



Big Data awareness and health care industry: An insight from Pakistan

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ABSTRACT

Introduction: Technologies like Big data are among one of the Quality 4.0 tools that seem to bring digital transformation in healthcare. Therefore, its awareness in healthcare providers is valuable to yield life-saving outcomes. A scarce literature has been found on the assessment of level of Big Data awareness, its utilization in healthcare and its role in firm performance.

Aims & Objectives: The objective of the study is to identify the relationship between the level of awareness, usage and mediation of big data with firm's performance (healthcare establishment) and the relationship of moderation of resistance to change with the level of awareness of big data and big data usage.

Place and Duration of Study: Riphah International University, Lahore, Pakistan. Healthcare providers were approached through social media groups for the period of three months during 2022 across all provinces of Pakistan.

Materials & Methods: A cross-sectional study was conducted using both self-administered and e-questionnaire as a survey tool. The tool was designed and validated specifically for Healthcare Establishments via extensive literature review and review by the experts. 540 questionnaires were randomly floated among the healthcare providers for the period of three months. Accurately filled 235 responses with a response rate of 52.2% were analyzed by using SPSS version 21.

Results: Results supported the proposed model and showed positive and significant relationship between the level of awareness of Big Data and firm performance ($\beta = 0.57, p < 0.01$) that is mediated by Big Data usage (LLCI = 0.1920; ULCI = 0.3008). There is a positive and significant relationship between Big Data usage & firm performance ($\beta = 0.66, p < 0.01$). Furthermore, we observed resistance to change as moderator between level of awareness of Big Data and firm performance ($\beta = -0.0068, p > 0.05$).

Conclusion: The current study concludes that level of awareness of Big Data & Big Data usage has a significant positive relationship with firm's performance. So, on the bases of above facts we recommend that healthcare establishments need to educate and train their managers and professionals about role of Big Data and its usage in health-related activities for improved performance.

Keywords: Big Data, Healthcare industry, Healthcare 4.0, Healthcare Establishments, Big Data Awareness.

INTRODUCTION

With the advent of fourth industrial revolution, like other industries, healthcare has also transformed to foster innovation in procedures in various parts of America and Europe. This transformed healthcare is named as healthcare 4.0.¹ Healthcare 4.0 is characterized by the integration of digital health associated technologies like Big Data analytics, the internet of things (IoT), artificial intelligence, cloud computing, and block-chain². It helps to improve patient care, systems, enhance overall efficiency and accessibility of health services.

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Big Data is collection of such large and complex data sets that traditional data processing tools and database systems are unable to handle it effectively. Big Data is categorized into five qualities, including velocity, volume, variety, value, and veracity¹. It is a high-volume, high-speed, high-variety information asset that enables organizations to make better decisions³. Healthcare centers generate a huge quantity of data because of compliance, records, and regulatory requirements. Traditionally all data were stored in hard copies, but now the industry has moved into the digital world to regulate many records⁴. Big Data holds the promise of supporting a wide range of health care and medical functions, including disease surveillance, clinical decision support, and population health management. These functions are driven by legal requirements and the potential to improve the quality of healthcare delivery while lowering costs⁵. According to reports, data of the US healthcare system exclusively surpassed 150 exabytes in 2011. If the trend continues, Big Data in healthcare in the United States will soon approach the

zettabyte mark⁶. Healthcare providers like physicians, surgeons, allied health professionals need to learn techniques related to Big Data to improve patient care. Patient monitoring using traditional techniques necessitates extra manpower and chances of error and overlooking of significant patient vitals like blood pressure, pulse rate, and oxygen saturation. In countries like Pakistan where nurse to patient ratio is 1:50, compared to the standard 1:5 and doctor to nurse ratio 4:1. Therefore, there seems much rationale to know about Healthcare 4.0 technologies for the smart clinics that lead to better patient care and improved service quality⁷. Better perceived service quality results in better word of mouth and changes consumer behavior²⁷.

This study emphasizes on the critical question; Is there any relationship between the levels of awareness of Big Data with firm performance? As literature is evident that implementing Big Data technologies like IoT lead to reduce waiting times, improve efficiency and better patient management⁷. According to reports from Research and Markets, the IoT healthcare market is estimated to increase from 41.22 billion USD in 2017 up to USD 158.07 billion in 2022, growing at a compound yearly growth rate of 30.8 percent⁶.

