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Big data analytics and supply chain performance: The mediating role of supply chain capabilities and innovation

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A B S T R A C T

This study aims to examine the influence of Big Data analytics, innovation & capabilities in the supply chain as well as to find the moderating effect of organisational flexibility on the performance of the supply chain (SCP) and find the effect of competitive intensity as a controlling variable on the performance of supply chain. This research aims to present a theoretical model based on the resource-based theory's relational view (RBV). The data was collected through a survey questionnaire and 25 manufacturer firms managers participate in this survey. According to the findings of this study BDA has a favourable and strong association with SCI and SCC, as well as SCP. The majority of the manufacturers' firms in this research employed BDA to speed up their standing algorithms quicker with massive data sets.

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1. Introduction

Big data become amazing innovation and its popularity is enhanced by technological innovations (Kusi-Sarpong et al.,2021). The term big data estimate the large volume of data that is growing rapidly and it analyzed the data according to the '4V' framework which uses for various processing measure for better decision making (Zhang et al., 2021) The availability of data has been quickly grown-up in recent years due to globalization (Yadegaridehkordi et al., 2020). Big data analytics (BDA) is now becoming a popular topic among researchers, scholars and executives, and it has a financial and non-financial benefit for businesses (Sena et al., 2019). The volume of data is currently increasing and rapidly growing up in volume within time (Jan et al., 2018; ŞENER et al., 2020). IT is a major factor that improves Supply chain performance, and organisations that invest in IT resources get benefits and boost their supply chain performance (Asamoah et al., 2020). BDA is focused on analytical tools and techniques that provide actionable insights for generating feasible value, enhancing business performance, and gaining a competitive edge (Mariani et al.,2021). The adoption of BDA depends on technological performance, environmental and managerial factors and it positively influences SCP (Yasmin et al., 2020). In recent years, firms have been continuously worried about innovating to win around the hypercompetitive business market. (Kim Wang, 2021). It is a big advantage for organisation and businesses to manage their data and gets competitive advantages (Afraz et al., 2021). The use of BDA in business may be liable for decisions making and managing operations, BDA has a substantial impact on operational efficiency through strategic innovations such as forecasting, statistical, and operational analysis (Mariani et al.,2021).

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Progress in innovation is a major component for an organisation to gain long-term survival and development, most research on the base of innovation in enhancing the supply chain performance of an organisation has been relatively ignored (Dalgıç & Fazlıoğlu, 2021). There are many studies conducted on both BDA and SCP, but there is a lack of studies on supply chain innovation & capability that has huge factors that impact supply chain performance (Ogbuke et al., 2020). This study intends to full fill the gap and find the mediating effects of SC innovation & capabilities among BDA and SCP with the controlling variable such as competitive intensity. This research will analyze the enhancement of BDA application on organisations and find the significance of BDA & SCP within the Pakistan manufacturing industries. The objective of this research is to find the impact of the BDA on SCP in a developing country that can help the manufacturing industry of Pakistan to be competitive with the new industrial revolution.

2 Literature Review and Theoretical Background

A theory which is called the resource-based view RBV is used to describe the structural link among the variables in this study. It highlights the benefits of BDA on SCP. The resource-based approach emphasizes in-house capabilities & resources that shape a firm's competitive edge, whereas RBV theory relies on inter-firm resources and abilities to enhance competitiveness (Fernando et al., 2018). According to Fernando et al (2018), there is a need for the improved individual performance of the firm created within a network and then they allocate resources in a specific way that's why the RBV theory was proposed to better describe business competitive tactics. The RBV theory integrates the perspectives of a particular firm's resources and competencies are frequently insufficient to handle the challenges offered by global competitiveness (Shokouhyar et al., 2020).

2.1 Big data analytics (BDA)

Big data (BD) is described as a combination of data set that is too enormous for current data processing techniques to handle, prompting the creation of new technologies to handle it (Jan et al., 2018). since the invention of the internet and the digital economy, BD has become one of the most important innovators in technology (Bag et al., 2020). BD is about massive volumes and data variety, as well as effective and unique storage, administration, analysis, and visualization methods (Ogbuke et al., 2020). Traditional database management solutions can't keep up with the expanding need for large-scale data storage and processing from a multitude of sources (Yadegaridehkordi et al., 2020). Companies like Google, Amazon, and Meta have created their strategies for deriving value from these high-speed, huge database systems (Bag et al., 2020).

BDA has been recognized as the most significant success in terms of innovation, competition, and productivity (Ciampi et al., 2021). It has been considered as the organisation can drive the use of BDA towards the achievement of an organisational goal. A result shows that the BDA provide a variety of data that may help in decision making (Mangla et al., 2020). Firms operate in a complex and fast exchange of data by increasing interest in BDA (Mikalef et al., 2019). Now a day manager decisions are depending on analytical insight created from big data and several initiatives growing in this direction (Mikalef et al., 2019). A new layer of studies describes that achieving value from BDA help organisation to focus on the technology into operation (Belhadi et al., 2020).

