BIG DATA APPLICATION AND ANALYSES IN CONSTRUCTION PROJECT DELIVERY IN OYO STATE, NIGERIA.

BY

ADEYERI OLUWAYOMI OYEYIMIKA (B.Sc, OAU)

REG. NO: 20184138218

A THESIS SUBMITTED TO

POSTGRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI IMO STATE.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE (M.Sc)

IN PROJECT MANAGEMENT TECHNOLOGY.

April, 2024.

CERTIFICATION

This is to certify that this thesis work **'Big data application and analyses in construction project delivery in Oyo state, Nigeria'** was carried out by Adeyeri Oluwayomi Oyeyimika with Registration number 20184138218. In partial fulfillment for the award of the Degree of Master of Science(M.Sc) in Project Management Technology in the Department of Project Management Technology of Federal University of Technology, Owerri, Imo State, Nigeria.

Dr B. Amade
Supervisor

05/10/2023
Date

Prof. E.C. Ubani
Co-Supervisor

05/10/2023
Date

Dr. I.I Echeme
HOD

21/5/2024
Date

Prof K.U Nnadi
Dean of SLIT

21/05/24
Date

Prof. B.O. Esonu
Dean of Post Graduate

Date

Prof S.I.J Onwusonye
External Supervisor

March 26, 2024
Date

DEDICATION

I dedicate this thesis to God Almighty, the Alpha and Omega who has brought me so far in my academy pursuit in life, to him I give all the glory.

ACKNOWLEDGEMENTS

To God be the glory who has brought me so far in my academy pursue. My profound gratitude goes to my supervisor Dr. B. Amade who took time out of his limited time to go through my thesis and make necessary adjustment on it, may God almighty bless you and your family in Jesus name.

My appreciation also goes to my departmental lecturers including Engr. Prof. F.P.O. Ukwuoma, Prof. E.C. Ubani, Prof. K.A. Okorocha, Prof. C.C. Nwachukwu, Dr. I.I Echeme, Dr. C.I. Anyanwu, Engr. Dr. S.O. Okpighe, and the others who has impacted one thing or the others to me in achieving my goal on earth may God almighty bless you all.

My appreciation also goes to my parents who give me the best legacy a child can have, may God almighty bless them and they will eat the fruit of their labour in Jesus name.

My appreciation also goes to my wonderful siblings for their support and encouragement may God almighty bless them and they will achieve their purpose on earth in Jesus name.

Finally, my appreciation also goes to friends who stand by me all the time and also to my classmate, may God almighty bless you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study aimed at big data application and analyses in construction project delivery in Oyo state, Nigeria. The study was inspire by the need to employ application and analyses of big data in the construction project delivery. The study also identified the big data application influencing construction project delivery, evaluated and established the determinants and the extent of deployment of big data application in construction project delivery in construction industry in Nigeria. Factor analysis and descriptive survey design were used for this research study to obtain data through sample selection and analysis. One hundred and fifty (150) copies of questionnaires were administered to the construction industry in Oyo state through the random sampling technique, a total of one hundred and twenty-four (124) copies of questionnaires were properly retrieved and adequately completed which represent a feedback ratio of 82%. Factor analysis was used for the analysis of the data, descriptive analysis was also used. This study is backed up with the following theories viz; schumpeter theory of innovation and big data, dynamic capabilities(DC) and big data, diffusion of innovation theory and resource based theory. The findings from this study revealed that effect of big data on project performance, Availability of big data technology, Accessibility of big data facilities and power, effectiveness and efficiency of big data are significant determinants of big data analytics in construction industry. The findings also demonstrated the significant methods of big data deployment which encourage construction industry to adopt these approaches as they motivate construction industry towards achieving the goals of the industry. The study recommends that construction industry should start with data that is already available in the enterprises, start with customer-centric outcomes, develop business case based on measurable outcomes and identify business priorities and build the strategy on that as they are crucial in ensuring the achievement of the construction industry.

Keywords: Big data application in construction project delivery, the determinants and extent of deployment in construction project delivery.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The volume of data created by the construction industry has expanded dramatically following a serious utilization of present day innovations. The data blast subsequently lead towards the big data marvel which is imagined to reform the construction more than ever. Like some other technologies, big data is a troublesome worldview and unavoidably will offer effect on the construction industry. As the industry is pulling together towards an improved profitability, the appeal to accept big data is sure given the worth it offers. This unquestionably will profit construction likened to the manufacturing and the retail industry the same. Big data has been humming among numerous industry all throughout the planet on its potential in dissolving a large portion of the ventures normal issues and change them into a more brilliant method of working. Big data refers to massive amount of data that outnumber traditional data processing methods (Benedict Amade, 2022). The approach of big data analysis started by the data blast came about because of the presence of trend setting innovation in this day and age. As indicated by Waal-Montgomery (2015) expectation, the world's data volume will ascend at around 40% each year, and will keep on heightening multiple times from the current volume constantly to year 2020. The speed in which data is being produced has lead towards data blast subsequently where big data acquire its footing. Essentially, big data is frequently named dependent on the 3V's to be specific (I) Volume - measure of the actual data, (ii) Velocity – the speed where the data is created and (iii) Variety – the variety and intricacy of data sources. The construction industry is known to manage huge measure of data that mirrors the 3V's and the usage of these

data could be the following outskirts for construction industry improvement. Peiffer (2016) stated big data as one of the critical driving variable in arranging the bearing which should lead towards improving the construction industry productivity. In spite of the fact that the construction industry is recognized as one of the marker for financial prosperity, profitability and effectiveness are at an untouched low which Harenberg (2017) painfully battled in contrast with when it was in the year 1993. This shortcoming, as per Santiago Castagnino et al. (2016) was the consequence of the sluggish development made by the industry in receiving new advances. This is upheld by the Mckinsey Global Institute (MGI's) digitization record that put construction industry as the least digitized industry on the planet. Santiago Castagnino et al. (2016) also added the intentional changes made by the industry is brought about by the inadequate data driven dynamic. Data is supposed to be the perfect example in upgrading the industry profitability. This follows as a continuous data trade could prompt an expanded understanding into the industry operational exhibition along these lines clearing a path for a more astute working (Peiffer, 2016). Nonetheless, yet of the gigantic measure of data that is created in the construction industry, the big data is generally siloed and not being completely used for a greater picture. As indicated by Burger (2017), the failures of data use is because of the restricted capacity in managing unstructured data like free content, pictures or sensors perusing. This is the place where big data could be the rescuer in improving the usage of data. As per the Construction Industry Development Board Malaysia (CIDB), dependable and quality big data is at present sought after to line up with the board's drives under the yearning of the Construction Industry Transformation Program (CITP). Related to this, it is fundamental to distinguish the degree of big data needs for the construction industry in Nigeria. The current move by CIDB is legitimized as the most average mistake made by associations was to use big data without surveying whether their

requirements could be fulfilled by the utilization of the innovation (Portela et al.,2016). Similarly, Addo-Tenkorang et al. (2016), added that there seem, by all accounts, to be a restricted comprehension on the worth and the capability of big data for construction industry. This had brought about a noteworthy debilitation in the advancement for the selection of big data in construction industry in Nigeria when contrasted with different ventures. Big data and the construction industry are indissoluble as the industry are managing a tremendous measure of heterogeneous data. This follows as data identified with construction industry has been anticipated by Bilal et al. (2016) to rise dramatically with the headway of advances and the Internet of Things (IoT). As indicated by Addo-Tenkorang et al. (2016), new freedoms as significant bits of knowledge can be created by excerpting the enormous measure of data acquired. Regardless of an investigation that centers on the possible utilization of big data especially in the construction industry has not been thoroughly attempted (Bilal et al., 2016). This cutoff point's comprehension of its latent capacity, where the industry is apparently ignorant hence couldn't relate and extricate its genuine worth. Subsequently, this research plans to draw bits of knowledge on the particular spaces of construction big data research in Nigeria. As big data is set to impact the industry, the examination discoveries would be an impetus for making the genuinely necessary attention to help the improvement of big data for the construction industry in Nigeria. This would additionally come out on top to outfit in building up their capacities in tackling the capability of big data just as empowering ability and framework advancement to participate in the approaching influx of big data innovation in the construction industry in Nigeria.

