EFFECT OF FIRM'S BIG DATA ANALYTICS CAPABILITY ON COMPETITIVE ADVANTAGE: MEDIATING EFFECT OF BUSINESS MODEL INNOVATION AND MODERATING EFFECT OF ENVIRONMENTAL UNCERTAINTY

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ABSTRACT

The purpose of the research is to investigate the effect of big data analytics capabilities on competitive advantage, the mediating effect of business model innovation, and the moderating effect of environmental uncertainties. The survey questionnaires are randomly distributed using multistage sampling technique amongst the respondents to collect 304 usable responses. The data is analysed using PLS-SEM. In parallel, interviews with eight individuals from middle management and high-level management are also conducted for the triangulation and in-depth analysis. The results reveal that big data analytics capabilities significantly affect the competitive advantage significant mediation of business model innovation between big data analytics capabilities and competitive advantage. Environmental uncertainties such as market turbulence, technological turbulence and competitive intensity negatively effect of big data analytics capabilities on competitive advantage.

The interviews reveal that telecommunication firms currently utilise their big data analytics capabilities for decision-making to improve their products, which provides them competitive advantage. Innovation in their business model through starting new services for the customers is further providing them a competitive edge which allows them to differentiate in the market. However, the uncertainties like technological turbulence, market turbulence, and competitive intensity are negatively impacting the relationship between big data analytics capabilities and competitive advantage. Keeping in view the dynamically changing requirements of the customers and rapidly evolving technology, the telecommunication industry is unable to enhance the infrastructure capabilities and retain human resource capabilities. The in-depth analysis reveals the reasons as the government policies, unstable local currency, lack of facilities provided by the government, and heavy taxation.

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INTRODUCTION

Information technology has transformed activities and processes in all fields across the world. Due to the changing dynamics of the business world and ever-increasing data, analyzing the data scientifically facilitates decision-making and also helps in improving the production process and eventually the quality of goods or services (Gao et al., 2020). Business analytics plays a positive role in improving business processes by providing a better understanding of changing business dynamics and consumer behaviors and preferences and then devising strategies accordingly (Min, 2016).

At the same time, Big Data (BD) also plays a very pivotal role in the success of the business through targeted marketing and customized service provision. Big Data, has been the focus of research interests in recent times because of its ability to analyze a large amount of data and transform it into valuable information which eventually enables the business to make better and informed business decisions that lead to improved goods and services and also cost reductions (Zhong et al., 2016).

Big Data Analytics (BDA) combines Big Data and Business Analytics. Hence, the use of Big Data Analytics by collecting, processing, and analyzing large amounts of data and providing better insights helps businesses make informed decisions that will eventually enable the businesses to improve customer relationships that improves customer satisfaction which finally gives them a competitive advantage (Dahiya et al., 2022).

The success of any business depends upon the Business Model adopted, as based on their Business Model firms materialize the available opportunities to improve their turnover and earn profits (Yunus et al., 2010). Business Model provides the base for the firms to implement their innovative ideas through the use of technology and thus achieve a competitive advantage (Chesbrough, 2007). However, considering the rapidly changing external environment even a successful Business Model adopted by any firm cannot be used permanently, and to cope with the changing dynamics of the business firms should innovate their Business Models (Schneider & Spieth, 2013).

The focus of the Business Model is limited to the firm level while Business Model Innovation is focused on the customer`s value proposition and structural redesigning of the firm (Spieth et al., 2014). Thus, through Business Model Innovation firms can address the changing dynamics and environmental uncertainty while maintaining their market share and can also achieve competitive advantage. As per the research firms having Big Data Capabilities perform better when it comes to innovation (Zheng et al., 2022).

1.1. Purpose and Scope of the Study

Competitiveness plays an important role in the growth and development of organizations (Sohail et al., 2024). Globally, organizations tend to outperform each other based on profitability, innovativeness, efficiency, and overall market share. Competitiveness is thus a multi-faceted concept which allows organizations to flourish in the market. Businesses compete with their competitors to gain more profit and market share. In Pakistan, businesses have faced issues due to considerable challenges faced by the industrial sector in the past years (Akhuand & Abbas, 2023). The telecommunication sector which had shown enormous growth and competitiveness in the past, the recent exit of a major mobile operator from the market has not only raised a flag about the fierce competition in the telecommunication sector (Ahmed, 2024) but also the capacity of the

organizations to innovate their business model and capabilities of the organizations to gain a competitive advantage over their competitors. In this era of technology, where organizations depend on knowledge-based decisions, it is important that the organizations develop their capabilities to handle the data appropriately and make decisions based on the information.

Pakistan has witnessed enormous digital penetration with 77.7% of the total population with mobile connections. A country producing an enormous amount of data has a huge scope for utilization of big data (Nasir, 2021). Therefore, telecommunication organizations can keep themselves competitive if they develop capabilities to handle big data (Sony & Naik, 2020). Mubarak, Shaikh, Mubarik, Samo, and Mastoi (2019) suggest that industries in Pakistan have been facing various challenges which include a lack of business information infrastructure, a lack of financial resources and a lack of human resources (Mubarak et al., 2019). As the efforts to digitize Pakistan remained half-hearted (Warf, 2017), it is suggested that the policies for industries need to be formulated to encourage the enhancement of experts and the upgradation of industries to promote the usage of big data (Latif et al., 2018).

Therefore, organizations must develop their big data analytics capabilities to make well-informed decisions to compete and sustain in the market. Pakistan's Digital Policy also emphasizes the development of infrastructure that could facilitate cloud and big data capacity building to attract the local and international markets for industrial competitiveness (MoIT, 2018). Considering the digitization of industries for the modern era, this study focuses on the competitive advantage of telecommunication firms in Pakistan, the effect of big data capabilities on competitive advantage, and internal/external factors affecting the big data capabilities and the organization's competitive advantage.

LITERATURE REVIEW

The importance of big data has increased exponentially in the last few years, Big Data Analytics (BDA) has a strategic part in making businesses successful operating in different industries (Jha et al., 2020; Persaud, 2021; Pizło et al., 2023). Organizations using big data are essential components of the economic growth and development of the developed economies as they have the ability, knowledge and skill that enable them to innovate (Duval-Couetil et al., 2016).

BDA Capabilities are the ability of an organization to capture, examine, and analyze data and give meaningful insights by arranging and coordinating unstructured and semi-structured data (Mikalef et al., 2018). There are three main dimensions of the big data capabilities i.e., management, infrastructure, and personnel capabilities. Big data analytics has revolutionized the way of doing business. Several noticeable advantages of big data analysis in various industries have increased the interest of companies in benefiting from its potential. The interest of researchers and practitioners has significantly increased in big data analytics (BDA) given its visible benefits to businesses (Jha et al., 2020; Persaud, 2021).

Many other aspects of big data analytics (BDA) apart from data and its analysis contribute to making big data projects successful. Through the use of big data analytics (BDA) organizations of different sizes are exploring ways of increasing their business value through innovation (Mikalef et al., 2019; Shinwari & Sharma, 2018). The use of big data can contribute positively to economic growth and development by increasing the innovative capabilities of the organizations using it (Shahzad et al., 2017) and in the future may increase the competitive advantage of the firm.

Hence this research project is going to analyze the impact of Big Data Analytic Capability on the creation of Competitive Advantage by way of Business Model Innovation (mediation) and moderating Effect of Environmental Uncertainty between Big Data Analytical Capabilities and Competitive Advantage.

2.1. Big Data Analytic Capabilities in Relationship to Competitive Advantage

Big data capabilities are defined comprehensively by the author that *"it includes resources, techniques, tools, and processes that enable an organization to process, analyze, and visualize big data in such a way that the resulting insights make data-driven planning, decision-making and implementation possible, and ultimately lead to the organization's competitive advantage"* (Dubey et al., 2019; Srinivasan & Swink, 2018).