Therefore, the present study focuses on four clear objectives.

1. To identify the relationship between the level of awareness of Big Data and firm performance.
2. To assess the role of Big Data usage (mediator) in the relationship between the level of awareness of Big Data and firm performance
3. To identify whether resistance to change is playing a role of moderator in the relationship between the level of awareness of Big Data and firm performance.
4. To examine the resistance to change as a moderator in the relationship between the level of awareness of Big Data and Big Data usage.

Based on these research questions a theoretical framework has been designed that is given in Figure 1.0. and respective hypothesis are generated that has been discussed as under:

1.1 Level of Awareness about Big Data Usage and Firm Performance

Businesses pursuing BD adoption confront several obstacles, including a lack of expertise and awareness. To fully exploit the rapidly growing data velocity, volume, and diversity of data, new methodologies, and technologies for organizing, analyzing, and displaying data are essential. But there

has been considerably less study focused on how businesses might use these innovations for further progress^{7,8,9}. Big Data is critical to the administration of the healthcare business, and it has the potential to transform healthcare companies. This is only achievable if organizations are aware of emerging technologies. Hence, raising awareness is critical for increasing the efficacy of company performance¹⁰. The studies that are focused on Big Data & Big Data analytics are given in Table 1.

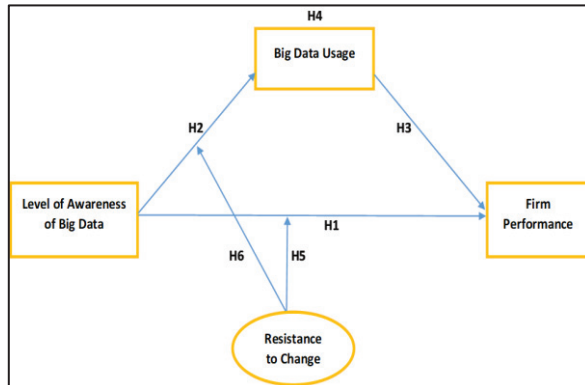
Table 1: A literature review on Big Data in health care from 2012 to 2022

Reference No.	Year	Core concept of article	Article Type
11	2021	Big Data technologies utilization for multiborbidity	Article
12	2022	Big Data technologies utilization for cancer diagnosis	Comprehensive review
13	2022	Big Data Analytics, Applications and Challenges	Article
14	2020	Big Data Analytics application in healthcare	Systematic Review
15	2021	Big data analytics adoption and management in healthcare organizations in Jordan	Article/Framework
16	2020	Role of Big Data analytics in healthcare	Article
17	2018	Challenges, utilization benefits and Big Data ethics in Healthcare	Comprehensive review
18	2017	Big Data usage associated advantages and disadvantages in healthcare	Article
19	2016	m IoT and big data in the healthcare associated fields	Review Article
8	2016	Potential use of big data analytics in healthcare	Framework
20	2018	Big Data associated challenges in healthcare	Article

In this study, the "Level of Awareness of Big Data" serves as the independent variable. The dependent variable, "Firm Performance (Healthcare Establishments)," is the ultimate outcome measured, reflecting the healthcare establishments' overall performance. These establishments' awareness of big data is hypothesized to influence their performance, with "Resistance to Change" serving as the moderator variable, potentially affecting the strength of this relationship. Meanwhile, "Big Data Usage"

acts as the mediator variable, elucidating how the awareness of big data translates into tangible performance improvements within healthcare establishments.

Figure 1.0: Theoretical Framework



Flores²³ surveyed awareness of industry 4.0 techniques, including big data. Industry 4.0 has gathered attention because of its positive role in firm performance. Results showed that only 10% of participants were unaware of the technology, while the rest were familiar with these techniques and using them in their business. The survey concluded that the awareness level of technology usage plays an important role in its adaptation.

H1: The level of awareness (LOA) of big data has a positive impact on firm performance.

1.2 Level of Awareness of Big Data (BD) and Big Data Usage (BDU)

BD is projected to encounter various challenges and will need systemic adjustments across the company. Unsurprisingly, almost half of BD initiatives do not reach completion⁹. Numerous industries and company operations are suffering due to the rapid influence of modern technical and data-driven breakthroughs. The basic reason behind these issues is the unawareness of BD usage¹¹.