1.2 Problem Statement

The size of data generated by construction industry in Nigeria has been increasing following an intense use of modern technologies (Ismail et al., 2018). According to Waal Montgomery (2015) predict, big data in construction industry rise at approximately 40% per year. Peiffer (2016) asserted big data as one of the important factor in configuring the direction which should lead toward improving the construction industry efficiency and Burger (2017), say the inefficiencies of data usage is due to the limited ability in dealing with unstructured data. The increase in data generated make it difficult for construction industry to analyze data using the right technique and approach. Using wrong technique and approach to analyze big data in construction industry in Nigeria is a great problem which any scholar or researcher has not addressed and which need to be addressed and provide the most suitable technique to be use to analyze big data in construction industry in Nigeria because use of wrong technique and approach affect the end result of a project thereby prone problem to the construction industry. The data explosion thus lead towards the big data analysis which is envisioned to revolutionize the construction industry like never before. This research work underscores on the technique and approach to analyze big data in construction industry in Nigeria as a gap that need to be addressed. This research work will empower specialists to investigate the key topics talked about big data application in construction industry in Nigeria as well as the practical applicability of big data techniques in the construction industry in Nigeria. The identification of knowledge gaps will help the academic researchers to push ahead for a persistently advancing group of knowledge. The suggested new research avenues will educate future researchers on potential moving and immaculate regions for research. This research work will bridge the identified gap by suggesting right technique and approach to big data application in construction project delivery in Nigeria.

1.3 Objectives of the Study

The aim of the study is the application and analyses of big data in project delivery in Oyo State.

The following specific objectives of this research work include:

i. To examine the sources of big data in construction project delivery in Oyo state, Nigeria.
ii. To evaluate the factor affecting the application of big data in construction project delivery in Oyo state, Nigeria.
iii. To appraise the techniques in use for analysing generated big data in construction project delivery.
iv. To evolve appropriate technique for analysing big data in construction project delivery

1.4 Research Question

In carrying out this research work the following are the research questions:

i. What are the sources of big data in construction industry in project delivery in Oyo state, Nigeria?
ii. What are the factor affecting the application of big data in project delivery in construction industry in Nigeria?
iii. What are the techniques use for analysing generated big data in project delivery in construction industry in Oyo state, Nigeria?
iv. What are the appropriate technique for analysing big data in construction project delivery?

1.5 Research Hypotheses

- H0: There is a significant relationship between data and technology system and project delivery.

  H1: There is no significant relationship between data and technology system and project delivery.

- H0: There is a significant relationship between human resource and project delivery.

  H1: There is no significant relationship between human resource and project delivery.

- H0: There is a significant relationship between organization resource and project delivery.

  H1: There is no significant relationship between organization resource and project delivery.

1.6 Justification of the Study

Many research works has been completed on big data investigation in construction industry by various researchers on the planet most particularly its suggestion on construction industry. The vast majority of the research work completed on big data investigation center around different nations and its suggestion on construction industry, none of them have talk seriously on big data application in construction industry in Nigeria in relation to project delivery which make my research work a remarkable one among others past work that have been done on big data application in construction industry. The past research work did by researchers on big data on construction industry have address issues like ramifications and difficulties of big data analysis on construction industry in different nations yet neglect to investigate issue/arrangement going

up against big data application corresponding to extend conveyance in construction industry in Nigeria. My research work will investigate the reasons for big data analytics and what lead to it, effect of big data analytics on construction industry in Nigeria and issues experience with construction industry utilizing big data and conceivable answer for them. This research work will in any case investigate the past issues that have been tended to by different researchers previously and decide if justices have been brought to them and if not this research work will bring justice to them. This research work will add to the economy and the overall population in light of the fact that it will give arrangement defying construction industry utilizing big data application, distinguish the effect whether positive or negative and give answer for the adverse consequence. Likewise this research will help the experts by and by in light of the fact that it will empower them to realize what and how to deal with project utilizing big data application comparable to project delivery in construction industry in Nigeria.

1.7 Scope and Limitation of the Study

This research work will focus on the big data analytics on construction industry Oyo State in Nigeria, recognize the reasons for big data analytics in construction industry in Nigeria, issues and give answer to them.

The significant limitation which limit this research work are the following;

i. Financial constraint is the major factor that limit this research work.
ii. The various offices and departments where vital information can be gotten for this research are not always responding to interviews due to their busy official schedule thereby making it difficult to get adequate information on time.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Review

Fundamentally, "Big data" is an antiquity created as an aggregate insight of human shared essentially through the innovative climate (Eadie et al., 2013). This climate gadgets a typical stage, where basically everything without exception can be reported, estimated and caught carefully where the advanced catch is then changed into data (Sivarajah et al., 2017). Mayer-Schonberger and Cukier (2012) alluded to this interaction as "datafication". As the world has now immersed with data, big data analytics (BDA) is progressively turning into a moving practice and has gotten generous fascination from the two scholastics and professionals paying little mind to the area. This enormous development in data age carries critical freedoms for information researchers to catch significant experiences and information. Seemingly, the availability of data and afterward its administration can improve the norm of numerous areas by reinforcing existing measurable logical procedures (Bilal et al., 2016). Despite the current circumstance, it is evident that this pattern will be improving later on. In consistence with the idea of "datafication" and the mechanical headways, it is obvious that the future will significantly depend on the data which is being produced and shared through machines, as machines speak with one another over information networks doing so will result less human inclusion (Van Dijck, 2014). Having said the condition of craftsmanship in big data by and large, the

construction industry isn't an exemption for the inescapable advanced upset. Without a doubt, the industry is managing critical measure of data emerging from different orders (for example Building Information Modeling (BIM) information) for the duration of the existence pattern of an office and on the off chance that they were better outfit (by finding the inactive examples, patterns and connections covered inside) it could help determining valuable social, financial and natural bits of knowledge that would uphold data driven dynamic for upper hand. These interests have made construction project for the reception of BDA, fully intent on producing significant key industry experiences for upgraded dynamic and in this way accomplish hierarchical upper hand as there is a huge worth creation potential from examination of big data in construction project (Cook, 2015). While big data seem, by all accounts, to be one of the creative patterns for construction project, it is as yet creating at a sluggish speed as it is beginning to see the extraordinary impacts of big data (Cook, 2015). Keeping that in mind, it is significant that the scholarly community advises some regarding the persuasive ramifications of big data in construction project for the better comprehension of its implementers and additionally adopters. This paper accordingly examines the past big data research in construction project writing to discover the holes that have not being tended to concerning social, financial and natural ramifications as the exertion will at that point could help both industry experts just as scholars to convey forward for the consistent improvement of the industry. There is presently no exhaustive overview of the writing, focusing on the use of big data analytics with regards to the construction industry in Nigeria tied-up for social, financial and ecological ramifications. This paper makes up for the shortcoming and present a wide-going interdisciplinary investigation of fields, for example, AI, information warehousing, information mining, and so on, and their application.