Previous research has established that advancement in Big Data Analytics has the potential of consequential effects on the operations providing goods and services (Zhong et al., 2016). Embracing Big Data Analytics would enable the service sector, particularly the telecommunication sector to improve the services as Big Data Analytics helps the firms to cater to the problems encountered while providing services to the customers. It will also enable the telecommunication sector to provide custom-made services to each customer using data analysis (Muharam et al., 2021).

As per Fortune Business Insights' latest report (FortuneBusinessInsights, 2021), the global Big Data Analytics market has a value of $271.83 billion, and it's forecasted to reach a value of $ 745.15 by 2030, showing a compound annual growth of 13.5%. Considering the importance of Big Data Analytics, it is also important to identify the factors which give rise to the competitive advantage of

firms. Hence this research study is trying to investigate if Big data analytic capabilities effect the competitive advantage of the firms in the telecommunication sector or not.

Previous studies depicted that the greatest achievement of big data analytic capability is creating valuable insights to understand the changes in the market as well as business environments and also creating a competitive advantage for the firm (Wamba et al., 2017). Another research has also emphasized that big data analytics may provide valuable information which enhances competitive advantage (Morabito, 2015).

BDA capabilities help firms enhance their operations through innovative business models and procedures and enterprise-oriented practices (Côrte-Real et al., 2017), this enables the firm to achieve competitive advantage. Firms that use BDA effectively perform better as compared to their competitors. As BDA facilitates the firms to recognize customer choices and develop the products and services accordingly which gives them a competitive advantage (Grimaldi et al., 2023). Big data Analytic Capabilities along with the right organizational and technological resources, provide valuable and instrumental insights and competitive advantage (Agarwal & Dhar, 2014; Côrte-Real et al., 2017).

The majority of the organizations focusing their investment on enhancing Big Data Analytical Capabilities have the basic motive to get important insights about customer behaviors, market dynamics, and emerging trends, enabling telecom companies to adapt, innovate, and excel in the market which may provide them with a competitive edge (Mikalef et al., 2018). Recent studies in the telecommunication sector also confirmed that BDA has a positive impact on the competitive advantage (Alshawawreh et al., 2024). Bag, Dhamija, Luthra, and Huisingh (2023) established that embracing BDA enables the management of firms to concentrate on organizational resources, capabilities and competencies which leads to competitive advantage.

In the telecommunication sector, studies have been done but it is also a point to focus on that limited studies have examined the relationship between Big Data Analytic Capabilities and competitive advantage specifically in the telecom sector. Therefore, further investigation regarding this aspect and the impact of big data technologies on the competitive advantage of firms will be quite useful for managers as well as employees who work with technologies (Nikolić, 2017). Hence, BDA is considered to play a vital impact on the company's competitive advantage by designing unique business strategies.

On contrary to above, few studies have shown that most of the companies are unable to create a competitive advantage based on their Big data Analytics initiatives (Côrte-Real et al. 2019). These researches also highlighted the need to research further for better understanding if the organizations can gain competitive advantage from Big Data Analytic Capabilities or not. So, to analyze this, the current study hypotheses that:

H1: Big Data Analytic Capabilities have positive impact on creating Competitive Advantage.

2.2. Big Data Analytic Capabilities Effect on Business Model Innovation

Pre-existing research has focused on new venture creation regarding technology use, but there is not enough consideration on the exploration of the dynamic process of interaction between resources (internal and external) of technology-based enterprises to promote business model innovation (Koka

& Prescott, 2008). It is established through the existing research that the organization that rely on big data analytics, report better innovation related performance (Khan & Tao, 2022; Zheng et al., 2022). However, the impact of Big Data Analytic Capabilities on a firm's innovation performance needs further research to be fully understood. Innovation is fundamental to achieving business value. Nonetheless, there is scarce research on what changes should organizations bring to grasp innovation (Munir et al., 2022). The use of big data analytics capabilities for implementing innovative strategies (Ciampi et al., 2021; Munir et al., 2022) is transforming the way many businesses are operated (Santoro et al., 2018).

Business models used by businesses all over the world were badly affected after COVID-19 pandemic (Clark et al., 2020). This made it essential for businesses to devise some effective mechanism to recover from challenges faced after COVID-19 pandemic (Breier et al., 2021). To recover from the effects of this global crisis, new opportunities need to be developed which can be done through innovation by making changes in the existing business models (Breier et al., 2021). This indicates the requirement of conducting research to understand the factors affecting business model innovation. Existing research indicates that innovation in business is significantly dependent on technology (Mostaghel et al., 2022). Existing research also establishes the positive impact of big data analytics capabilities on business model innovation (Ciampi et al., 2021). However, this area needs to be explored as only a handful of research has been done in this area. To explore this relationship further this study has proposed the following hypothesis.

H2: Big data Analytic Capabilities have positive impact on Business Model Innovation

2.3. Business Model Innovation and Competitive Advantage

Most of the authors have the common view point that continuous business model innovation can be a sustainable source of competitive advantage, where firms constantly change business model components based on new technology development and try to satisfy the changing needs in the emerging market. Chesbrough and Rosenbloom (2002) initiated the idea about the business model innovation that it may capture the value and can be a source of creating competitive advantage, later on, multiple authors followed this principle (McGrath, 2013; Osterwalder, 2004; Teece, 2010).

As per the study conducted by Saqib and Satar (2021) on an Indian online transport service OLA which provides ride-sharing services was able to get a competitive advantage through their innovative business model that includes customized customer services, collaborative ecosystem, consumption-based pricing, and competitive expansion strategies. This supports the idea that competitive advantage can be achieved through business model innovation. However, this has not been studied in the context of other emerging markets such as the telecom sector. Based on this connotation, it is hypothesized for the telecom sector of Pakistan that:

H3: Business model innovation has a positive impact on creating Competitive Advantage

Based on H2 and H3 it can also be hypothesized that:

H4: Business Model Innovation mediates the relationship between Big Data Analytic capabilities and Competitive Advantage

2.4. Environmental Uncertainty as a Moderator

Uncertainty is defined as *"the inability to assign an objective probability to each potential outcome or the inability to predict the likelihood of an event occurring"* (Knight, 1921). Environmental uncertainty is considered as the likelihood of unexpected changes in the environment in which firms operate, this includes the unexpected economic, technological, and political changes (Eroglu & Hofer, 2014; Sharfman & Dean, 1991).