2.2 Supply Chain Innovation (SCI)

The insecurity and unpredictability in business can increase the competitive pressure and organisation face uncertainty that forces an organisation to develop new ideas and be competitive in the market (Dalgıç & Fazlıoğlu, 2021). Innovation in the supply chain has become a great idea to be competitive and it helps organisations and businesses to develop new strategies (Afraz et al., 2020). Because of old traditions, insufficient security, and a lack of proper infrastructure in developing countries organisations facing these challenges (Afraz et al., 2020). Organisations who are operating in developing countries need to change their system and should adopt innovation on their systems, Integration in innovation will ultimately change organisation performance and firms get a competitive advantage (Wadho and Chaudhry, 2018). Supply chain innovation help organisation to generate new ideas and that idea can be implemented in supply chain operations that help the organisation to be competitive (Shamout, 2021). Organisation enhanced their performance in the field of operational efficiency, service effectiveness, and contribution to the economy, social responsibility, and environmental protection with the help of innovation in supply chain management (Wong and Ngai 2019). The object of supply chain innovation is to bring new technologies that enhanced supply chain performance (Wong and Ngai 2019).

2.3 Supply chain capabilities (SCC)

Firm resources and strategies should be managed perfectly that help organisations in developing SC capabilities (Shafiq et al., 2020). The SCC represents the firm's ability to find, utilize, and integrate information and resources, both internally and externally, to support the activities of the supply chain (Asamoah et al., 2019). A firm's resources and capabilities should be utilized internally and externally to increase firms superior capabilities it will assist them to improve their firm's performance (ERBV, Xu et al., 2019). According to Mabrouk (2020) "capabilities of the supply chain, exchanging of information, and production flexibility, consider an important factor of supply chain improvement".

As a result of global operations, scientific and technological developments, and a rapidly changing industrial environment, therefore, SCCs are progressively significantly (Tigga et al., 2021). “Supply chain competence is a key component of the strategic plan as well as a competitive edge for business success”(Shukor et al., 2020). To support distinct value disciplines, several capabilities have been developed, while the first value discipline is demand-oriented logistics capability, while the second value discipline is supply-oriented logistics competence (Saad & Bahadori, 2020). A supply-driven process capacity is a simplified and standardized supply chain management process for evaluating extensive or intensive distribution in order to establish strategies for efficiently delivering products and services while lowering total operating costs (Bag et al., 2020). Customer request for individual products or customized services drives the need for value-added capabilities, which are aimed to increase customer satisfaction and promote continual development (Bag et al., 2020).

2.4 Organisation Flexibility (OF)

OF is the ability of firms that assists the firms to function in a more disturbance environment (Dubey et al., 2021). OF is an organisational strength that includes a variety of managerial qualities that may be implemented quickly to strengthen the management's clarity and efficiency and the organisation's controllability (Settembre-Blundo et al., 2021). The OF creates organisational activities that increase a company's ability to respond quickly to external developments. (Settembre-Blundo et al., 2021). OF emphasizes adaptability or changeability, which is frequently reliant on the creation of appropriate conditions to substitute organisational flexibility (Pearl et al., 2021). Organisational flexibility in the domain of the supply chain relates to a supply chain manager's capability to quickly and efficiently reorganize their internal supply chain processes in response to changing demand and supply market situations (Bag et al., 2020).

2.5 Firm Age

The age of a firm refers to the number of years it has been in operation, from its beginning to the present (Coad et al. 2018). Elder firms allow for the exchange of ideas, the creation and improvement of effective communication within employee teams, and the rise of multifunctional work teams, all of which are critical for the growth of innovation (Mabenge et al., 2020). On the other side, (YARDIMCI, 2021) says that newer companies will be able to innovate than older companies because of their flexibility, boldness, and proactive approach to doing business (Farooq et al., 2021) state that because of years of organisational learning, expertise, and maturity, older firm do better than younger firms in terms of innovation. The age of a business has little bearing on its ability to innovate (Morone et al., 2020). The age of the firm has a controllable effect on the impact of BDA on SCP (Chatterjee et al., 2021). As a result, the literature fails to provide the most persuasive perspective on the impact of a firms age on its success (Mallinguh et al., 2020).

2.6 Firm Size

The number of employees or the annual revenue turnover of a company determines the firm size (Mabenge et al., 2020). Similarly, Abdu and Jibir (2018) claim that a firm's size has a major impact on how it behaves in terms of innovation. Larger companies have an edge over SMEs in terms of innovation since they have a lot of collateral and can borrow a great deal of money (Chatterjee et al., 2021). SMEs have more flexibility in terms of innovation and responding quickly to environmental changes, as well as satisfying client needs (Benzidia et al., 2020). Aziz and Samad (2018) SMEs, in comparison to larger companies, are said to be less innovative. Small and medium-sized businesses (SMEs) are more open to new ideas than larger corporations. Literature (Aziz and Samad 2018; Abdu and Jibir 2018; Benzidia et al., 2020) show that there is an impact of firm size on performance, hence the findings of this study are beneficial for SMEs.

2.7 Competitive Intensity

In competitive intensity, there is a lack of opportunity for further growth, This concept contributes to the environment's hostility toward businesses (Zhou et al., 2020). Intensified rivalry elevates the importance of refining existing competencies and developing new capabilities (Wang et al., 2020). Firms must think imaginatively to develop and seek new markets in the face of solid competition (Wang et al., 2020), by redeploying current resources and altering company portfolios, you can save money and increase efficiency (Micheli et al., 2020). According to significant studies on the influence of competition, organisations can be pressured to enhance creativity and competitiveness as a result of competition (J. Wang et al., 2020). To resist increased competition, some experts argue that businesses should participate in more business ventures such as innovation, exploration, and strategy renewal (Bag et al., 2020). The competitive intensity of firms within the same industry can improve the efficiency of their supply chains. This benefit can also help minimize the risk of over-reliance on one supplier (Zhou et al., 2020). In the framework of our research, the authors propose that supply chain performance is strengthened by competitive intensity.