The analytics of big data collections in endeavors, the term of big data analytics is related with data science, business knowledge and business investigation. Data science is characterized as an assortment of essential rules that advances taking data and information from information. Throughout the most recent years, data driven methodologies like Business Intelligence (BI) and Business Analytics are described vital to working endeavors (Vassakis et al., 2018). BI is characterized as the techniques, frameworks and applications for gathering, planning and examining information to give data helping chiefs. All in all, BI frameworks are data driven dynamic frameworks, while Business Analytics are the procedures, innovations, frameworks and applications that are utilized to dissect basic business information for supporting them to comprehend their business climate and take business choices on schedule. The force of Business Analytics is to smooth out immense measures of data to improve its worth, while BI predominantly packs chronicled data in diagrams and information table reports as an approach to give answers to inquiries without smoothing out data and upgrading its worth. Business Analytics was initiated to diagram the primary scientific component in BI in the last part of the 2000s. A while later, the conditions of big data and huge information investigation have been used to scientific methods for informational collections that are so huge and complex, portray requiring progressed information stockpiling, the executives, examination and perception advances. In that quickly developing climate, the speed of information makes the transformation of information into important information rapidly a need. The contrasts between traditional examination and quick investigation with Big data are in investigation qualities (type, objective and technique), information attributes (type, age/flow,volume) and essential evenhanded as demonstrated in the table

Table 2.1: Conventional and big data analytics

	Conventional analytics	Big data analytics
Analytics type	Descriptive, Predictive	Predictive, Prescriptive
Analysis methods	Hypothesis-based	Machine learning
Primary objective	Internal decision support and performance management	Business processes driver and data-driven Products
Data type	Structured and defined (formatted in rows & columns)	Unstructured and undefined (unstructured formats)
Data age/flow	>24 h Static pool of data	<Min Constant flow of data
Data volume	Tens of terabytes or less	100 terabytes to petabytes

Source: Vassakis et al, 2018.

The advancement of the Internet and later on the network coming from the web has contributed in the increment of the volume and speed of data(https://www.researchgate.net/publication/320771893). Since the mid-2000s, Internet and Web innovations have been offering extraordinary data assortment and examination for ventures. Web 1.0 frameworks empower endeavors to build up a web presence and offer their items/administrations internet communicating with their clients. Web 2.0 frameworks, including the presentation of web-based media networks like Facebook, give endeavors more information data about ventures, items and clients. The continuous increment of cell phones against the quantity of PCs presented another period of business examination, including the investigation of client created content by online media channels. Cell phones have the ability to advance for example profoundly portable, area mindful and individual focused cycles and exchanges.

Accordingly, Data-driven dynamic is on information coming from every one of the wellsprings of undertakings, while expectations and AI depend on customary information and new imaginative sources like IoT and (Vassakis, 2018). Information examination is the way toward reviewing, cleaning, changing and demonstrating information acquiring valuable data for ideas and backing in dynamic. It has numerous aspects and approaches, incorporating assorted strategies under an assortment of names, in various business, science and sociology plans, while "Big Data Analytics" alludes to cutting edge scientific procedures, thinking about enormous and different kinds of datasets to analyze and separate information from huge information, comprising a sub-measure in acquiring bits of knowledge from big data measure. Utilizing trend setting innovations, Big Data Analytics (BDA) incorporates information executives, open-source programming like Hadoop, factual examination like assessment and time-arrangement investigation, perception apparatuses that assistance structure and associate information to reveal covered up designs, unseen relationships and other significant experiences. The cycle of BDA is an asset for vital choices prompting huge upgrades in activities execution, new income streams and seriousness against rivals. Around there, the way toward getting experiences from big data can be partitioned into two stages: data the board and data analysis. Information the executives is connected with the cycles and advances for information age, stockpiling, digging and groundwork for examination, while information investigation alludes to the strategies and procedures for examination and understanding of the bits of knowledge coming from big data (Konstantinos et al, 2018). Investigation can be separated into four classes, going from graphic and demonstrative examination to the further developed prescient and prescriptive investigation.

Unmistakable investigation, in light of recorded and current information, is a huge wellspring of bits of knowledge about what occurred previously and the connections between's different

determinants recognizing designs utilizing factual measures like mean, reach and standard deviation

2.1.1 Descriptive Analytics

Utilizing procedures like online insightful preparing (OLAP) misuses data from the past experience to give answers in what's going on in the associations. Regular instances of expressive investigation incorporate information perception, dashboards, reports, outlines and charts introducing key measurements of endeavors including deals, orders, clients, monetary execution and so on (Vassakis et al., 2018).

2.1.2 Diagnostic analytics

Based likewise in chronicled information give bits of knowledge about the main driver of certain results of the past. In this way, associations can take better choices staying away from mistakes and adverse aftereffects of the past(Vassakis et al., 2018)

2.1.3 Predictive analytics

Is tied in with gauging and giving an assessment to the likelihood of a future outcome, characterizing openings or dangers later on. Utilizing different procedures including information mining, information demonstrating and AI, the execution of prescient examination is critical for any association's fragment(Vassakis et al., 2018). Quite possibly the most known utilizations of that kind of investigation is the forecast of client conduct, deciding activities, showcasing and forestalling hazard. Utilizing recorded and other accessible information, prescient investigation can reveal designs and distinguish connections in information that can be utilized for estimating.

Prescient examination in the advanced period is a huge weapon for associations in the serious race. Thusly, associations abusing prescient investigation can distinguish future patterns and examples, introducing imaginative items/administrations and advancements in their plans of action.

2.1.4 Prescriptive analytics

Give a determining of the effect of future moves before they are made, replying "what may occur" as result of the associations activities. Accordingly, the dynamic is improved thinking about the forecast of future results. Prescriptive examination utilizing significant level demonstrating devices can contribute strikingly to the presentation and productivity of associations, through more brilliant and quicker choice with lower cost and hazard and distinguishing ideal answers for asset assignment (Vassakis et al., 2018). The high level prescient and prescriptive investigation can assume pivotal part in effective vital dynamic managing critical issues of associations like plan and improvement of items/administrations, store network and development.

2.1.5 Big Data synthesis

Big data as an idea. The data idea of being "big" is hard to characterize as what seems, by all accounts, to be huge today may have all the earmarks of being more modest sooner rather than later (MIT, 2013). Further, no proof demonstrates that monstrous informational indexes are consistently perplexing or little informational indexes are consistently straightforward (Sivarajah et al., 2017). Along these lines, the intricacy of the information isn't kept to information size, since informational collections will increment later on. Supporting this argument,McGuire et al. (2012) allude huge information to informational collections whose size is past the capacity of run