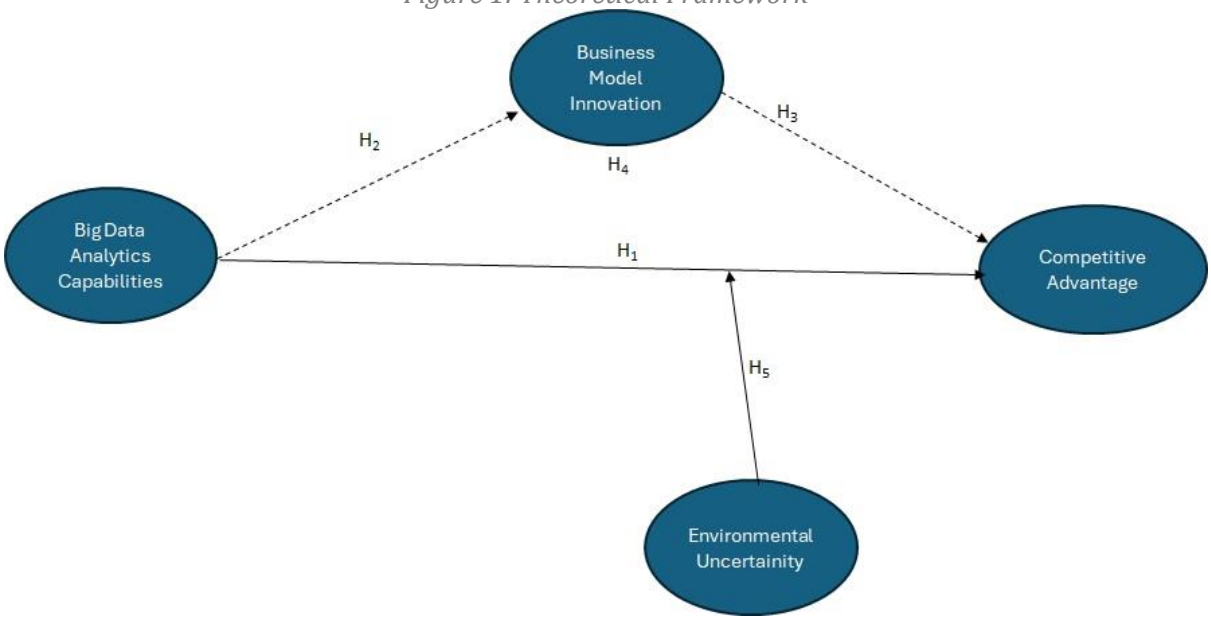
Companies have to deal with environmental uncertainties so that they remain competitive by continuing their business activities (Aldrich, 2008). Environmental uncertainty can be considered as both an opportunity and a threat for firms to innovate their business processes and operations. It can be explained as firms spending most of their resources to cope with the changes in external factors rather than focusing on innovation that leads to competitive advantage (Zhou et al., 2007). On the other hand, firms facing high levels of environmental uncertainties might divert most of their resources to innovation which helps them achieve a competitive advantage as compared to those with lower levels of uncertainties.

The ability of the company to achieve its goals and objectives is dependent upon the environment in which the firm operates. Hence, firms operating in a dynamic environment need to respond quickly to maintain their competitive advantage (Koka & Prescott, 2008). Therefore, apart from posing a threat to the firms, environmental uncertainty has a lot to offer. As environmental uncertainty acts both as an opportunity and a threat for the firms, companies that can combat the threats related to environmental uncertainty and avail the related opportunities by making the right investment decisions and implementing innovative ideas can achieve competitive advantage (Dreyer & Grønhaug, 2004). Therefore, apart from creating the risk for the firms environmental uncertainty at the same time gives many opportunities (Lee et al., 2015). The direct effect of environmental uncertainty has been studied on competitive advantage in various studies (Koç et al., 2022). Also moderating role of environmental uncertainty between digital platform capability and the competitive advantage of manufacturing companies has been studied (Liao et al., 2024). However, there is no evidence of a study conducted on the moderating role of environmental uncertainty between big data analytic capabilities and competitive advantage. Hence the study proposes that:

H5: Environmental Uncertainty acts as a moderator between Big Data Analytical Capabilities and competitive advantage:

The research model is given in Figure 1.

Figure 1: Theoretical Framework



Source: Authors' compilations.

THEORETICAL LENS

Literature is expanding on the business potential of big data analytics but still, the empirical work is quite limited on which established theories should be used and applied in the IT-business value domain (Gupta & George, 2016). The current study used a deductive approach based on the resource-based view (RBV) of the firm, as well as the emerging dynamic capabilities view (DCV).

The recourse-based view provides the base upon which all relevant resources can be identified and evaluated towards their importance. It has been widely used in the information technology context, especially in measuring IT-related capabilities (Bharadwaj, 2000). The recourse-based view rationalizes that an organization consist of a bundle of tangible and intangible resources which may provide the basis to create competitive performance gains (Mikalef et al., 2016). Resources are defined as assets, knowledge, capabilities, and processes. So Big Data Analytic Capabilities are organizational intangible resources which may create a competitive advantage for the firm. Encompassing the resource-based view, which suggests that organizations may attain competitive advantage based on various resources and capabilities (in the current research big data analytics capabilities) which are in their control, and based on these capabilities organizations can innovate by introducing new concepts and models. While the Dynamic Capability View endeavors to explain how organizations sustain a competitive advantage in the changing environments (Eisenhardt & Martin, 2000). Thus, both the internal and external environmental factors should be considered to take the necessary actions required to perform operations according to changing demands. So in the current research Environmental Uncertainty is taken as a changing environment which indirectly affects competitive advantage while acting as a moderator.

On the basis of the given theoretical lens, the theoretical framework of the study is developed which explains Big Data Analytic Capabilities lead to creating a competitive advantage for the companies involved in big data usage, by the mediating effect of Business Model Innovation and the moderating effect of Environmental Uncertainty between big data Analytic Capabilities and Competitive Advantage.

MATERIALS AND METHODS

Most of telecommunication firms are using big data in their day to day operations and require financial and human resources to take advantage of big data. Financial resources are required for deploying databases on servers and human resources are required to maintain the databases and information extraction from the data through analytics. Therefore, to analyse big data analytic capabilities and its effects, the target population for this study is the telecommunication sector of Pakistan.

4.1. Sampling and Research Design

For the selection of a sample from the telecom sector multistage sampling technique is used. In the first stage random sampling is adopted to select the targeted population i-e. 9 telecom companies (main offices located in big cities like Karachi, Lahore and Islamabad) from the sample frame of a total of 18 telecom companies in Pakistan. Letters to all the randomly selected companies were written to participate in this research, through emails and post. In response to the letter, 7 companies responded to participate in the research. In the second stage, the focal persons from the middle and high organizational tier were contacted. These focal persons were also requested to select the branches of their respective firms randomly to collect the data. In the 3rd stage, a random selection of the respondents/participants was done by the firms from the lower, middle and higher tiers based on the criteria that employees are directly or indirectly involved in the usage of big data analytics in the firm operations. In total 304 responses were collected based on random sampling by all the telecommunication firms.

The adequacy of sample size was verified through multiple methods. First, suggestion provided by (Hair et al., 2021) were taken under consideration. According to (Hair et al., 2021), minimum sample should be equal to 10 times the largest number of structural paths directed at a particular construct in the structural model. In this study, there are three paths directing towards the endogenous variable (including the moderator). Therefore, according to this principle, minimum 30 samples are adequate. Second, inverse square root method suggested by (Kock & Hadaya, 2018) was assessed for the minimum sample size. Keeping in view significance level of 5% and minimum path coefficient 0.3, the minimum sample size comes out to be 68.66. Third, (Cohen, 1992) suggests calculating the sample size using maximum number of arrows pointing towards the construct and R^2. Keeping in view the model, there are three arrows pointing towards the construct (including moderator variable) and if the minimum achievable R^2 is 0.50 (medium effect size), minimum sample size comes out to be 38. Sample size calculator available on the web (Soper D. S, 2024) was also used for sample size calculation. (Soper D. S, 2024) is supported by the suggestions of (Cohen, 1992) and (Westland, 2010). According to (Soper D. S, 2024), for the anticipated medium effect size of 0.3, desired statistical power of 0.8, 8 latent variables, and 45 observed variables, the minimum sample size is determined as 177. A sample of 304 responses proves to be sufficient for the analysis using PLS-SEM and exceeds all the minimum sample size criterion discussed above. Also, as PLS-SEM is a non-parametric technique, some researchers argue that it proves to be robust for smaller sample size as well.

