignment with the ones in [1, 28, 48], which they also reported positive effects of these factors on performance of SMEs in Thailand and Indonesia. However, the influence of IoT on performance was revealed insignificant in the current study, which is in contradiction with the results of [1] on the SMEs of Thailand. The potential reasons for these inconsistent results can be the varying technological and business environment of Pakistan and Thailand. Reportedly, Thailand is a tourist country and it has adopted advanced technology earlier than Pakistan, which has reasonably enhanced the absorptive capacity of its SMEs. However, despite the emergence and development of SMEs, the pace of growth and development of SMEs in Pakistan is sluggish. Gone are the days of mere reading such innovation discourses to find the corroboration of such technologies, it is rather the time to embrace it in order to attain competitive advantage and to sustain in the increasingly challenging marketplace [49, 50]. Therefore, the managers need to balance the exploration and exploitation of their companies to attain agility which is a pre-requisite to evolve the business settings in modern times [51]. Consequently, Industry 4.0 tools including big data, CPS, and interoperability are needed to balance such a situation in order to enhance productivity and performance while achieving competing advantage.

VI. CONCLUSION

This study investigated the impact of industry 4.0 technologies including big data, CPS, IoT, and interoperability on the performance of SMEs in Pakistan. The positive significant role of big data, CPS, and interoperability in enhancing SMEs performance was verified. Assimilating and exploiting modern technologies is in the limelight of businesses and firms are vulnerable to the impact of innovation. Advanced technologies are transforming and overturning entire business models. The government of Pakistan should facilitate and encourage SMEs to adopt such technologies in their operations extensively, thus not only reducing cost and increasing productivity, but also adding extra value to their products, value that is currently missing in Pakistani SMEs. Furthermore, the appropriate type of human capital equipped with modern-day skills is inevitably needed in order to comply with the advanced business settings of industry 4.0.

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