of the mill data set programming instruments to catch, store, oversee and examine. A comparative definition was given by Amir Gandomi et al. (2015) with a clarification of three 'v's (volume, assortment and speed). Bilal et al. (2016) likewise draw out the 3'V's idea as clear obvious in development information. Since, development information is enormous, heterogeneous and dynamic (Aouad et al., 1999), they become voluminous because of huge volumes of information built up at a quick momentum. These information as recommended by Bilal, Oyedele, Akinade et al. (2016); Bilal, Oyedele, Qadir et al. (2016) include: plan information, plans, venture asset arranging (ERP) frameworks, monetary information, and so forth The last creators have considered the enhancement of these information in such a profound level that they can be sorted into single configuration (for example DWG, DXF, DGN, RVT, ifcXML, XML, ifcOWL, OWL, DOC/XLS/PPT, RM/MPG and JPEG). This unique nature of development information has permitted frameworks to stream through sensors, RFIDs and BMS (building the executives sensors). This rich scholarly presentation of sensors has been effectively tried by Akhavian and Behzadan (2015) with the utilization of cell phone sensors and AI classifiers to improve the quality and dependability of venture dynamic and control. Hence, Bilal, Oyedele, Akinade et al. (2016); Bilal, Oyedele, Qadir et al. (2016) imply that usage of these voluminous information in an ideal way would undeniably be the following boondocks of advancement in the construction industry. The creators further recognize the idea of big data designing (BDE) and BDA as two ideas that necessities cautious thought. Big data logical strategies/methods. Amir Gandomi and Haider (2015) portray a few famous BDA strategies explicitly can be utilized in development area. These methods incorporate content examination (information mining) like data extraction (IE), element acknowledgment (ER) and connection extraction (RE), text summarisation, question replying (QA), estimation investigation –

information mining (Fan et al., 2015), content-based examination, structure-based examination (Chen et al., 2016) for cloud-based framework system for organized BIM information), sound investigation (ref) and visual-picture/video examination Han and Golparvar-Fard(2017); social media investigation (Tang et al., 2017.), GIS investigation (Buffat et al., 2017) and prescient examination (Li, 2017; Fan et al., 2017). Bilal, Oyedele, Akinade et al.(2016); Bilal, Oyedele, Qadir et al. (2016) recommend conceivable BDE and BDA techniques that can be effectively applied into development works on, considering BDE to be a foundation supplier to help BDA. The creators further present huge information handling methods (Map Reduce (MR), Directed Acyclic Graphs (DAG)) and capacity procedures (disseminated record frameworks, NoSQL data sets) for BDE. Guide Reduce measure has been generally utilized in development as a mean of laser examining/point filtering for superior quality studying (HDS) where significant data can be extricated from LiDAR point mists like the area, direction and size of items and conceivable harm. Aljumaily et al. (2016) propose a major information approach-MapReduce interaction to naturally recognize and separate structures from an advanced surface model made from elevated laser checking information. Han and Golparvar-Fard (2017) utilize a comparative point cloud framework to investigate the structure execution. Then again, for BDA strategies like measurements: information mining, Machine learning procedures, relapse, grouping and bunching are accounted for. The construction industry has utilized a portion of these factual techniques in an assortment of use territories, for example, distinguishing reasons for construction delays (Chau et al., 2003) gaining from post-project surveys (PPRs) (Carrillo et al., 2011), choice help for construction suit (Jordan and Mitchell, 2015; Mahfouz, 2009), recognizing primary harms of structures (Jiang & Mahadevan, 2008), distinguishing activities of laborers and large equipment (Gong et al., 2011; Huang & Beck, 2013). Chau et al. (2003) in

their study of distinguishing basic components for construction delays has utilized data mining methods to catch ML calculations to create data revelation dataset (KDD). Another research directed by Buchheit et al. (2000) additionally displayed a KDD cycle for a task identified with development of framework. KDD measure is rethought by Soibelman and Kim (2002) to show it is pertinence to construction industry in recognizing construction questions, for example, delays, cost overrun and quality disappointments. While Carrillo et al. (2011) utilize information mining methods to use past projects as learning material for hazard free future activities, Liao and Perng (2008) endeavored to utilize affiliation rule mining strategy to examine the anticipation degree of working environment just as word related wellbeing security dangers. A comparative report has been directed by Cheng et al. (2012) utilizing information mining to research the word related wounds in building locales. Curiously, the framework was adequately able to uncover the most effective motivations as falls and implodes. Information warehousing (DW) is another method utilized by numerous development related examinations. Chau et al. (2003) and Kimball and Ross (2011) utilized DW to assess development efficiency information by a SQL multi-facet examination. SQL has been accounted for its wide utilization explicitly in construction for is assistance for questioning fractional BIM models inquiry dialects, for example, express inquiry language (EQL) and Building Information Modeling Query Language (BIMQL) (Bilal, Oyedele, Akinade et al., 2016; Bilal, Oyedele, Qadir et al., 2016). Such investigations incorporate Kimball and Ross (2011) and Koonce and Judd (2001). AI is a kind of prescient measurements that is generally applied in construction information forecasts. Arditi and Pulket (2005) a nearer form of computerized reasoning (AI) permitting a program to gain from information about explicit errand naturally and anticipate the conceivable future results. AI rule-based learning is an industry-wide application where numerous analysts found gainful with an assortment of utilizations like

counterfeit neural organizations strategies, case-based thinking procedures and cross breed techniques (Ahn & Kim, 2009, Arditi & Pulket, 2005, 2010, Chau, 2005, 2006, 2007; Chen and Hsu, 2007; Cheng et al. 2009; Choi et al. 2014; Du et al. 2010; Pulket & Arditi, 2009; Sanyal et al. 2014). A comparable report did by Sacks et al. (2018) presented a period and cost saving mechanized strategy for checking building plans for code consistence utilizing AI procedure. This strategy is viewed as profoundly valuable at the period of preprocessing and planning BIM models for checking. Prescient examination has been generally utilized in construction movement forecasts through recreations. Li (2017) in his examination of arena development utilized an obliged parametric file investigation model of the advancement investigation to screen, anticipate and control the asset (i.e labor, planning) progress. Relapse models have likewise been in the utilization for a long time in construction research. The utilization of relapse model frequently accompanies an AI method. A significant number of the examinations have utilized relapse models to foresee development delicate costs, quotes and material value variances (Cheng et al., 2009; Fallis, 2013; Lau et al., 2010; Narbaev & DeMarco, 2014). Utilizing a comparable strategy Shrestha et al. (2017) utilized unique things container (DIB) strategy, which depends on relapse demonstrating for huge sum parkway bid information to set up a system for improved estimation interaction of Highway Construction Cost Index (HCCI). Huge information openings and difficulties. There is an impressive assemblage of exploration on the chances and difficulties offered by BDA (Bilal, Oyedele et al., 2016; Bilal et al., 2016; Wamba et al., 2016; Wang et al., 2016; Devlin, 2016). The real test of handling with big data as recommended by Mishra et al. (2017) "was to manage expanded information types (assortment), ideal reaction necessities (speed) and vulnerabilities in the information (veracity)". Mishra and Sharma (2015) advocate taking care of both semi-organized and unstructured information is

testing particularly when they are not gotten in an opportune way. The explanation as last creators notice is basically be because of the absence of inadequate sources expected to assemble, store and investigate big data yet inside a specific time period. The creators further notice the unwavering quality of data is likewise a major issue where moreover purging strategies needed to be applied to moderate the vulnerability which may devour considerably more time and assets. Manyika et al. (2011) state distinguishing the specific space of uses as perhaps the greatest test in big data. Moreover, Data security, security and assurance, nature of construction industry informational collections, cost suggestions for big data in construction industry, web network for big data applications, misusing big data to its maximum capacity are additionally examined in the current writing (Tene & Polonetsky, 2013; Bilal, Oyedele, Akinade et a., 2016; Bilal, Oyedele, Qadir et al.,2016).