To fulfil the objectives of the project quantitative study is conducted. The motive behind conducting the quantitative study is supported by the view of various authors (Windmann et al., 2015; Huynh et al., 2023) who suggested analysing the big data capabilities of the firm in quantitative terms,

especially in the service sector (limited studies have been conducted) other than the qualitative which remained a common approach in the past (like (Bhatti et al., 2022; Sabharwal & Miah, 2021). Also, quantitative research employs standardised procedures, measurement instruments, and statistical methods which lead to more reliable and valid research, grounded in the managerial employees of multiple telecommunication firms. This also helps promote evidence-based decision-making in domains like psychology and organisational behaviour (Saunders et al., 2019). Quantitative research is performed with the help of survey distributed among respondents. To validate the data collected through survey, triangulation technique is used by conducting semi-structured interviews with the top and middle management. Interviews provided us with in-depth opinions and views regarding the big data analytics capabilities of the telecommunication firms, innovation techniques and models the firms are using, the level at which firms can create competitive advantage and the uncertainties due to dynamically changing market and external forces involved in it. The interviews are used to validate the findings of quantitative responses and to identify the reasoning. A total of 8 individuals from the high-level and middle-level management were interviewed.

4.2. Measurements

The measurements proposed by Sun and Liu (2021) and Ashaari, Singh, Abbasi, Amran, and Liebana-Cabanillas (2021), were used to measure big data analytics capabilities. These measures are comprised of three dimensions, i) Infrastructure capabilities with the sample question as *"Our organization gathers data from multiple sources for data analysis"*, ii) Human resource capabilities with the sample question *"Our analytic staff are very knowledgeable about the role of business analytics"*, and iii) management capability with sample question *"Our organization performs big analytics planning processes in systematic ways"*.

The questionnaire contained the Business model innovation is measured using a six-item scale adapted from (Asemokha et al., 2019). The sample question of business model innovate-on is *"We leverage big data insights to optimize our internal operations for better opportunities"*.

Environmental uncertainty was measured using three dimensions, Market/Demand Turbulence having 4 items, Technology Turbulence having 4 items, and Competitive Intensity having six items. The measures were adopted from previous studies (Grewal & Tansuhaj, 2001; Jaworski & Kohli, 1993; Uzkurt et al., 2012). Sample question for environmental uncertainty is *"The demand of our customers varies a lot"*.

Competitive advantage was measured with the six-item scale adopted from (Singh et al., 2019). The sample question of competitive advantage is *"Our organization's products/services are better than its competitors"*. The responses of all the constructs will be taken on a 5-point Likert scale (1 = Strongly Disagree and 5 = Strongly Agree).

4.3. Analysis Tools

After data collection, SPSS is used for the basic data analysis. The testing of hypotheses is carried out using PLS-SEM as it provides high statistical power (Hair et al., 2023) and is widely accepted and preferred in business research fields such as information systems, consumer behaviour, and marketing (Peng & Lai, 2012). SmartPLS version 4.0, which is a scientifically grounded software

(Memon et al., 2021) was used for data analysis in this study. This software has proven to be very useful in helping researchers analyse complex relationships between latent variables i.e., moderation and mediation (Cheah et al., 2024).

RESULTS

The demographic information extracted from respondents' telecommunication sector in Pakistan unveils a comprehensive snapshot of the industry's composition and characteristics and is illustrated in Table 1. Key findings shed light on various aspects, including gender, education, organization representation, and the distribution of roles within these organisations.

The sample population is characterised by a strong male majority, with 76.6% of respondents identifying as male. This suggests a significant gender disparity within the sample. In terms of age, the sample is relatively young, with a concentration of respondents between 25 and 40 years old (82.9%). This implies that the study primarily focuses on individuals in the early to mid-stages of their careers, which may influence their perspectives, experiences, and priorities in the workplace. The sample population also exhibits a high level of education, with 75% holding a bachelor's degree or equivalent. This suggests a focus on individuals with a strong academic background, which may contribute to their career trajectories and aspirations. The sample is distributed across higher, middle, and lower management tiers within their organisations. This distribution allows for a comparison of perspectives and experiences across different levels of management responsibility and authority. The sample population exhibits a wide range of experience levels, but the majority (66.5%) have between 1 and 15 years of experience. This suggests a focus on individuals who are relatively early or in the mid of their careers. Overall, the sample population is characterised by a young, well-educated, predominantly male workforce employed in the private sector. This demographic profile provides valuable insights into the characteristics and experiences of the individuals participating in the study.

The researchers meticulously assessed the measurement model to see the reliability and validity of the constructs. The results are displayed in Figure 2. Researchers used reflective measurement techniques, which rely on the influence of the measures themselves on each other. To ensure the measures accurately captured the intended concepts (construct validity), researchers focused on three key aspects: internal consistency reliability, convergent validity, and discriminant validity (Hair et al., 2023).

Construct validity essentially refers to how well a test measures the intended constructs. Hair et al. (2023) identify two main approaches to assess this validity: convergent validity and discriminant validity. Convergent validity examines how closely measures of the same construct are related. High correlations between these measures (indicated by standardised outer loadings above 0.700) suggest they capture the same concept effectively (Hair et al., 2023). However, even if some loadings fall below this threshold, the measure can still be acceptable if the Average Variance Extracted (AVE) for the construct surpasses 0.50 (Hair et al., 2023). A high AVE indicates that, on average, the construct explains more than half of the variation in its measures, suggesting a good fit. Table 2 presents the results of this measurement model evaluation.

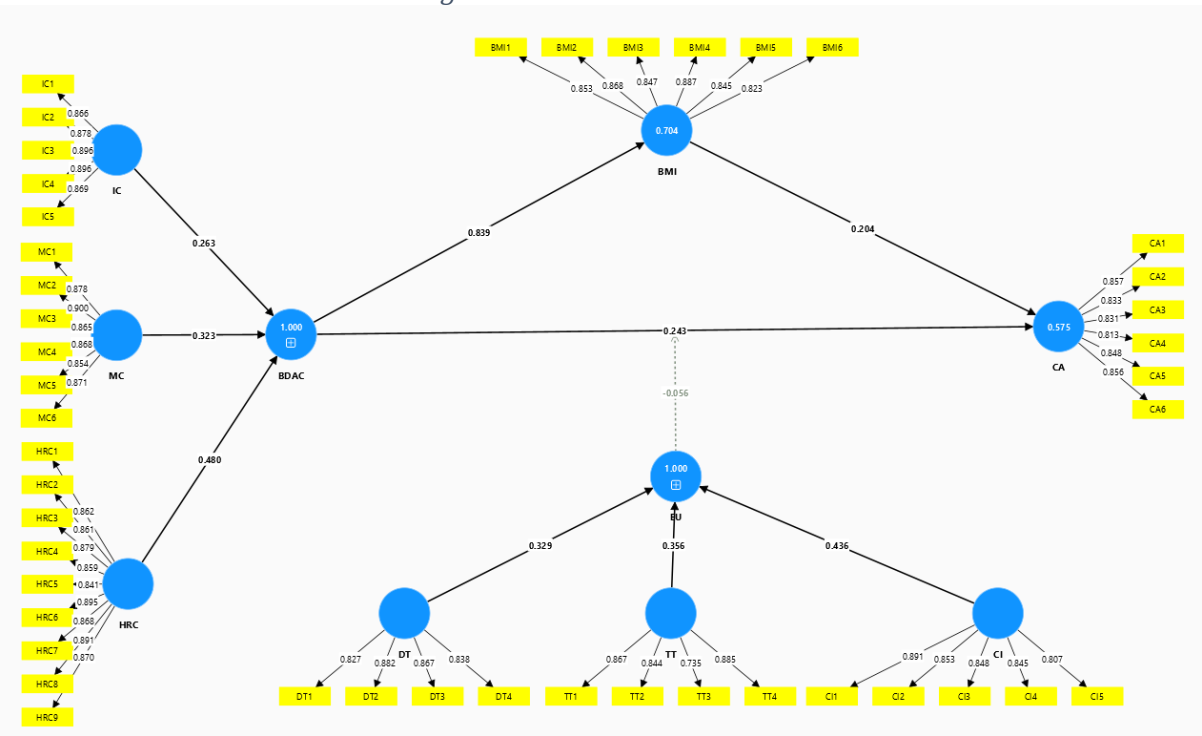
Table 1: Frequency distribution of Industry characteristics