3. Hypothesis development and Theoretical frameworks

3.1 implementation of big data analytics on supply chain performance:

According to Zhou et al (2020), multiple types of data processing techniques exist in BDA, and the variances in each data analysis approach will have diverse influences on SCP and its costs. BDA can assist organisations in decisions making that will diminish demand instability and assure great service to clients (Zhou et al., 2020). Organisations that implement BDA should be able to cut order-to-delivery times (Shouman & Chehade, 2020). It will have the ability to increase production efficiency by at least 10% while reducing costs (Pearson, 2019). The usage of BDA to communicate information within production networks will improve supply chain flexibility, according to empirical studies, the distribution of data and information throughout the supply chain network could improve a firm's flexibility to meet unpredictable uncertainty (Jin et al., 2019). The constancy of organisation effectiveness helps it obtain competitive advantages in industrial innovation (Shamout, 2019). BDA's veracity is one of its characteristics; traditionally, veracity has been defined as how well an organisation manages its data so that it can be recognized and trusted (Yasmin et al., 2020). SCP is improved by BDA's efficiency and reliability as a forecasting technique (Shouman & Chehade, 2020). A tool's cost estimation should be linked to its dependability, and appropriate methods should be developed to assess the costs and risks of improving business analytics for consumers and suppliers (Woldt et al., 2020). Evaluating the accuracy and reliability of input data and its outcomes is a big challenge faced by the manufacturing industry in the implication of BDA (Assunção et al., 2020). When an organisation can perform the task efficiently, the supply chain's reliability can be expected. As a result, the following hypothesis is developed:

H_1: BDA has a significant relationship on SCP.

3.2 Supply chain innovation and capabilities has mediating relation with BDA and SCP

Market uncertainty and business unpredictability have prompted a firm to increase its supply chain capabilities through an innovative approach (Afraz et al.,2020). Innovation is necessary for firm competitiveness (Afraz et al.,2020). Innovation can improve an organisational value, increase its demand, and reduce its expenses. Meanwhile, a business's face difficulties on how to manage and utilize innovation effectively (Giannakis, 2019). The ability of the industry to grow its supply chain activities and its structure, it will allow its firms to respond more quickly and enhance supply chain procedures (Bag et al., 2020). According to Prajogo et al (2021), the importance of information exchange in the supply chain has been emphasized. Based on Wu et al. (2019), a firm maintains up with client trends and boost flexibility by exchanging information across its supply chain network. Sharing of information improves the linkages between all levels of the supply chain, as well as between the organisation and its end customers (Gunasekaran et al., 2018). A proposed hypothesis is:

$H_{2a:}$ SCI has significantly associated with BDA and SCP.

SCC has played a vital role in achieving greater operational responsiveness as a key interaction effect (Mabenge et al., 2020). SCC is examined by looking at the impact of BDA on supply, distribution, and demand flexibility (Hallavo, 2019). Organisations have shifted their existing tactics to give new and unique outcomes, realizing the importance of client interaction in providing added value (Croxton et al., 2021). The ability of big entities to produce supply chain innovation in strategies to adapt and provide the resources that customers require is essential to supply chain performance (Rameshwar Dubey et al., 2019). Supply chain processes should be continually prioritized in the advancement of supply chain capabilities, particularly when resolving customer complaints about inconsistent performance (Shokouhyar et al., 2020). In order to grow the green supply chain literature, researchers looked at the efficiency and capabilities of supply chains, and they discovered that innovation and capabilities must be prioritized in order to succeed. Therefore, the following hypothesis is suggested:

$H_{2b:}$ SCC has been positively associated with BDA and SCP.

3.3. Organisation Flexibility has a moderating effect among BDA and SCP

BDA support organisations to take decisions it helps an organisation to decrease their demand unpredictability and ensure their performance (Yadegaridehkordi et al., 2020). To deal with unanticipated increases, decreases, and eliminations, as well as the ability to process forward or backwards in response to supply chain development an organisation must be flexible enough (Chatterjee et al., 2021). A long-term focus by managers influences flexibility rather than reacting to difficult uncertainties with previous measures (Angkiriwang et al., 2019). Businesses that have integrated BDA into their processes should be able to reduce order-to-delivery timeframes (Bansode et al., 2018). BDA would have the likelihood to improve production efficiency by at least 10% while reducing expenses (Pearson, 2021). Many studies have identified organisational flexibility as one of the most important levers for reducing supply chain uncertainties (Dubey, Gunasekaran, and Childe 2019). Authors believe that businesses with high degrees of organisational flexibility would be more effective to utilize new information or knowledge derived from data analytics capacity (Yasmin et al., 2020). Businesses that are dependent on limited data sets to

gain information from raw data have an edge over competitors when it comes to improving their performance in the supply chain (Shokouhyar et al., 2020). Thus, the suggested hypothesis is

H_3: Organisation flexibility has moderate and significant relation between BDA and SCP.