2.1.6 Big Data Analytics Application

These days, as the developing age of accessible data is a perceived pattern across undertakings, nations and market sections, most of ventures notwithstanding industry is gathering, putting away and breaking down information to catch esteem. Advanced economy through the gigantic utilization of web and computerized administrations has changed practically all the business areas, including construction industry and assembling, to more assistance focused. There are numerous and various areas, similar to e-commerce, (Vassakis et al.,2018). Politics, science and innovation, wellbeing, taxpayer driven organizations and so forth, where big data examination are applied. Information driven organizations from different industries explain the force of big data, making more precise forecasts driving on better decisions. The huge surges of data created ordinary need better foundations to be caught, put away and examined. A market with a wide stock of new items and apparatuses intended to cover every one of the requirements of big data

has been made and it is growing quickly. There is a wide assortment of logical devices that can be utilized to perform BDA, among others based on SQL questions, factual examination, information mining, quick bunching, characteristic language handling, text investigation, information perception and man-made reasoning (AI). These procedures and apparatuses give effectively and quickly misuse of big data. The information got from abuse of big data gives undertakings added esteem through better approaches for profitability, development, advancement and customer excess, subsequently big data turns into a significant determinant of seriousness and endeavors are needing information examination ability to misuse the maximum capacity of big data. Undertakings that figure outhow to underwrite big data using constant data coming from different sources like sensors, associated gadgets and so forth can comprehend in more detail their current circumstance and characterize recent fads, make new and imaginative items/administrations, react rapidly in changes and improve their showcasing activities. The influence of big data can add to the proficient assets' designation and management, squander decrease, help of new bits of knowledge and more elevated level of straightforwardness in various areas of endeavors from creation to deals. Along these lines, big data analytics applications in pretty much every business area exist (K. Vassakis et al., 2018). Applications likewise in legislative issues and e-government, science and innovation, security and wellbeing, brilliant wellbeing and prosperity exist. Moreover, there are bounty and different kinds of large information applications among undertakings and industry areas. BDA can be utilized in web based business and showcasing applications like internet publicizing and strategically pitching, while it assists undertakings with investigating client conduct in molding 360-degree client profile for execution of focused and upgraded advertising activities to affect client procurement and fulfillment. It offers better comprehension of clients' conduct and inclinations and

subsequently improve client administration. A few instances of the manners in which BDA are misused appearance the meaning of investigation in different topics:

Table 2.2: Some example of the ways BDA are exploited showing the significance of analytics in various themes

Marketing	Market basket analysis	Recommendation systems	Customer Intelligence	Retention modeling	Customer churn Prediction
Processes	Supply chain analytics	Demand and supply forecasting	Business Processes analytics	HR analytics	
Government	Fraud detection	Terrorism Detection	Tax avoidance	Cost reduction	Social security
Risk Management	Credit Risk Modeling	Market risk modelling	Fraud detection		
Web and Social media	Web analytics	Social media analytics	Multivariate testing		

Source: Vassakis et al., (2018)

Industries and associations gather a lot of safety significant data, for example, programming application occasions, network occasions, individuals activity occasions. The age of information coming from these activities are expanding quickly each day as associations empower signing in more sources, running more programming programs, have additional functioning representatives and move to cloud arrangements. Shockingly, the volume and assortment of safety information immediately become overpowering and existing logical strategies can't work productively and dependably. BDA applications become part of safety the board and checking, since it adds to cleaning, arrangement and investigation of different unpredictable and heterogeneous datasets productively. Perhaps the most widely recognized employments of BDA is misrepresentation recognition, along these lines monetary organizations, governments and telephone organizations

utilize huge information innovations to dispose of hazard and improve their adequacy. What's more, BDA is broadly applied in inventory network and coordination's tasks assuming a critical part in creating production network techniques and store network activities the executives. BDA can uphold dynamic through the comprehension of changes of advertising conditions, ID of production network hazards and abusing production network abilities to demonstrate inventive store network methodologies, in this way improving the adaptability and productivity of inventory network (Huang et al., 2020.). BDA contributes likewise in dynamic at operational level, since it measures and examinations store network execution considering request arranging, supplies, creation, stock and coordination's. It along these lines improves proficiency of tasks, measures production network execution, diminishes measure alterability and adds to the execution of the best production network systems at operational level. Discussing computerized and information driven undertakings, the firsts coming as a primary concern are Google, Amazon, Apple and Facebook. Amazon that was conceived advanced, misused huge information accomplishing to disturb conventional book market and turned into the pioneer in computerized shopping (K. Vassakis et al., 2018). Another illustration of a renowned conceived computerized firm is Google that outfit data from motor inquiry to advanced advertising to give and customize search to its clients, while Google and Facebook gather information giving freedoms to customize a lot showcasing. By and by, customary non-innovative endeavors are likewise endeavoring to acquire information driven advantages. General Electric (GE) has fostered a cloud-based stage for Industrial Internet application named "Predix" that gives constant bits of knowledge to specialists to plan upkeep checks, improves machine productivity and decreases personal time. GE this way offered new assistance offers in the moderate market of the oil and gas industry, while it faces its most squeezing difficulties: improving resources and activities

profitability and wiping out the expense of inferred information from maturing labor force . (Vassakis et al.,2018).Walmart et al. (2017), significant retailers utilizing BDA in the whole business measure, from store network the board to promoting, acquired advantages from information. Uses of BDA are all over and in computerized areas, yet additionally in no online areas including producing, agribusiness, medical services, energy, voyaging and others. In medical care areas, different utilizations of BDA exist, from nature of therapy administrations and cost productivity of clinics to progress and expectations of patient ailment. In voyaging and retail, BDA applications can give client knowledge through web and online media examination, along these lines endeavors can offer customized items/administrations. Also, in energy the executives most of the undertakings use information investigation to track and control gadgets accomplishing a more proficient energy the board without administrations deviation.

2.1.7 Big Data Analytics Prospect

Investigation showed up as right on time as in the mid1950s Analytics 1.0 time with the approach of instruments that had the option to create and catch bigger measures of information in undertakings information stockrooms and find designs more rapidly than human personalities with business knowledge apparatuses. In that first period, supervisors acquired an information based understanding going past instinct in dynamic. Until mid-2000s, the fast development of information age and the appearance of huge information have flagged another time Analytics 2.0 where undertakings have the chance to use that information with new more incredible assets (Ibrahim et al., 2016). The need of new inventive innovations showed up and endeavors moved rapidly to procure the essential abilities and information for acquiring bits of knowledge from big data, with the significant distinction between periods being in abilities needed for information examination. In the following period, investigation is a fundamental piece of undertakings

supporting dynamic and endeavors move to formation of examination based items/administrations (Emmanuel,2018). Pushing forward, the following time Analytics 3.0 or "information economy" is portrayed by the gigantic increment of information age coming from the development of Internet of Things (IoT) with 8.4 billion associated gadgets in 2017 internationally and 20.4 billion by 2020. The latest period Analytics 4.0 incorporates intellectual advances including AI, where activities and dynamic are moved to expansion with dynamic machine mechanization. In the current time of investigation, the arising new advances will build the age of information, in this manner endeavors and associations need to look up specialized difficulties to approach more and better information. The overall incomes of big data analysis (BDA) will be more than $203 billion of every 2020 and banking, assembling, government and expert administrations will be the top ventures in BDA speculations as per International Data Corporation (IDC). Consequently, undertakings should zero in on catching worth from information utilizing insightful methods and devices. BDA can assist construction industry with looking at patterns and find new ones for acquiring upper hand, presenting better than ever items. Among others, information perception and interaction reenactment, text and voice examination, web-based media investigation, prescient and prescriptive procedures can give important information to undertakings, while they can make experiences more straightforward and effect any endeavor's segment. Information science and enormous information advances procedures advance information driven dynamic and hence contribute in better undertaking's exhibition, since a definitive objective of information science is the improvement of dynamic. Subsequently, regardless of whether associations couldn't catch esteem from applying information driven dynamic as their system, they have fizzled. There is proof that information driven dynamic contributes essentially and emphatically to big data presentation as far as efficiency and