Demographic	Frequency	Percent	Cumulative Percent
Gender			
Male	223	76.6	76.6
Female	71	23.4	100
Total	164	100	
Age			
Below 25	52	17.1	17.1
25-30	117	38.5	38.5
31-40	83	27.3	27.3
41-50	48	15.8	15.8
Above 50	4	1.3	1.3
Total	304	100.0	100.0
Education			
BS or equivalent	228	75.0	75.0
MS or equivalent	69	22.7	97.7
PhD	3	1.0	98.7
Other	4	1.3	100.0
Total	304	100.0	
OrgTier			
Higher Management	48	15.8	15.8
Middle Management	113	37.2	53.0
Lower Management	143	47.0	100.0
Total	304	100.0	
Age			
Below 25	52	17.1	17.1
25-30	117	38.5	55.6
31-40	83	27.3	82.9
41-50	48	15.8	98.7
Above 50	4	1.3	100.0
Total	304	100.0	
Experience			
1-5 years	68	22.4	22.4
6-10 years	80	26.3	48.7
11-15 years	54	17.8	66.4
16-20 years	29	9.5	76.0
21-25 years	34	11.2	87.2
26-30 years	14	4.6	91.8
31-35 years	18	5.9	97.7
36-40 years	7	2.3	100.0
Total	304	100.0	

Table 2: Measurement Model

Construct		Item	Factor Loading	Composite Reliability	AVE
Business Model innovation		BMI1	0.853	0.926	0.730
		BMI2	0.868		
		BMI3	0.847		
		BMI4	0.887		
		BMI5	0.845		
		BMI6	0.823		
Competitive Advantage		CA1	0.857	0.918	0.706
		CA2	0.833		
		CA3	0.831		
		CA4	0.813		
		CA5	0.848		
		CA6	0.856		
Big Data Analytics Capabilities	Human Resource Capabilities	HRC1	0.862	0.960	0.756
		HRC2	0.861		
		HRC3	0.879		
		HRC4	0.859		
		HRC5	0.841		
		HRC6	0.895		
		HRC7	0.868		
		HRC8	0.891		
		HRC9	0.870		
	Infrastructure Capabilities	IC1	0.866	0.928	0.776
		IC2	0.878		
		IC3	0.896		
		IC4	0.896		
		IC5	0.869		
	Management Capabilities	MC1	0.878	0.938	0.761
		MC2	0.900		
		MC3	0.865		
		MC4	0.868		
		MC5	0.854		
		MC6	0.871		
Environmental Uncertainty	Technological Turbulence	TT1	0.867	0.859	0.697
		TT2	0.844		
		TT3	0.735		
		TT4	0.885		
	Market Turbulence	DT1	0.827	0.876	0.729
		DT2	0.882		
		DT3	0.867		
		DT4	0.838		
	Competitive Intensity	CI1	0.891	0.904	0.721
		CI2	0.853		
		CI3	0.848		
		CI4	0.845		
		CI5	0.807		

Figure 2: Measurement Model



The measurement model assessment utilizing PLS-SEM revealed strong psychometric properties across all constructs. Business Model Innovation (BMI) exhibited excellent internal consistency and convergent validity, as evidenced Composite Reliability (CR) of 0.926, and Average Variance Extracted (AVE) of 0.730. Similarly, Competitive Advantage (CA) demonstrated exceptional reliability and validity, with CR of 0.918, and AVE of 0.706. Big Data Analysis Capabilities (BDA) construct has three dimensions. The Human Resource Capabilities (HRC), CR of 0.960 and AVE of 0.756 also showcased remarkable internal consistency and convergent validity. The Infrastructure Capabilities (IC), CR 0.928 and AVE 0.776 also meets the convergent validity criteria. Management Capabilities (MC) were also found to be internally consistent with CR of 0.938 and AVE of 0.761. Environmental Uncertainty (EU) is also measured using three dimensions. Technological Turbulence (TT) exhibited good internal consistency with a CR of 0.859 and AVE of 0.697. Similarly, other dimensions, Market Turbulence (DT) and Competitive Intensity (CI) were also found out to be consistent with CR of 0.876 and 0.904 and AVE of 0.729 and 0.721 respectively.

After assessing the internal consistency and convergent validity of the constructs, discriminant validity was assessed. Hair et al. (2023) defines discriminant validity as a measurement instrument's ability to distinctively represent a concept, affirming its uniqueness in a model. This validity is confirmed when the square root of the average variance extracted exceeds inter-construct correlations. Three criteria, including cross-loadings, the Fornell-Larcker criterion, and HTMT, were used to assess discriminant validity (Hair et al., 2023; Henseler et al., 2009). The Fornell-Larcker criterion states that each construct's square root of the average variance extracted should surpass its inter-construct correlations. Table 3 shows that all AVE values surpassed the corresponding squared correlations, confirming the distinctiveness of each construct. For instance, Competitive Advantage (CA) had an AVE of 0.840, significantly higher than its highest squared correlation of 0.689 with other

construct. This indicates that CA is a unique concept, separate from others in the model. Similar patterns were observed for all other constructs, with AVE values consistently exceeding squared correlations, underscoring the model's strong discriminant validity. These results demonstrate that the constructs are distinct and well-defined, allowing for clear interpretation and analysis of their relationships. The model's robust discriminant validity further solidifies its foundation for further investigation, ensuring that any observed relationships between constructs are not due to overlap or measurement error, but rather reflect true differences in the underlying concepts.

Table 3: Fornell-Larcker Criterion

	BMI	CA	CI	DT	HRC	IC	MC	TT
BMI	0.854							
CA	0.688	0.840						
CI	0.622	0.633	0.849					
DT	0.602	0.534	0.575	0.854				
HRC	0.779	0.708	0.628	0.617	0.870			
IC	0.768	0.554	0.599	0.549	0.795	0.881		
MC	0.815	0.658	0.551	0.529	0.826	0.824	0.873	
TT	0.701	0.657	0.784	0.710	0.687	0.629	0.601	0.835

The discriminant validity was assessed using the Heterotrait-Monotrait (HTMT) ratio, following the recommendations of (Hair et al., 2023). The outcomes of this analysis are presented in Table 4. When the HTMT value exceeds 0.85, it indicates a potential issue with discriminant validity. Conversely, values below 0.85 are indicative of good discriminant validity (Hair et al., 2023). As demonstrated in Table 4, all HTMT values were below 0.85, signifying robust discriminant validity. Thus, the evaluations of convergent and discriminant validity have affirmed the reliability and validity of the measurement items, thereby facilitating hypothesis testing.

Table 4: Heterotrait-Monotrait (HTMT) ratio

	BMI	CA	CI	DT	HRC	IC	MC	TT	EU x BDA
BMI									
CA	0.744								
CI	0.680	0.690							
DT	0.667	0.595	0.647						
HRC	0.826	0.752	0.674	0.673					
IC	0.828	0.596	0.654	0.609	0.842				
MC	0.875	0.704	0.597	0.583	0.868	0.882			
TT	0.786	0.741	0.891	0.825	0.759	0.706	0.671		
EU x BDAC	0.682	0.634	0.613	0.623	0.672	0.640	0.623	0.724	

The quality of the structural model was evaluated using various indicators, including R^2 values, Q^2. According to (Hair et al., 2021), R^2 values fall within a range of 0 to 1, with values of 0.75, 0.50, and 0.25 representing substantial, moderate, or weak levels of variation in endogenous constructs, respectively. The Table 5 illustrates the assessment of the structural model quality in the PLS-SEM analysis. It showcases the model's strong explanatory and predictive power. For each construct, a substantial portion of the variance is explained by the model, as indicated by the high R^2 values. Specifically, Business Model Innovation (BMI) has 70% of its variance explained, Competitive Advantage (CA) has 57%, while Human Resource Capability (HRC), Infrastructure Capability (IC),

and Management Capability (MC) exhibit even higher explanatory power at 91%, 82%, and 87%, respectively. Similarly, Technological Turbulence (TT), Market Turbulence (DT), and Competitive Intensity (CI) exhibit explanatory power of 86%, 69% and 81% respectively. All the values of R^2 show that the constructs explain medium to high level variation. The model's predictive relevance is further validated by the Q^2predict values, all of which are above 0.67, suggesting the model's ability to forecast omitted data for each construct and indicating a good fit between the observed and predicted values.