3.4. Competitive intensity and supply chain performance

The level of rivalry or competitive intensity has a direct influence on the firm performance (Goundar & Rayani, 2021). Auh and Menguc (2019) described that amount of rivals and prospects for expansion, competitive intensity is defined as the severe competition among enterprises. Anning-Dorson (2019) Competitive intensity, refers to the level of inter-firm competition, promotional battles, competitive movements, and the matching of competing offers within a business. While competitive intensity may have a positive impact on business performance, Authors believe that a critical market condition may limit this relationship (Fernando et al., 2018). According to Wang (2019) if firms do not pay adequate attention to client necessities then there would be no effect on performance during periods of low competition. They would, however, remind out that during times of intense competition, customers are considerably more likely to switch among different products, and it helps businesses to better understand consumer needs (ŞENER et al., 2020). To have a beneficial impact on their performance, organisations must match their performance development with competitive trends (Shokouhyar et al., 2020). In the competitive landscape, consumers have a lot of power and to increase a company's success, it must collaborate with its customers (Benzidia et al., 2020). Organisations that are better to generate and implementing innovation are more likely to reach their competition (Farooq et al., 2021). Thus Authors believe that there is a beneficial association between competitive intensity and supply chain performance, the suggested hypothesis:

H_4**:** Competitive intensity has a significant effect on SCP

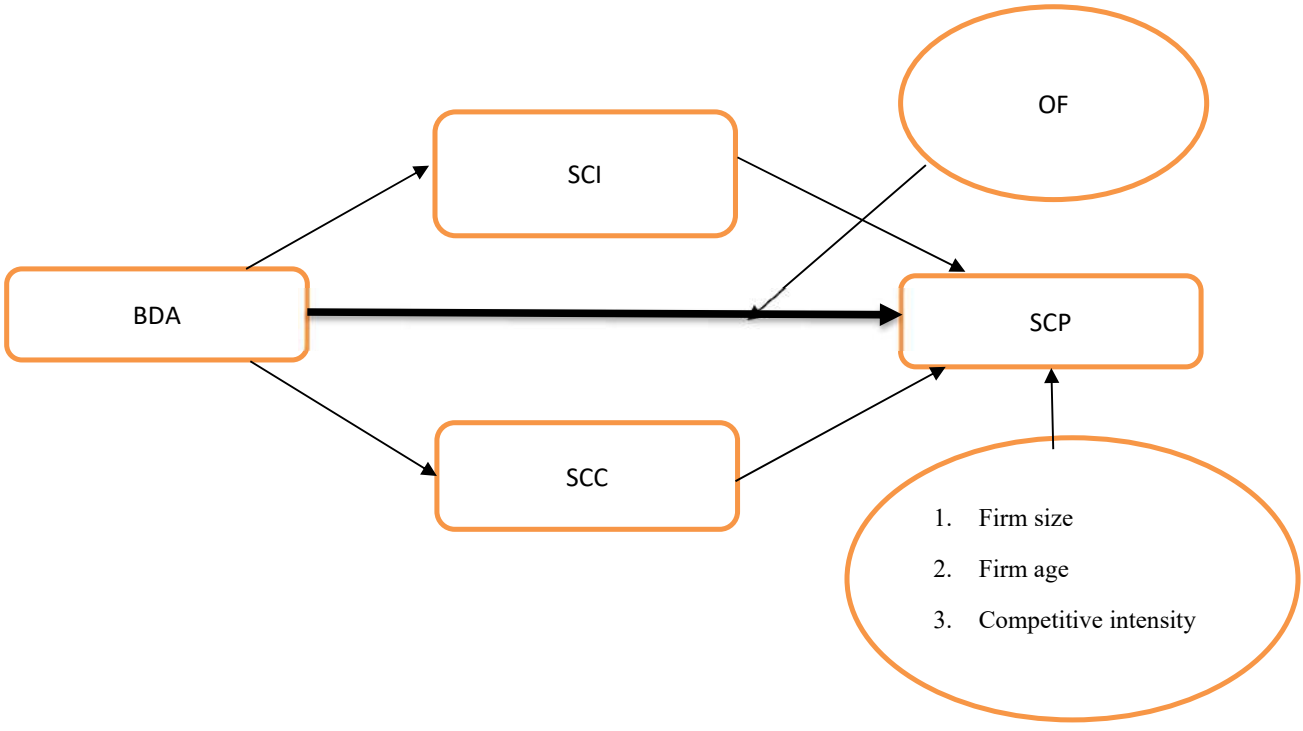

Fig. 1. Theoretical Framework

4. Research methodology

4.1 Research Design

According to Cooper and Schindler (2019) research is designed as a systematic plan, methodology, or strategy for gathering data to answer multiple research questions. To examine the relation between BDA and SCP in Pakistani manufacturer industries by using an exploratory research approach. This research is based on a quantitative approach it helps to evaluate the influences of BDA on SCP. The data was collected through survey form and the data has been collected from the top and middle managers of small and medium manufacturing enterprises. The data were analysed through the smart PLS. The purpose was to use this software is to "predict and comprehend the role and formation of measurement items, as well as their interrelationships"(chin, 2018). Using the G*Power statistical tool, Priori and post-hoc power experiments have been conducted for study to further validate the sample size's validity (Faul et al. 2019). Minimum values were used in the a priori analyses, such as an R^2 value of 0.10 is a minimum statistical power of 80%, and the number of the predictors. According to the G*Power calculation, a viable sample size of 122 was necessary. The statistical power obtained by the post-hoc G*Power is 0.99, which generally meets Cohen's (2018) requirements for the present sample size of 25 enterprises.