According to Khanra¹⁴, although there is considerable potential for BD adoption, just a few communities use this strategy. One of the key causes of this problem is a lack of understanding among firms, health care executives, and employees. The first step toward implementing new technology is to raise public awareness. Hence, understanding prospective technology sources such as Big Data utilization is critical in Healthcare institutions.

Habibullah²⁴ surveyed awareness of big data usage in Pakistan. The study explains that modern countries are using BDA to revolutionize the industrial system because of the high awareness level of BDA usage. On the other hand, developing countries including Pakistan face awareness issues regarding the usage of big data among practitioners in the field of Statistics.

It is the age of digital information, and modern countries are witnessing a revolution in the field of analytics and communication, but the situation is quite different in developing countries.

Schenker²⁵ claim that, despite the huge potential for contribution by statisticians, they have not been sufficiently engaged in Big Data activities. Only a few statisticians work on Big Data programs. One major reason for this disconnection is a lack of understanding of big data usage in firms and industries. It shows that big data usage presents new opportunities for businesses and firms, but it requires a high level of public awareness regarding these modern techniques.

H2: The level of awareness of big data has a positive relationship with big data usage.

1.3 Usage of Big Data and Firm Performance

Big data awareness involves the understanding and learning of big data-related technology goods and services. Firms have invested enormous resources in developing the skills for boosting their capacity to handle large amounts of data, which has several potential benefits for businesses. Healthcare and biological research need big data technologies to operate efficiently²². Although adopting big data may have significant advantages for businesses, many are still skeptical about whether doing so would enhance their performance as compared to their rivals²². A survey found that, although investment in big data continues to rise, many big data initiatives have failed to deliver on their promises. 60 percent of programs' big data has failed to go above the prototype stage in 2017. These concerns led many businesses to question if engaging in big data analytics would improve firm performance²⁶.

H3: Big data usage has a positive relationship with firm performance.

H4: Big data usage mediates the relationship between the level of awareness of big data and firm performance (FP).

1.4 Resistance to Change as A Mediator Between the Level of Awareness of Big Data and Big Data Usage

Workers showing resistance to change (RTC) is a significant impediment to the introduction of new technologies. Health care departments are expending significant resources and effort in implementing BDA, but RTC remains a significant hurdle. RTC has been found to have a deleterious effect on both BDA awareness and usage^{28,29}. Various experts assert that the effectiveness of a change relies not only on the excellence of an innovative idea but also on the capacity to contrast the phenomena of resistance²⁵. Employees at the American Department of Health and Human Services generated significant RTC for

e-healthcare enterprises when they implemented new healthcare technology like BD and other record systems²⁵.

H6: Resistance to change moderates the level of awareness of big data and big data usage.

1.5 Resistance to Change as A Mediator Between Level of Awareness of Big Data and Firm Performance

Resistance to change negatively affects the firm performance. Resistance to change needs to be controlled for effective results. One of the biggest challenges faced by the manager of firms is to convince the employees to accept change³⁰. According to researchers, Individuals' situational resistance to change (RTC) is seriously detrimental to their work performance because it inhibits workers from taking appropriate risks, adopting novel patterns of thinking and performing, and implementing change, all of which are necessary components of creative performance¹⁴. According to scholars, work environments may either foster or stifle employee performance. Any new technology can disturb the environment; hence, employees may create resistance to the change, lowering the firm's productivity¹⁰.

H5: Resistance to change moderates the level of awareness of big data and firm performance.

MATERIALS AND METHODS

Effective research requires an effective research design. Therefore, for this study, the quantitative research design is preferred because it is more accurate and reliable. In the current study, the administration of the survey took place in two stages; first we identify the big data usage in Pakistani healthcare establishments. Second, the pre-notification letter was sent to the firm managers to explain our research objective and ask them to direct to the person of your firm, who is confident to answer this topic. The items were adapted from literature^{21, 24, 29, 31} and discussed with the field experts prior to piloting. The questionnaire after pilot study was finalized. The first segment consists of statements associated to the study variables viz., level of awareness of big data, resistance to change, use of big data, and firm performance. The responses of all the constructs incorporated were assessed on a five-point Likert scale showing “strongly disagree (5)” to “strongly agree (1)”; “Extremely aware (5)” to “not at all aware (1)”; “never (5)” to every time (1)”. The second segment constituted the demographic details of study respondents. The data was collected using both printed questionnaires / e-questionnaire. The respondents were asked for the informed consent and