Table 5: Quality of Structural Model

Constructs	R^2	R^2 Adjusted	Q^2predict
BDAC	0.705	0.704	0.704
BMI	0.579	0.574	0.561

The Q^2 statistics were computed in SmartPLS software using a PLSPredict procedure. This method is employed to assess the quality of both the path model and data fit. When the Q^2 value exceeds zero, it suggests that the conceptual model possesses the capability to measure endogenous latent constructs (Henseler et al., 2016). Table 5 illustrates that the results of the Q^2 statistics demonstrate the model's capacity to forecast the endogenous latent constructs effectively. All the Q^2 values surpass the predefined threshold values, indicating that the conceptual model exhibits sufficient predictive relevance.

Figure 3: Structural Model

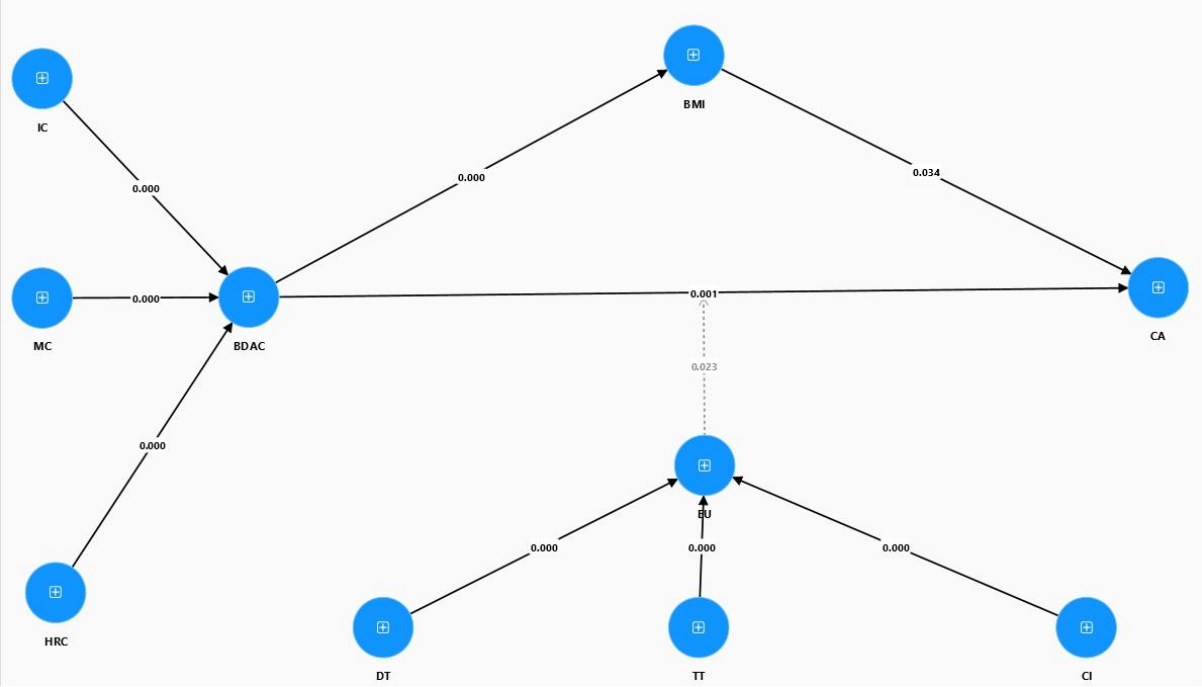


Table 6 provides the results of hypothesis testing. The analysis of the hypotheses reveals intricate relationships between the constructs, shedding light on the dynamics within the model. The first hypothesis (H1), examining the impact of Big Data Analytics Capabilities (BDA) on Competitive Advantage (CA), is supported, with a statistically significant relationship of (p-value = 0.000; β = 0.415; t-value = 6.330), reinforcing the notion that big data capabilities (BDA) do offer a competitive advantage.

The second hypothesis (H2), proposing a positive effect of Big Data Analytics Capabilities (BDA) on Business Model Innovation (BMI), is strongly supported by the data. Significant relationship of BDA and BMI with (p-value = 0.000; β = 0.839; t-value = 33.252), it is evident that BDA plays a substantial role in driving BMI. This suggests that firms leverage big data to innovate their business models successfully.

The third hypothesis (H3) investigates the direct link between BMI and CA, shows the relationship is statistically significant with (p-value = 0.034; β = 0.200; t-value = 2.120). The overarching aim of this research is to investigate whether business model innovation mediates the relationship between big data capabilities (BDA) and competitive advantage (CA). Results depicted that the mediation of BMI between the BDA and CA remains significant with (p-value = 0.037; β = 0.168; t-value = 2.084). Ensuring the accuracy of the lower and upper confidence limits is paramount. In accordance with the guidelines outlined by Preacher and Hayes (2004), the acceptance or rejection of the mediation hypothesis hinges on whether the confidence interval for the mediation effect includes zero. A non-zero interval suggests the acceptability of the mediation hypothesis, while an interval encompassing zero warrants rejection. To accomplish this, a two-step approach was employed in this study. The initial stage involved the evaluation of all direct relationships, both without and with mediators. Subsequently, in the second phase, all indirect effects were computed, and their significance was ascertained through bootstrapping. The analysis of indirect effects was conducted at stage two, where all relevant mediators were computed. The mediation analysis results revealed a significant indirect effects of big data analytics capabilities (BDA) on competitive advantage (CA) through the mediation of business model innovation (BMI) as lower and upper bounds do not encompass zero (LCL 2.5% = 0.015, UCL 97.5% = 0.332), providing evidence of the mediation existence. Hence accepting H4

The fifth hypothesis (H5) reveals a moderating effect of EU on the relationship between BDA and CA. The negative interaction with (p-value = 0.023; β = -0.056; t-value = 2.279) signifies that the positive impact of BDA on CA is attenuated when environmental uncertainty is high. This suggests that while BDA is beneficial, its effectiveness in enhancing competitive advantage may be limited in highly uncertain situations.

Table 6: Results of the Direct Relationship of Hypothesis Testing

Path	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	2.5%	97.5%
BDA -> BMI	0.839	0.025	33.252	0.000	0.784	0.882
BDA -> CA	0.415	0.066	6.330	0.000	0.291	0.547
BMI -> CA	0.200	0.094	2.120	0.034	0.018	0.390
EU x BDA -> CA	-0.056	0.024	2.279	0.023	-0.099	-0.003
BDA -> BMI -> CA	0.168	0.081	2.084	0.037	0.015	0.332

PRILIMINARY FINDINGS AND DISCUSSIONS

The study aimed to investigate three objectives. The first objective was to investigate the effect of big data analytics capabilities on the competitive advantage of the telecommunication firms of Pakistan. The results show that the big data analytics capabilities significantly affect the competitive advantage. The big data analytics capabilities are comprised of infrastructure capabilities, human resource capabilities, and management capabilities. Telecommunication firms have all three capabilities in place. According to telecommunication firms, they can store an enormous amount of data. According to telecommunication firms, the data is increasing at an enormous speed. One of the respondents mentioned that:

"If the data being generated by the customer was 2 terabytes a few years ago, now the same user is generating 30 terabytes of data".