4.2 Research Procedures

Statistical procedures are used to examine the relationship between variables. In this study, a survey research approach was used, which assesses to give a related framework to clarify variables and their relationships (Malhotra and Galletta, 1998). The research procedure in this study begins with the definition of the research problem. In summary, the research's theoretical statement is derived from a survey and analysis of past literature on continual use and ongoing knowledge-sharing issues. More research is needed to understand the elements that influence participants desire to share their expertise in business organisations, according to the findings of this study.

4.3 Sample and Sampling Methods

The purpose of sampling is to reflect a random sample of a larger population of interest. It acknowledges a researcher to generalize and characterize the population by understanding the sample characteristics (Sekaran et al., 2019). In this research, authors have collected data from the top and middle-level managers. The authors ensured that participants must have adequate knowledge about BDA and its relation to SCP. The survey was conducted through a questionnaire form from 500 individuals during the two months of October and November 2021. Authors get 250 responses and authors filter out questionnaires and get 169 reliable responses out of 250 responses. A random sampling technique was used to ascertain the respondents for this study. The research is mono method research because only quantitative data will be used to gather data through a survey questionnaire and online survey form. This study is based on primary data which has been collected from small and medium manufacturing industries of Pakistan. Questionnaires were distributed with a measurement of 7 Likert-scale for the independent variable and 5 Likert-scale for a dependent, moderator and mediator variable intervals that range from ‘strongly disagree’ to ‘strongly agree’. The 95% confidence level and the 5% margin of error will be maintained in this study. The sample size was chosen from the manager and executive of the small and medium manufacturing industry the demographic study is shown in Table 1.

4.4 Measurement

The authors employed structural equation modelling to conduct the empirical study. Researchers use SEM to evaluate a model is overall fit as examine the structural model is organized (Hashim, 2019. SEM analysis entails evaluating numerous variables and their relationships at the same time (ITOGA et al., 2018). The main purpose of PLS-SEM, on the other hand, is to optimize the covariance between the predictor and dependent latent variables (Tigga et al., 2021) PLS employs least square estimation for single and multi-component models, as well as canonical correlation (Yadegaridehkordi et al., 2020). PLS-SEM analysis was chosen for this study because it is recommended for research involving complicated models and theory testing using current theoretical foundations (Shah and Goldstein, 2018) whereas PLS-SEM is considered to be more appropriate for exploratory research (Peng and Lai, 2019). The proposed hypotheses were analyzed by using partial least squares in this study. The first part of the analysis was to assess the variables' validity and reliability, which was followed by a structural model analysis. Following Malhotra and Grover's (2018) recommendations, authors used established scales from the literature.

4.5 Unit of Analysis and Instrument Selection*:*

The unit of review and analysis on how the research questions are developed or stated can be considered as the principal entity type being investigated, about which data is obtained. In a conclusion, the unit of analysis is the level of the individual in this study. Questionnaires was distributed with a measurement of 7 Likert-scale for the independent variable and 5 Likert-scale for a dependent, moderator and mediator variable intervals that range from ‘strongly disagree’ to ‘strongly agree’. 7 points Likert scale used for independent variables and 5 points Likert scale used for dependent, mediator and moderator variables, the double Likert scale is commonly used in management research because it is consistent and gauges the greatness and insight of subjective ideas (Podsakoff, 2012). The statistical tools were used to determine the validity of the variables, reveal the material's logicalness, and analyse the data's variables' strength. The data's consistency and dependability are also checked using statistical methods.

Table 1
Personal characteristics of the participants

Demographics			
Job_Title		Number	Percent
Valid	General Manager	7	4.1
	Senior Manager	18	10.6
	Deputy Manager	33	19.4
	Assistant Manager	59	34.7
	Supervisor	52	30.6
	Total	169	99.4
Total		169	100
Current_Organisation_Experience			
		Number	Percent
Valid	0-5	111	65.3
	6-10	36	21.2
	11-15	14	8.2
	15-20	8	4.7
	Total	169	99.4
Total		169	100
Professional_Experience			
		Number	Percent
Valid	0-5	98	57.6
	6-10	2	18.8
	11-15	15	10.6
	15-20	21	12.4
	Total	169	99.4
Total		169	100
Age_of_the_organisation			
		Number	Percent
Valid	0-5	87	51.2
	6-10	2	1.2
	11-15	15	8.8
	15-20	61	35.9
	More than 20	3	1.8
	7	1	0.6
	Total	169	99.4
Total		169	100
		Number	Percent
Valid	1-100	83	48.8
	201-300	1	0.6
	301-400	5	2.9
	401-500	80	47.1
	Total	169	99.4
Total		169	100
Job_function			
		Number	Percent
Valid	Supply Chain	110	64.7
	Operation/Production	20	11.8
	Procurement	9	5.3
	Logistics	11	6.5
	Other	19	11.2
	Total	169	99.4
Total		169	100
Organisation			
		Number	Percent
Valid	Textile and Apparel	140	75.2
	Pharmaceuticals	30	19.1
	Total	169	99.4
Total		169	100

Table 1

5. Analyzing of data

5.1 Method and Tool for Data Analyzing

Smart-PLS 3.0 is used to perform the PLS-SEM analysis (Tigga et al., 2021). This SEM method uses a causal-predictive approach to facilitate the explanation of possible connections in statistical models (Hair et al., 2019). To examine the result of the proposed model measurement and structural models were utilised by PLS-SEM to evaluate the suggested model and draw insights from the results. The hypotheses of this research examine the relation among BDA, SCC, SCI, and OF and on the SCP through the testing of five hypotheses that include controlling variable competitive intensity.