were ensured for strict anonymity and confidentiality. Study respondents were Healthcare professionals/providers in the health-related sector of Pakistan from both public and private sectors. The Healthcare Establishments (HCE’s) include hospitals, clinics, nursing homes, maternity homes, diagnostic centers, dental clinics, homeopathic clinics, acupuncture clinics, and physiotherapy clinics as per the definition of Punjab Healthcare commission.³³ The study was approved by ethical review board of Riphah international university Lahore with a reference no. Riphah/LHR/RSBM/EM/039242. The study was cross-sectional in nature. When it comes to humans’ participants' research, the rule is that the sample size must be at least five times the size of scales.³¹ The sample size must be 4 * 30 =120 observations. Hence more than 450 questionnaires have been floated and 235 valid responses were taken all over the country. Survey Data was coded into numerical data and input into SPSS software³². Subsequently, the data was screened to address missing data, outliers, and responses with very low standard deviations. Hypothesis testing was conducted through regression analyses using SPSS Hayes’ PROCESS.

RESULTS

The demographic section of the questionnaire highlights the information associated with study participants and their HCE’s given in Table 2.

Table: 2 sample profile of the respondents

S #	Variables	Categories	Frequency	Percent
1.	Gender	Male	133	56.6
		Female	102	43.4
2.	Age (years)	18-35	163	69.4
		36-55	6	28.5
		56 or above	5	2.1
3.	Education	Doctorate	7	3.0
		Postgraduate	35	14.9
		Undergraduate	180	76.6
		College / Diploma	13	5.5
4.	Experience (years)	1-10	164	69.8
		11-20	48	20.4
		21 or above	23	9.8
5.	Firm Type	Public	96	40.9
		Private	135	57.4
		Not for Profit	4	1.7
6.	Firm's own Experience (years)	0-5	23	9.8
		6-10	32	13.6
		11-40	87	37.0
		41-70	69	29.4
		71 or above	24	10.2

Data Normality:

Table 3: Skewness and Kurtosis

	LOA	BDU	RTC	FP
Skewness	-.057	-.901	.551	-.700
Kurtosis	-.497	-.258	-.788	1.386

Reliability Analysis

For reliability assessment Cronbach's alpha values of study variables were estimated and found its range from 0.820-0.933 shown in Table 4.

Table 4: Study variables associated with Reliability Statistics

	Variables	No. of items	Reliability
1.	Level of Awareness of Big Data	9	.933
2.	Resistance to Change	4	.924
3.	Big Data Usage	7	.938
4.	Firm Performance	13	.820

Correlation and Descriptive Statistics

Correlation analysis was performed in SPSS between the LOA, RTC, BDU, and FP and found signification relationship.

Regression Analysis

Regression analysis for LOA and FP has been performed. The result shows that “there is a positive and significant relationship between both of them” ($\beta = .573, p < 0.01$). Hence, the above results support our hypothesis H1: The LOA has a positive impact on FP. Similarly, Regression analysis for LOA and BDU has been conducted. The result shows that “there is a positive and significant relationship between both of them” ($\beta = 0.658, p < 0.01$). Hence, the above results support our H2: LOA has a positive relationship with BDU. Regression analysis for BDU and FP has been performed. The result shows that “there is a positive and significant relationship between both of them” ($\beta = .781, p < 0.01$). Hence, the above results support our H3: BDU has a positive relationship with FP.

Mediation Analysis (LOA→BDU→FP)

Mediation analysis was conducted using the bootstrapping method in line with the recommendations of Preacher and Hayes (2008). Similarly, an indirect effect of LOA on FP through BDU has not included 0 (LLCI = 0.1920; ULCI = 0.3008), indicating mediation of BDU. Moreover, direct effect is non-significant (LLCI = -0.0011; ULCI = 0.1107). Hence, it is a case of full mediation. The above results support our hypothesis H4: BDU mediates the relationship between the LOA and FP.