productivity. Information driven methodology can give incredible freedoms to acquiring upper hand, as estimating and overseeing all the more decisively business examination can empower associations to settle on better expectations and more brilliant choices additionally to target more-successful intercessions. Moving to a totally different time in information examination, associations and undertakings are investigating new creative methodologies and strategies to stay serious in their market. Utilizing BDA assist them with presenting new as well as improved items/administrations, oversee all the more effectively their stockpile chains and cycles, wipe out hazard through extortion recognition and security improvement and adventure client knowledge. The advancement of investigation periods (Vassakis et al., 2018). Applications of BDA can give a few benefits in associations and undertakings that have a productive information driven methodology. Big data analysis can give top to bottom information about the various branches of an association and consequently utilizing big data investigation for forecast causing to add to expanded execution and better yields on construction industry with lower cost and hazard, while more straightforwardness is accomplished. A portion of the possibilities of big data analysis are acquiring bits of knowledge from large information investigation of the relative multitude of branches of an association to foster a thorough business methodology, or the whole association. This methodology will actually want to add to more elevated level of profitability and productivity, inside the divisions, yet additionally in the entire association with cost decrease and end of cycles. Associations will abuse more man-made consciousness (AI) advancements that can rehash associations differently. In any case, associations ought to foster robotizations and organized examination, before they proceed onward the reception of cutting edge AI. The reconciliation of organized and unstructured data investigation with AI frameworks makes it conceivable to look at, clarify and foresee client inclinations and conduct. Information driven

development (DDI) depending on the information based capital, alludes to advancements emerging from information driven choice cycles that lead to the disclosure of new and problematic plans of action, the upgrade of client insight and the presentation of new/improved items or administrations. The capability of information driven construction big data in UK private and public area organizations will prompt £24.1 billion commitment to UK economy during 2012–2017(Bital et al., 2016). Ongoing investigation is a major pattern that undertakings need to focus at soon. In spite of the difficulties and issues that are tended to, it is demonstrated that examination driven administration has critical ramifications on ventures, regardless of whether they are searching for development, productivity or serious separation. Consequently, big data analysis have apparently limitless potential to assist a venture with developing and uncover its information potential. The quick development of the interest for information investigation in mix with the absence of ability lead on coordinated efforts and drives among the scholarly community and industry to connect the ability hole. Around there, numerous colleges are getting ready and beginning scholarly courses related with information science. Furthermore, organizations understanding the capability of big data, give preparing to their representatives. As of late AirBnB began its own inward college called "Information University" to democratize information science and help to drive information educated dynamic (Vassakis et al., 2018). There are various assumptions from endeavors with respect to big data investigation. Authoritative pioneers need to abuse examination to be more astute and imaginative more than ever, while senior chiefs need to utilize information driven dynamic for their productive tasks. Directors utilizing an information driven choice framework (DSS), approach chronicled and new information supporting them to acquire bits of knowledge for association cycles and assets' exhibition. DDS are huge not just for Big Data Analytics: Applications, Prospects and

Challenges 15global associations yet additionally for little and medium associations that can abuse them to their advantage.

2.1.8 Big data analytics in construction industry

The assembled climate and venture the executive's research in the course of recent years has zeroed in on arising innovative work points. "Big Data" is one such concern where examination interests incorporate the impediments of using big data, challenges related with its representation; the part of improved anticipating in BDA , for example, AI; access and responsibility for; and the chances for testing huge information procedures for brilliant city and foundation components. The construction industry creates huge measure of data that can be rapidly voluminous from assorted orders for the duration of the existence pattern of an office. BIM is an ideal model for such big data gathering. BIM catches multi-dimensional CAD data efficiently to help multidisciplinary coordinated effort and reconciliation among partners (Eadie et al, 2013).With the development of inserted gadgets and sensors, developments have even begun to deliver enormous chunk of information during the activities and upkeep stage. These are additionally changed over into "large; BIMdata". The present circumstance has lead construction industry to enter the big data period (Bilal et al., 2016; Bilal, Oyedele, Qadir et al., 2016). Advancement and computerization of work measures with more cooperation innovations (digitalisation) were the critical worries during mid-2007. During the last prompt not many years, research has started to examine to a greater extent a lifecycle viewpoint on expenses and advantages of big data based choices made during plan and construction (Levitt et al., 2007). These days, contemplations have been more centered around various viewpoints of big data as a method of boosting profitability and gain upper hands over business rivals (Oyedele, 2016; McGuire et al., 2012; Gandomi & Haider, 2015; Marr, 2017). Nonetheless, paying little mind to

the methodology or the ontological viewpoint utilized, large numbers of the articles guarantee that Big data is a useful asset that can be considered as a source when "appropriately oversaw, handled and examined, have an incredible potential to produce new information along these lines proposing inventive and noteworthy experiences for organizations" (Jukić et al., 2015.s).Construction is one of the significant business that is capable towards a nation improvement. The development attempts to be completed in a task is dynamic (Wood, 2016) and include a high volume of information trade from different partners to be accumulated and prepared (Shrestha, 2013). Shrestha (2013) added that information is produced all through the different periods of development projects from arranging stage to fulfillment. As demonstrated in Table , the surge of information incorporates plan and monetary information, sensors and hardware information, photographs and recordings and others. This information is frequently enormous in volume, exceptionally different in configuration and dynamic. The diverse information mirrors the large number qualities of information gushing from development exercises consequently sits in conformity with the 3V's idea of big data.

Table 2.3: Big data context in Construction Industry

Characteristics	**Contributors**	**Examples**
Volume	Large volume of data from different sources	Design data, cost data, financial data, contractual data, Enterprise resource Planning (ERP) system, Etc
Variety	Diversity in the content format	DWG (drawing), DXF (drawingexchange format), DGN (design), RVT (revit), ifcXML, ifcOWL, DOC/XLS/PPT (Microsoft format), RM/MPG (videos), JPEG (images)
Velocity	Dynamic nature of data sources	ensors, RFIDs, Building Management System (BMS)

Source: Aouad, Kagioglou, Cooper, Hinks, and Sexton (1999); Bilal, Oyedele, Qadir, et al.(2016).

The Table above shows that the progression of development measures through the inescapable use of these information will be the following outskirts of construction industry advancement and efficiency. This is upheld by Harenberg (2017) who referenced continuous information preparing as the future supporter of efficiency in construction.

2.1.9 Triggering Constituents of Big Data in the Construction Industry

The digitalized upset has affected the construction industry rather fundamentally as the industry is managing heterogeneous measure of data (Bilal, Oyedele, Qadir, et al., 2016). These setting off constituents to big data are recognized and examined as the accompanying:

2.1.9.1 Building Information Modeling (BIM)

BIM is expected to catch the multi-dimensional CAD information to purposely uphold the multidisciplinary and facilitated working climate among the partners engaged with a venture (Eadie et al., 2013). As BIM includes with catching the extra layers of data all through the whole structure lifecycle, BIM is seen to change the development business across different points of view (Azhar, 2011). In spite of the fact that information volume has been the attribute of BIM, yet Humphreys (2016) contended that this information are not exactly enormous information. This follows as the tremendous documents of BIM with the mix of the various models is still speedily pre-arranged distinctly to be prepared by BIM applications. In like manner, the appearance of underlying gadgets and sensors has expanded the measure of information created where it at last prompts the wellsprings of Big BIM Data (Bilal et al., 2016). Subsequently, this triggers the construction industry to infiltrate the big data period.