The availability of the data allows telecommunication firms to make information-based decisions. The telecommunication firms are currently equipped with the infrastructure, human resources and management capabilities to handle and convert the data into useful information.

The second objective was to investigate the mediating role of business model innovation and competitive advantage. The results reveal that the business model innovation does not mediate the relationship between big data analytics capabilities and competitive advantage. One of the reasons for the insignificant mediation of business model innovation is the hyper-competitiveness of the telecommunication sector. As one of the respondents from the telecommunication sector said that:

"It is a hyper-competitive sector. If one company offers a product, the second company offers the same for 3 Rupees less and in another two hours the third company offers 10 Rupees less. Unfortunately, what that has led in Pakistan, partly, although policies also have also part in it, but I think where the competition has gone wrong is, that our ARPU (Average Revenue per User) has reduced to a very low level, which on one hand the customer might think from the affordability that it is great but we are unable to improve the network, because there is no money in the sector."

The respondent further added that:

"Although the ARPU is low, we are only able to keep our heads over the water due to the increasing number of subscribers".

This suggested that it is mostly the pricing strategy which is employed to attract the customers and there are no substantial innovative propositions to attract the customers. For this, one of the respondents said that:

"Not really, in any competitive market pricing is an issue. People would always choose the cheaper solution".

As telecommunication firms have enormous amounts of data, they use the data for providing various services, suggesting the firms innovative business model. The respondents said:

"We remain within the limits and abide by the policies but monetise the data. As we have the data, we have the ability to provide exact information to any firm or business coming to us. We slice and dice the data and then, we tell them that there are 1 million customers which are identified. If they want targeted marketing, we can do it using our network".

The value is not generated only by one innovative solution provided. There are many services that were offered to the customers based on the evaluation of the data. These services were found out to be used by the customers on the regular basis. The respondents in this regard said:

"All the services that are being offered to the customers are based on the evaluation of the data. We will not be able to differentiate the specific value that is being generated from a single service. One should understand that that transforming from a simple telecommunication firm to digital world is in itself is the innovation in the business model. Now that we live in a digital world, we evaluate the type of the services required by the customers through data. We analyse the data and then we offer what our customer requires".

It is interesting to see that telecommunication firms are not only capable of offering the communication channel to the customers but also the services to the other public and private sectors. Now, the private and public sector can seek the services from the telecommunication firms. Telecommunication firms have the capability to provide the public and private sector with the required information. However, the respondents identified various challenges, which becomes a possible barrier to innovating the business model. The respondents were very much concerned with the services to be offered to the public sector organisations. As one of the respondents highlighted:

"We can offer the services to both private and public sectors. The issue is not with the private sector, but the public sector. One of the biggest customers can be the public sector, but they don't pay for the services. I will give you an example. During COVID-19, the government required data for identification of the areas which were Covid-19 infected. The government asked the telecommunication firms for their assistance in identifying the COVID-19 infected areas based on the data that we have. We analysed our data and identified the COVID-19-infected areas. But this was all done in the name of corporate social responsibility. The government did not pay the telecommunication firms. On the other hand, a customer has to buy a SIM, they have to register the biometric which is authenticated by NADRA. The government charges us for every biometric that is registered. If the government has enabled the monetisation of their services, why cannot telecommunication firms monetise the services for the Government of Pakistan?".

The monetisation of the services was not the only issue why telecommunication firm thinks innovating the business model is an issue. Two more concerns were shown by the telecommunication firms. The first is the limitations pertaining to the infrastructure/hardware and the second pertains to the human resource. Although telecommunication firms have the infrastructure capabilities, there are two limitations where the new services and innovations cannot be implemented. The first is the data protection bill, in which the firm in Pakistan cannot store customer data on the network infrastructure/clouds outside Pakistan. This leads to constraints in the hardware for the telecommunication firms. According to the respondents:

"The clouds available in Pakistan are not mature enough and cannot be relied upon".

Respondents further added:

"The future is in the predictive analytics. This requires artificial intelligence-based solutions which would provide this sector with a new dimension of competitive advantage. Unfortunately, we do not have the equipment to support predictive analytics either."

Another respondent added:

"We wanted to develop an artificial intelligence-based chatbot, unfortunately, we could not test it due to the hardware limitation. We can procure the hardware, but it requires a lot of time and is usually very heavily taxed. Take an example of a graphics processing unit which is required in the processing of huge data. Unfortunately, there are huge taxations and embargos on the imports of the hardware."

The respondents also highlighted that:

"As the dollar is also highly unstable, the purchase of the equipment also comes out to be costly for us. Therefore, any innovation in the business which can provide benefit to the customers, cannot be offered due to the fluctuating dollar and government policies."

The respondents continued:

"The solution to the infrastructure problems is that the government should try bringing data centres of the international clouds such as Amazon Web Services (AWS), Google and Microsoft Azure to Pakistan. These are very mature services and can solve the storage as well as processing issues."

Another respondent said:

"The government is encouraging to develop the cloud which can be used for the big data analytics, but it's the cost of the infrastructure which is a real challenge. The costs are too high, the conversion of Pak Rupee to Dollar is a gamble, and then the taxes and duties on the top of it. The way the technology is changing and customer requirements are evolving, better infrastructure is not becoming a requirement but a necessity. On the other hand, it is becoming equally difficult to get the technology which supports customer requirements."

The respondents not only added the issues with the infrastructure capabilities but also with the human resource capabilities. Although the telecommunication firms, according to their requirements, establish good human resource capabilities, they show their concern about the brain drain in Pakistan. A good human resource is necessary to innovate the business models and provide solutions according to the dynamically changing market. The respondents from the telecommunication firms added:

"Good human resources is also difficult to find. There is a lot of brain drain in Pakistan. The people who know data science and work in the big data analytics area are uncertain about the future. Why would a person like to stay in Pakistan when even after paying such heavy taxes, the government is not going to facilitate the taxpayers? People find attractive opportunities, and take an exit from the country."

In such cases, where telecommunication firms are facing multiple challenges in infrastructure capabilities and human resource capabilities, it becomes a challenging task to innovate the business model to gain a competitive advantage. Therefore, insignificant mediation of business model innovation is due to the challenges being faced by telecommunication firms in further improving the infrastructure capabilities and human resource capabilities.

The third objective was to investigate the moderating effect of environmental uncertainty on the relationship between big data analytics capabilities and competitive advantage. The environmental uncertainty has a significant negative effect on the relationship. This suggests that environmental uncertainty reduces the positive effect of the big data analytics capabilities on competitive advantage. Environmental uncertainty was measured using market turbulence, technological turbulence and

competitive intensity. Although telecommunication firms are continuously facing a dynamically changing market, they are trying their best to adapt and remain competitive in the market. There is evidence that telecommunication firms try to meet the requirements of their customers, but the firms have concerns which lead to the negative moderating effect of the environmental uncertainties on big data analytics and competitive advantage.

The improvement in the infrastructure and the government policies are identified as the reasons. It has already been discussed in this section that telecommunication firms need to improve their infrastructure if they need to provide new services to customers. Heavy taxation, the embargo on the hardware, fluctuation in the rate of the dollar and inconsistent policies of the government make it difficult for telecommunication firms to remain competitive in the market. The respondents highlighted in one of his comments that:

"There is a reason why we are unable to jump to 5G whereas there are countries that are implementing 5G now. This is because of the cost of infrastructure. The telecommunication firms are unable to develop the infrastructure because of a very high cost. Along with that, the economy of Pakistan is very unstable which also destabilises the dollar."