5.2 Measurement Model Assessment

In several studies on BDA e.g. (Shokouhyar et al., 2020; Sreedevi and Saranga 2019; Chowdhury and Croxton et al., 2021), the constructs of BDA, OF and SCP has been measured reflective, whereas SCI and SCC have been deemed formative (Chowdhury and Quaddus 2019). The characteristics suggested by Jarvis, MacKenzie, and Podsakoff (2003) and Chin (2010) this category of constructs should be reinforced. As a result, changes in the underlying construct are expected to lead to changes in the indicators in reflecting structures (Shokouhyar et al., 2020), i.e. the latent construct's fluctuations cause all of its measurements to reflect this shift. Formative structures, on the other hand, are made up of a variety of measurements (Chin, Marcolin, and Newsted 2019) in which deviations due to modifications of the essential construct (Shokouhyar et al., 2020). The model's suitability for measuring reflective constructions is evaluated by (i) item loadings and composite reliabilities, (ii) convergent validity and (iii) discriminant validity which has been shown in table 2. Composite dependability and Cronbach's values should be greater than 0.60, and all outer loadings should be greater than 0.70 it indicating that the items were reliable (Hair et al. 2019). Additionally, the average variance extracted values for all constructs were greater than 0.50, it showing acceptable convergent validity (Table 2).

Table 2
Estimation of the measurement model parameter

Construct/item	loadings	Composite	Cronbach's	Average variance
Big data Analytics		0.932	0.915	0.663
BD_1	0.838			
BD_2	0.808			
BD_3	0.841			
BD_4	0.781			
BD_5	0.804			
BD_6	0.850			
BD_7	0.774			
Supply chain capabilities		0.862	0.789	0.610
SCC_1	0.798			
SCC_2	0.781			
SCC_3	0.783			
SCC_4	0.762			
Supply chain innovation		0.897	0.857	0.637
SCI_1	0.793			
SCI_2	0.821			
SCI_3	0.875			
SCI_4	0.770			
SCI_5	0.724			
Supply chain performance		0.884	0.836	0.605
SCP_1	0.802			
SCP_2	0.757			
SCP_3	0.712			
SCP_4	0.785			
SCP_5	0.828			
Organisation Flexibility		0.881	0.821	0.652
OF_1	0.831			
OF_2	0.882			
OF_3	0.812			
OF_4	0.692			
Control Variable				
Competitive Intensity		0.926	0.907	0.677
CI_1	0.898			
CI_2	0.834			
CI_3	0.805			
CI_4	0.810			
CI_5	0.801			
CI_6	0.784			

Items eliminated for insufficient loadings (< 0.7).

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Authors used Fornell and Bookstein's (1982) criterion to determine the discriminant validity of constructs, including this condition, each hypothesis's square root of AVE must be higher than its correlation with all other hypotheses. This condition was met for all reflective constructions, according to table 3. In addition, the authors used the Heterotrait–Monotrait ratio (HTMT) approach of Henseler, Ringle, and Sarstedt (2019). Using a PLS algorithm with 5000 iterations in Smart PLS, HTMT values ranging from 0.005 to 0.588 are used shown in table 3, which are below the limit of 0.90 (Sarstedt et al., 2019). The bootstrap approach (bias-corrected and accelerated BCA) bootstrap method and a resampling number of 500 are used to determine whether the HTMT inference differs from 1 substantially. As a result, the combination of all of these findings supports the constructs' discriminant validity.

Table 3
Discriminant Validity

3.1 Fornell-Larcker Criterion

	BDA	CI	OF	SCI	SCP
BDA	0.814				
CI	0.459	0.823			
OF	0.485	0.306	0.807		
SCC	0.688	0.430	0.303		
SCI	0.600	0.419	0.540	0.798	
SCP	0.549	0.306	0.448	0.477	0.778

3.2 Heterotrait-Monotrait Ratio (HTMT)

	BDA	CI	OF	SCC	SCI	SCP
BDA						
CI	0.485					
OF	0.563	0.345				
SCC	0.803	0.501	0.376			
SCI	0.672	0.463	0.647	0.666		
SCP	0.625	0.327	0.524	0.568	0.548	

Table 4
Formative Construct Items Validation

Items	VIF	Outer weight	Outer loading
Big data analytics			
BD_1	3.633	0.180	0.838
BD_2	4.019	0.178	0.808
BD_3	3.572	0.172	0.841
BD_4	2.576	0.151	0.781
BD_5	2.854	0.165	0.804
BD_6	3.669	0.189	0.850
BD_7	2.253	0.194	0.774