2.1.9.2 Cloud Computing

Cloud figuring is a web processing pattern which on demand, offer admittance to the converge of configurable assets (Bughin et al., 2010). The principle design is to give numerous clients admittance to information stockpiling and calculation without each turning for an individual permit. The speed increase of distributed computing innovation has added to the development of big data (Qubole, 2017). As distributed computing is supporting the coordination of tasks in the BIM-based application, it has been comprehensively applied in the construction industry and big data execution in this upheaval is dumbfounding (Bilal, Oyedele, Qadir, et al., 2016). Moreover, distributed computing and big data are supposed to be an ideal combo that adds to the expense productivity and extensible foundation in supporting Big Data and Business Analytics (Ferkoun, 2014).

2.1.9.3 Internet of Things (IoT)

The Internet of Things (IoT) has been the fundamental column that triggers the big data. Fundamentally, IoT is an arrangement of Internet-associated gadgets that assemble and move information through introduced sensors (Meola, 2016). IoT application regularly passed on a significant number of sensors gadgets for information gathering. As the business presents endless big data use cases for IoT, big data is naturally the subject of interest (Bilal, Oyedele, Qadir, et al., 2016). Among the conspicuous spaces of IoT applications incorporates coordinations, transport, resource recording, canny homes and structures, energy and construction industry. Bilal, Oyedele, Qadir, et al. (2016) asserted that IoT and big data are related patterns where a colossal measure of information is made, gotten to and dissected progressively in construction applications. Furthermore, Pal (2015) proposed that during the choice of big data handling

innovation, tremendous surge of data created by IoT triggers big data on a proportional premise following the determination of big data preparing innovation.

2.1.9.4 Smart Buildings

Brilliant Building innovation absorbs the contemporary advancements with existing structure frameworks to pull in the conservative compromise between solace boost and energy decrease Khan and Hornbæk(2011). Frequently, these frameworks will deliver a huge volume of data and most of this data regularly stay unseen and at last discarded. As per Bilal et al. (2016), this data should be deciphered to genuinely reflect keen structures henceforth gives big data analysis a huge task to carry out. The data and correspondence innovation (ICT)- based combination and improvement frameworks, especially Internet of Things is a significant impetus for different applications, both industry and everybody in understanding the keen structures (Perera et al., 2014). In this sense, Moreno et al. (2016) thought that large information and IoT are a flawless mix in improving energy proficiency for Smart Buildings.

2.1.9.5 Augmented Reality (AR)

Expanded Reality is an innovation that directions virtual item pictures into true pictures. These pictures can be taken from the camera or, by utilizing a live view, the crowd can be added straightforwardly to the world (Reiners et al., 1998). As per Jiao, Zhang, Li, Wang, and Yang (2013) AR comes from 'Augmented Reality' (VR) and gives a half-profundity climate that features the specific arrangement between real scenes and virtual world pictures continuously. It is additionally extensively perceived as a guaranteeing innovation to improve human perspective. Moreover, the way to upgrade winning large information representation procedures is associated with AR and VR where it is applicable for human restricted insight abilities (Olshannikova et al.,

2015). Subsequently, AR and bigdata are positively unavoidable where the intricacy related with big data in construction industry is huge and should be overwhelmed by cutting edge perception strategies, explicitly AR and VR (Bilal, Oyedele, Qadir, et al., 2016).

2.1.9.6 Social Networking Service

Online media is one of the energizing patterns that could help the construction industry to improve the correspondence among project groups (Jiao et al., 2013). However, one of the principle challenge is to acquiesce the worth and investigating methods of examining it (Chen et al., 2012). This follows from the tremendous volume of heterogeneous information created by the interpersonal organizations. Henceforth, to appropriately dissect information from web-based media, the insightful procedures of information examination should be changed and consolidated into the new gigantic information for tremendous data handling (Bello et al., 2016). Comparable to this, big data can be used in creating engaging space applications through the high volume, speed, and assortment of interpersonal organization information to improve partners efficiency.

2.1.10 Mapping Ideas and Analytics

Planning includes assembling various strands that make up the subject to empower examination and union to be attempted. The cycle includes collecting the writing content from the survey and arranging the rundown into classifications to build up associations (Hart, 1998). As per Hart (1998), the point of this interaction is to progressively decrease the enormous measure of data extricated from the survey with due underlined given to separate the central matters of the contention. For this investigation, an included guide, in a type of a table proposed by Hart (1998) was created. The table showed the aftereffects of the investigation which has occurred by mirroring the words (or terms) got from the separated information. These were reflected as the

highlights which had portrayed the writing and a primary type of acknowledgment of the main ideas. Regardless of, at this stage, apparently the ideas determined were fairly incoherent and had followed the individual reflection from the sources. This requires the subsequent stage in the process amalgamation.

2.1.11 Determinants of Big Data Analytics in Project Construction

2.1.11.1 Customer Satisfaction

Customer fulfillment is one of the main models for estimating the accomplishment of a construction project (Krajangsri&Pongpeng 2016; Surlan et al., 2016; Williams 2016). Without help from customers, big data analytics can't be generally taken on in construction projects on the grounds that most of property developers are stringently market arranged (Yang et al., 2017). Likewise, the utilization of big data analytics should empower the arrangement of better support of end customers and the viable fulfillment of their requests (Lee 2017; Yang et al., 2017).

2.1.11.2 Post project Evaluation

After project culmination, the exhibition of big data analytics ought to be assessed to judge whether the big data advances or techniques used accomplished the ideal outcomes. This post project assessment is critical in aiding experts decide the limits of their big data analytics related practices and recognize future bearings for development. Model activities can be chosen as reference baselines for deciding the adequacy and effectiveness of big data related practices. The consequences of these post project assessments can be utilized to direct directors future choices on big data usage (Tao Yu et al., 2020).

2.1.11.3 Effect of Big Data on Project Performance

The inspiration for big data analytics usage lays fundamentally on its latent capacity sway on project construction. Presenting the usage of big data analytics in development tasks can bring about a sharp expansion in project costs (Bilal et al., 2016). Due to the intricacy of big data innovations, specialists might confront a scope of undertaking dangers, for example, time delays, absence of information about big data analytics, and absence of gifted staff. In any case, big data can likewise make extra incentive for construction projects (Zhang et al., 2015). The advantages related with big data analytics should plainly counterbalance any expected misfortunes, to such an extent that the last by and large exhibitions of construction projects are quantifiably improved (Yang et al., 2017).

2.1.11.4 Human Resource

The absence of undertaking administrators, developers, and laborers gifted in big data analytics has been recognized as a noticeable boundary upsetting the usage of big data in construction projects (Frankova et al., 2016). Most of professionals in the project construction industry have inadequate information what's more, experience identified with big data. In that capacity, it is hard for project construction experts to utilize big data investigation. To develop experts with reasonable data in the utilization of big data, venture should be made in big data instruction and preparing (Kharrazi et al., 2016).