It was further added by the respondents:

"In Pakistan, if you need the license, the telecommunication firms have to give approximately $ 300 million upfront. Usually, the governments in Pakistan last 2-3 years, the license is for 15 years, and governments don't care about what is going to happen later on. So, they intend to recover as much money as possible during their tenure."

The respondent further added:

"Now that $ 30 million is a huge money, what they have said is that the operators can make deferred payments, but with Kibor plus some percentage. This thing given that there is a devaluation and inflation is asking for a disaster for telecommunication firms. If I agree with the deferred payment and the dollar rate goes up and the rupee has devalued, I am earning in rupee. The same $30 million dollars that I had to give as a deferred payment will become $50 million dollars. This is the reason why mostly the operators had an operational loss."

One of the respondents further added:

"Warid and Telenor left because both of them were struggling. This is not possible that these companies were run with bad management but rather there is something fundamentally wrong with how this sector is being run."

On top of this, the competitiveness of telecommunication firms is further affected by the facilities that are expected to be provided by the government to the telecommunication sector. The respondents added:

"Our base stations are supposed to run on the electricity. Due to the unexpected load shedding, we run the base stations on diesel. This eventually affects our overall cost further affecting the competitive gains."

As already discussed, the telecommunication sector faces high costs in the procurement of hardware and other infrastructure development, these escalating costs of the infrastructure and the

government policies result in the reduction of big data analytics capabilities and the competitive advantage.

CONCLUSION BASED ON FINDINGS

The telecommunication firms have developed big data analytics capabilities which contribute to the competitive advantage of telecommunication firms. The telecommunication firms have established their local cloud and hired competent human resources who can perform data analytics based on the data stored on the cloud. The big data analytics run by the firms are either for the improvement of their existing products or to identify their target market for their new products/ services to be offered in the market. By doing so, the telecommunication firms have enabled themselves to innovate their business model, where they are offering more than just a medium to communicate to their customers. The telecommunication firms based on their innovative business models, have managed to gain a competitive advantage where they are able to differentiate themselves in the market. However, insights from the respondents from the telecommunication firms point towards multiple challenges towards the big data analytics capabilities, especially infrastructure and human resources due to the dynamically changing market (customers' requirements change rapidly) and rapid change in the technology.

To address the dynamically changing requirements of the customers and the evolution of technology, telecommunication firms need to improve their infrastructure continuously. The infrastructure which includes the hardware, costs in US dollars and due to the fragile Pakistani economy, the rate of the Pakistani Rupee keeps on fluctuating against the US dollar. The telecommunication firms in Pakistan, which acquire spectrum licenses in US dollars, are earning in Pakistani Rupee. Pakistan has one of the lowest ARPU in the world and the ARPU has declined in USD terms over the last few years. As the ARPU of telecommunication firms is decreasing in this hyper-competitive market and overall macroeconomic challenges, the telecommunication firms have faced a considerable reduction in revenue in USD, which is threatening the telecommunication sector survival. Along with this, there are heavy taxes and embargos on hardware imports.

Along with the infrastructure, there are issues related to another capability of big data analytics, which is, human resources. Telecommunication firms are finding it difficult to hold a good human resource. One of the reasons for this is the heavy taxes being imposed by the government and little facilities being provided. Due to these reasons, any good and experienced human resource finding a good opportunity abroad leaves the country. The telecommunication firms face the challenges due to the lack of experienced human resource.

Although telecommunication firms currently have big data analytics capabilities in place, through which they are gaining competitive advantage using big data analytics capabilities and through business model innovation. Their overall competitive advantage is negatively affected due to the environmental uncertainties caused by market turbulence, technological turbulence and competitive intensity. The rapid change in the technology also change the customer preferences/ requirements, causing an intense competition. The reason for negative effect of the environmental uncertainty on the effect of big data analytics capabilities on the competitive advantage is due to the government policies, unstable Pakistani Rupee, heavy taxation, and lack of facilities. Although the government is encouraging to develop the local clouds, it needs to facilitate the firms to develop the clouds where they can compete in the international market.

POLICY RECOMMENDATIONS:

Although telecommunication firms were found to have a capability to operate the big data analytics and gain competitive advantage and innovate their business model. Following concerns were noted during research, for which following recommendations are made for the policy reforms.

1. Concern

Clouds at the national level are not mature in comparison to the international clouds. One of the reasons is the lack of improvement in the infrastructure capabilities. Keeping in view the rapidly growing technology, telecommunication firms are unable to provide innovative big bata analytics solutions. The reasons are, high taxation, custom duties and embargos on the hardware equipment.

Recommendations: To take the cloud services to maturity, it is important that telecommunication firms are provided with the appropriate equipment for infrastructure to improve big data analytics capabilities. To do so, the government needs to develop a framework to facilitate the telecommunication firms with the easy access to the required hardware equipment. In case, import of hardware for the development of clouds with big data analytics capabilities is not possible, government should try getting the international cloud providers to invest in Pakistan and bring their data center in Pakistan. As data secrecy act does not allow firms in Pakistan to store the data on international clouds, the government must look into the revision of policy.

2. Concern

As the procurement of the hardware necessary for the development of cloud services and big data analytics infrastructure is done in US dollars, due to the unstable Pakistani Rupee, procurement process poses a serious issue. Due to this reason, the telecommunication firms, who are already paying for the licenses in US dollars to the government, poses difficulty in buying the required equipment.

Recommendation: As data secrecy act does not allow to store big data on international clouds and government encourages the development of clouds at the national level, the government should facilitate such organizations. The government may in such cases, plan a supportive financing/subsidy so that the firms are provided with the hardware easily. Pakistan also has embargos on the hardware which provides the high processing capacity. Efforts should be made to lift the embargos on such equipment.

3. Concern

The telecommunication firms are facing high turnover ratio with expertise in the big data analytics. According to the telecommunication firms, the human resource having expertise in big data analytics joining the firms leave after a short span of time due to international offers. The reason is better placement and facilities internationally as compared to Pakistan.

Recommendation: A framework is to be developed by the government to retain the intellect within country and reduce the brain drain in Pakistan. The individuals with the expertise in the area of computing/ big data analytics/ computer related knowledge should be facilitated with better quality of living, financial stability, and stable infrastructure. The government should try to create more secure environment in the country with equality and guarantee of better living standards.

4. Concern

The telecommunication firms are concerned that at the time of the purchase of spectrum license, the spectrum base prices are kept excessively high, benchmarked and denominated in USD which makes extremely difficult for the operators to invest into new technologies and infrastructure, which is the backbone for digital enablement in the country. Operators can pay license fee 100% upfront or 50% upfront and the rest of the 50% on 5 years' instalments with LIBOR+3%. However, due to the fluctuation of USD, the business model against which they bought the license does not remain feasible, as they earn in Pak Rupee.

Recommendations: The licensing of spectrum for the telecommunication firms should be rationalized and aligned with Pakistani market realities. The steps taken to reduce the spectrum cost for telecommunication firms may allow them to leverage the cost to develop cloud infrastructure. This will further improve their big data analytics capabilities and allow them to adapt to the rapidly changing technology and market dynamics. It is crucial for the telecommunications industry to remain financially sustainable to invest in infrastructure, which serves as the foundational layer for digital ecosystem and enablement.

5. Concern

The telecommunication firms having an enormous data with them remain concerned about the provision of services to the government. According to the telecommunication firms, the government usually treats the telecommunication firms as vendors and offer unreasonable rates to offer digital/ICT services; and puts pressure on vendor/service providers to reduce the tariff against the legitimate commercial interests.

Recommendations: The government while receiving the services from the telecommunication firms should treat telecommunication firms as partners rather than as vendor. The tariffs offered by the government to the telecommunication firms should keep the commercial interests in view. An agreement should be developed between the government and the telecommunication firms which encompasses these commercial interests of telecommunication firms and benefits to the government.

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