The validation of the variance inflator factor (VIF), the outside weight, and the outer loading scores are used to analyse BDA items. The authors discovered that there was no collinearity among the formative 2017 data (Table 4). Furthermore, the variables remained acceptable as their outside weights or outer loadings are greater than 0.50 it called significant (Hair et al. 2019). The coefficient of determination R^2, the effect size f^2, and the predictive relevance Q^2 are often used to assess the structural model's quality. The coefficient of determination R^2 or adjusted R^2 measures the predictive control of the model through the amount of endogenous variables' variance explained by exogenous variables. In this respect, 0.473 of SC capability and 0.359 of SC innovation, and the latter two explain 0.404 of supply chain performance. Assumed that a determination coefficient above 0.20 is considered valid (Hair et al. 2017; Lopes de Sousa Jabbour et al. 2020b), the attained results underline the predictive level of the research model. The effect size f^2 measures the strength of predictor variables in explaining the endogenous constructs. General, f^2 values of 0.897, 0.561 and 0.026 represent, respectively, the effects of predictor variables (Cohen 1988). The findings show that effect size in the model range from weak to significant levels (0.02–0.705) of the variables. Furthermore, all the Stone–Geisser Q^2 values are greater than zero (Q^2 = 0.242 for SCC, Q^2 = 0.263 for SCI and Q^2= 0.251 for SCP) As a result, the model's predictive relevance is supported. Thus showing a mediating model fit. Overall, the results in Table 5 demonstrate the adequate quality and fit of the structural model.

Table 5
Quality and fit indices of the structural model

Construct	R^2	Adj.R^2	F^2	Q^2
SCC	0.473	0.468	0.897	0.242
SCI	0.359	0.354	0.561	0.263
SCP	0.404	0.370	0.026	0.251

5.3. Analysis of Structural Model

PLS results of the structural model analysis are shown in table 6. Authors run the bootstrapping that alleviates the coefficient β this estimates based on the 95% bias that corrected confidence interval. Our results show positive and significant relationships between BDA and SCP and between BDA, SCC and SCP. Therefore, H_1 and H_{2a} are supported. The findings demonstrate that OF has a positive and significant influence on BDA and SCP; hence, H_3 is supported. Conversely, the authors found that there are no significant influences of SCI on SCP; thus, H_{2b} is rejected. Finally, our steady revealed that CI does not affect SCP. Zhao, Lynch, and Chen (2017) and Nitzl, Roldán, and Cepeda (2019) delivered a categorization of mediation relationships between variables into three types: (i) The direct and indirect effects, according to complementary mediation, are both significant and point in the same direction (ii) Competitive mediation is utilized when the direct and indirect effects are both significant and point in different directions. and (iii) Indirect-only mediation is performed when the indirect effect is significant but the direct effect is not. The findings reveal a significant and positive indirect effect of SCC on SCP (β = 0.182, p < .016), which supports the presence of complementary mediation. Therefore, indirect effects of SCI on SCP, the results shows no significant effects.

Table 6
Hypothesis Test

Hypothesis test	β Coeffi	Sample Mean	Standard Deviation	P Values	Conclusion
BDA → SCP	0.891	0.395	0.150	0.006	Supported
BDA → SCC	0.732	0.735	0.046	0.000	Supported
BDA → SCI	0.724	0.730	0.050	0.000	Supported
SCC → SCP	0.831	0.244	0.099	0.012	Supported
SCI → SCP	0.167	0.116	0.096	0.257	Not Supported
OF → SCP	0.149	0.159	0.076	0.039	Supported
CI → SCP	0.054	0.070	0.091	0.565	Not Supported

Table 5
Total Indirect effect

Specific Indirect Effect	β Coeffi	Sample Mean	Standard Deviation	P Values	Conclusion
BDA → SCC → SCP	0.182	0.180	0.075	0.016	Accepted
BDA → SCI → SCP	0.079	0.084	0.070	0.260	Not Accepted

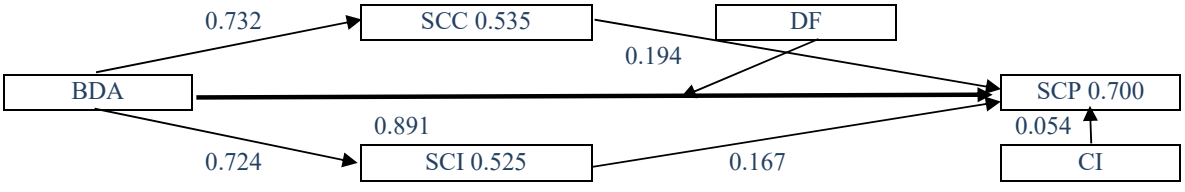

Fig. 2. The proposed study

6. Discussion

The objective of this paper was to see how BDA influences SCP. There has a strong and significant effect between BDA and SCP, according to the empirical studies. This study showed strong relation among BDA, SCC, and SCP. SCC has a positive mediating effect on BDA and SCP. While supply chain innovation (SCI) has no effect and correlation with BDA and SCP. The degree of understanding of sustainable supply chain growth is determined by SCP's vision and objectives, as well as attention to regulating the business's supply chain's social, environmental, and economic effects. The more businesses that have a clear vision and goals, the more likely they are to develop a practical BDA framework for acquiring, integrating, and analyzing high-quality data and information. Forming a committee to determine how to maintain supply chain performance and growth entails identifying internal roles and responsibilities. Organisations must hire BDA specialists with technical knowledge, business insight, data processing, data presentation, data simulation, analysis, and deployment abilities, Then, as demonstrated by the findings, the authors considered dividing the individuals into distinct groups to carry out various data mining and data analysis procedures. Building relationships with suppliers and other organisations is vital, as is discussing and examining organisation capabilities and its performance in comparison to the business's expectations, and even suggesting that industries correct supply chain problems in order to improve company performance. A good BDA system is required to exchange and integrate data and information, and each firm's IT department must be capable of supporting organisation operations.