Table 5: Mediation Result Analysis of LOA→BDU→FP

		BDU				
		B	Std. Error	Beta	t	Sig.
		LOA	2.352	.156		15.122
	LOA	.444	.060	.436	7.403	.000

Note: N=235 R Square: 0.432 p < 0.01

Moderation Analysis

(LOA→RTC→FP/LOA→RTC→BDU)

A significant interaction value ($\beta = -0.0068, p > 0.05$) shows there is no moderation of resistance to change between the level of awareness of big data and firm performance. The above results reject our hypothesis H5: RTC moderates between the LOA and FP. Significant interaction value ($P = 0.0001, p < 0.05$) shows there is a moderation of RTC between LOA and BDU. The above results support our hypothesis H6: RTC moderates between LOA and BDU. The graph plotted high and low moderator values for the level of awareness of big data and resistance to change in firm performance. Results show a significant relationship between the firm performance.

Hayes process (Model 1) was used to test the moderation analysis.

Table 6: Moderation Result Analysis

LOA→RTC→FP						
Variables	β	S.E	T	P	LLC I 95%	ULC I 95%
LOA	.2563	.0717	3.5755	.0004	.1151	.3975
RTC	-.1162	.0768	-1.5127	.1317	-.2676	.0351
LOA*RTC	-.0068	.0233	-.2902	.7719	-.0527	.0392
LOA→RTC→BDU						
Variables	β	S.E	T	P	LLC I 95%	ULC I 95%
LOA	.0958	.1077	.8896	.3746	-.1164	.3080
RTC	-.0866	.1154	-7.5112	.0000	-.0942	.6394
LOA*RTC	.1317	.0350	3.9141	.0001	-.0681	.2060

DISCUSSION

In this survey, we sought to understand whether healthcare professionals in Pakistan's healthcare establishments were aware about big data and modern technologies used in the healthcare industry. Although most healthcare professionals recognize the importance of using big data related to disease prevention in healthcare, business, and research, they are not utilizing it frequently in their daily work. Furthermore, most respondents indicated they were particularly interested in using big data in healthcare on disease prevention and predictions, and other information^{6, 7, 8}. Respondents have a lower awareness of many new technologies that are used in the health industry than big data, small cities hospitals have the lowest level of experience with big data. Respondents in the healthcare industry are most likely to show a willingness to pay for big data. Almost all respondents found big data to be an economically valuable resource, indicating that respondents are aware of this²².

Big data plays an important part in the management of the Healthcare industry, and it can revolutionize healthcare organizations^{2,6}. According to our assumptions, it can only be possible when the organizations have awareness of modern technologies and BD. Therefore, the development of awareness level is important to increase the effectiveness of firm performance. It was also observed that there is a need for research on how technology awareness affects the use of technology by the government sector. It is estimated from the above studies that big data usage may mediate the relationship between firm performance and level of big data awareness²².

Resistance to change (RTC) by healthcare providers is a serious obstacle to the implementation of innovative technologies. Healthcare Establishments are investing a lot of funds and effort in the implementation of Big Data, but RTC is a critical barrier²⁸. RTC is an attitude of a worker that prevents him/her from accepting an actual or potential change. Employees usually produce RTC when a new creative system is implemented since it goes against their established behaviors and comfort zones³¹.

Limitations and Future Directions

The study came across the limitations that focuses on and justifies that the current study is cross-sectional and because of its nature of the data, causation cannot be proven. The other limitation of this study is a small sample size due to time constraint, hence study cannot be generalized across health sector of Pakistan. In our opinion, further qualitative research

would be useful on this subject since many aspects have not been explored in current study due to time constraint. This research provides serial mediation of big data usage between the level of awareness of big data and firm performance. Future researchers can take other variables like service quality as the dependent variable.

CONCLUSION

The study was focused to investigate the relationship between LOA and firm performance. Findings further suggest that level of awareness of big data is significantly positive related to firm performance. The other contribution of this study is that LOA is also significantly positively related to big data usage. With these results, we concluded that LOA of big data positively relates to firm performance. Furthermore, BD usage moderates the relationship while RTC act as moderator. A healthcare establishment will perform better if its staff has a well level of awareness of big data and other innovative technologies used in healthcare firms like artificial intelligence. Study can predict that awareness of big data can be helpful in reducing the RTC.

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