Our findings support the improvement and enhancement of BDA, SCP, OF, SCC, and SCI theories, as well as providing managers with empirically-based normative suggestions. The findings contribute to improving our understanding of the interrelationship between BDA, SCP, OF, SCC and SCI. the previous result (Xie, 2017; R Dubey et al., 2021; and Shamout, 2021) found that the size (OS) and age (OA) of an organisation did not affect SCP. These findings imply that the manufacturing industries sector is rapidly using big data analytics to enhance SCP and gain a competitive advantage in the time of increasing change and that the SCP relationship is unaffected by the size or age of the business. Meanwhile, in the study mentioned above, the competitive intensity had a favourable influence on SCP, but in my study, CI has a negative effect on SCP the above study was conducted on developed countries and this research has been conducted in developing countries hence there is need of more research should be conducted in under developing countries to know the effect of CI on SCP. Our predictions that the relationship between BDA and SCP would be reinforced in the presence of high OF were confirmed. Our data support our hypothesis that OF moderates the relationship between BDA and SCP in a positive way. Table 6 summarises the justification provided by our findings in favour or non-favor of the hypotheses proposed in our study based on a thorough examination of the above literature.

7. Conclusion, Implications, and Limitations

The empirical findings revealed a direct and significant correlation between BDA and SCP, as well as a considerable impact on BDA and SCP by supply chain capabilities. The findings contribute to the existing knowledge about the impact of BDA on SCP by supply chain innovation, and capabilities to improve SCP. The theoretical model framework is based on PLS structural equation modelling, and it was able to describe the RBV theory and its impact on BDA and SCP. As a result, the mediating effect of SCI on BDA, and SCP was not favorably significant. Manufacturer firms have a lack of understanding and skills on how to make the best use of real-time market data, it becomes a common barrier that has been faced by firms. According to the study of Arya et al.'s (2020) employees' skills and expertise were insufficient to provide Big Data technologies. Utilising the 4.0 revolution technology and cyber-physical production systems to help the firm to gain competitive advantages, this study recommends that manufacturing organisations must investigate the essential domains of Supply chain management.

7.1 Research implications

This research examines the many aspects of BDA and determines the amount to which BDA has an impact on SCP and its various dimensions. As a result, this work may provide researchers with a better understanding of the structures of SCP and BDA, allowing them to conduct additional research into the various functions of BDA in other fields. BDA structures and operates in a variety of industries and regions, in terms of a combination of supply chains. Some elements of the estimated model for this investigation were eliminated, which highlight various important issues that Pakistan's manufacturer industry supply chain faces, as well as the challenges to establishing a flawless, long-term supply chain performance and a strong BDA.

7.2 Theoretical Implication

The authors established an integrated framework and a set of propositions in this study to consider how BDA might assist organisations to achieve their supply chain performance objectives at the intra- and inter-organisational levels. A fundamental theoretical perspective such as RBV defines how it may be used to develop quality resources and develop skill management decisions in organisation and supply chain domains It should be adopted by modern-day managers. In conclusion, the manufacturer's organisation may objectively use the RBV-based integrated framework to guide organisations on how to establish and coordinate Deliverable supply chain performance across their supply chains domains by using the RBV framework. With the conceptual and analytical insights generated from this research, authors assume that it will benefit both scholars and organisations in identifying future advancements of BDA applications in the supply chain management sector.

7.3 The managerial implications

The research's managerial implications will encourage manufacturing companies to invest in and enhance their existing BDA approaches. This research may inspire manufacturing supply chain managers to adopt BDA best practices and include these tools into their operations strategy. This is due to the fact that BDA can assist an organisation in precisely forecasting client requirements based on purchase patterns or market trends. Aside from that, BDA will lead to enhanced SCC and SCI because it can be utilized as a useful tool to assist organisations in producing products that are suited to the specifications of their customers. As a result, a manufacturing company would be able to figure out what a target consumer looks like and what his demands are. In terms of production excellence, flexibility and reliability, and quick response to market demands, BDA has a positive impact on SCP.

7.4 Limitations and recommendation for future research

Although this research methodology is predicated on reasonable hypotheses and these hypotheses have been tested by utilizing the standard questionnaire survey and it has been focused on accurate data. However, there are some challenges and limitations that must be overcome. To investigate the model's stability, it has been tested by using cross-sectional data. It is then recommended that it should be retested by using both cross-sectional and time-series data. Second, while this study focuses on how SMEs perceive BDA on SCP, objective assessments are necessary for determining its true impact. Third, although this research was restricted to only manufacturing industries, this model should be expanding to other industries and will provide more insight into the BDA-SCP relationship. Fourth, there are some other aspects of the supply chain that influence business strategies, such as decision-making and long-term viability, that are not explored in this study and more aspects, which include industry position, supply chain status, partnership condition, organisational culture, level of innovation, profitability, and market share, could be considered relevant research topics for future study.

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