2.1.11.5 Protection from Change

The use of big data analytics requires significant changes in project construction process, authoritative design, work jobs, and undertaking the executives modes. Protection from change might ruin the hierarchical changes essential for big data use. This obstruction can prompt

negative practices like postponement, ill-advised use, and obstacle (Lines et al., 2015). In big data construction projects, protection from change normally comes from false impressions and way reliance. Since most of specialists in the construction industry are new to big data analytics, project members might stress over their ability to change their work jobs and not plainly comprehend the advantages of utilizing big data. With regard to way reliance, people's past project experience can fundamentally influence their future task rehearses (Aaltonen et al., 2017). Appropriately, way reliance might prompt constant protection from big data analytics use.

2.1.11.6 Availability of Big data Technology

Big data can't be viably gathered, put away, handled, or examined utilizing conventional data innovations (Alharthi et al., 2017; Bilal et al., 2016; Yang et al., 2017), which implies that imaginative innovations should be created to work with its use. According to Bilal et al, (2016), BD advancements can be arranged into two classifications that is., Big data examination and Big data designing. Big data investigation provide information examination instruments for the extraction of helpful data or then again information from gigantic volumes of development project information. Big data designing spotlights on the improvement of equipment to help big data examination. It records the key innovations that can be utilized to support the usage of big data in development projects, which are in view of the investigations led by Bilal et al. (2016), Omran and Chen (2016), and Yang et al. (2017). In the development business, BD advancements have not been broadly applied by development project experts (Yang et al., 2017). Thusly, while formulating procedures for using BD, the accessibility of BD advances ought to be painstakingly considered by project administrators and designer.

2.1.11.7 Organization Structure and Culture

Accepting the use of BD requires a couple of changes in organizational design and culture (Alharthi et al., 2017; Halaweh & Massry, 2017). The foundation of new practical offices also positions might be important to oversee big data offices and provide specialized help (Janssen et al., 2017). Hierarchical structures with more levels of opportunity ought to be set up to enable grassroots individuals (i.e., people not holding senior positions or undeniable degrees of expert in their associations) with the capacity to separate and use information (Franková et al., 2016). Supportive hierarchical societies ought to be developed to set up clear hierarchical dreams concerning the usage of big data with the goal that association individuals can foster a thorough understanding of the expected worth of big data to their work (Alharthi et al., 2017; Lavalle et al., 2011).

2.1.11.8 Stakeholder Management and Collaboration

Development projects regularly include a scope of partners with contending claims (Olander & Landin, 2005). The data and information assembled from various partners address an important information source that can be utilized in BD investigation (Li et al., 2016). Thusly, assuming key partners will share their knowledge with the task group and a partner coordinated effort mechanism can be set up to work with information sharing, then, at that point, BD can be viably used to smooth out project tasks. In addition, partners regularly hold distinct advantages that decide the endurance and improvement of development projects (Yang et al., 2011). As needs be, their perspectives and concerns can essentially influence BD usage. In the period of BD, key partners ought to be effectively occupied with independent direction and their key cases sufficiently considered (Giest 2017; Kharazi et al., 2016).

2.1.11.9 Accessibility of Big Data Facilities

Using BD is a difficult and tedious assignment that requires viable IT foundations for information assortment, stockpiling, handling, also investigation (Hashem et al., 2015; Kharrazi et al., 2016). BD facilities like the NoSQL data set, web foundation, and cloud registering hardware are assuming an inexorably huge part in BD use (Bilal et al., 2016). Scientists have started to investigate the utilization of BD offices in development projects (e.g., Chen et al., 2016; Zhong et al., 2017). Notwithstanding, in genuine ventures, the development of BD offices requires huge interests in both programming and equipment. Appropriately, the accessibility of BD offices is being perceived as a basic variable influencing BD use.

2.1.11.10 Guidelines, Handbooks, or Guidance for Using Big Data

The manners by which information are gathered, put away, and handled must be normalized to improve the effectiveness of information investigation and alleviate the advancement of data islands in various IT gear (Schroeder 2016). Bilal et al. (2016) contended that BIM ought to be the accepted norm for overseeing building information across each life-cycle phase of an undertaking. In any case, there is at this pointno settled BIM-based data standard for settling interoperation gives that emerge by the utilization of various IT hardware. Also, handbooks or guides should be developed to train experts on the compelling reception of BD devices and techniques in their undertakings. In rundown, the advancement of norms, handbooks, and guides would significantly work with big data utilization.

2.1.11.11 Ethics and Legal Mechanism of Copyright, Privacy and Data Security

The issues of information security, protection assurance, and copyright have become significant difficulties to BD use in the development industry (Bilal et al., 2016). Weak data security can

easily be provoke individual or authoritative obstruction and may altogether damage an organization's standing (Lee, 2017). A security the executives convention dependent on law and morals should be set up and broadly perceived by the business (Lee 2017). To address potential obstructions, a comparing legitimate component should be intended to protect licensed innovation freedoms and the security of information providers (Hashem et al., 2015; Yang & Zhou, 2015). Notwithstanding laws also guidelines, a moral structure is expected to layout essential standards and give direction to BD use (Varley-Winter & Shah, 2016).

2.1.11.12 Power, Effectiveness, and Efficiency of Big Data

The power, adequacy, and productivity of BD presently can't seem to be assessed in many genuine cases since BD has not been generally embraced by specialists in the development business (Yang et al., 2017). Because of helpless information the executives rehearses, the quality and honesty of information address a huge test to the compelling use of BD in development projects (Bilal et al., 2016). The presence of commotion in informational indexes and the explorative idea of BD can undoubtedly prompt off track results and independent direction (Janssen et al., 2017). BD examination normally spend around 80% of their time tidying up boisterous informational indexes prior to playing out any examination assignments (Bilal et al., 2016), which features the current need of viable and productive BD rehearses. All the more significantly, in spite of the fact that huge volumes of information can be gathered from different plan and construction exercises, the full worth of these open information has not however been adequately acknowledged (Yang et al., 2017). Therefore, the strength, adequacy, and productivity of BD should be fundamentally improved to work with its use in development projects.

2.1.11.13 Exemplary Projects

The advancement of BD is reflected not just in its hypothetical advances yet in addition its undertaking rehearses. Exemplary undertakings can illustrate the advantages of BD, and consequently persuade more specialists to embrace BD in their tasks. Likewise, commendable undertakings can give important experience to BD use just as serving as a proving ground for BD advances (constr *et al.,* 2020) in this manner empowering the change and progressive improvement of BD rehearses. Therefore, exemplary undertakings can play a critical role in big data utilization.

2.1.11.14 Incentive Policies

To work with the use of BD, strategy producers ought to create unified associations to process, oversee, bind together, and monetarily support basic informational indexes (Kharrazi et al., 2016). Thusly, these associations could assume a basic part in planning systems to help the accessibility of open data sets and work with information sharing in the development business. Appropriations ought to be presented to inspire pioneers who use BD in their tasks. Likewise, states should make huge ventures to support the improvement of IT frameworks important for BD oriented plans of action (Schroeder 2016).

2.1.11.15 Top Management Support and BD-Oriented Management Modes

The reception of BD needs the help of top administration on the grounds that use requires a progression of key changes must be endorsed by senior forerunners in the association (Halaweh& Massry, 2017; Surabhi&Sekhar, 2017). Without top administration support, project supervisors can't get the essential assets, e.g., assets for buying IT gear (Halaweh& Massry, 2017; Kanwal et al., 2017; Young & Jordan, 2008). Top administration support can likewise

essentially work with the overhaul of work processes and the board modes, which assume a basic part in BD use (Halaweh& Massry, 2017). BD-arranged administration modes must be created to work on the effectiveness of BD advances and cultivate a positive hierarchical culture (Yang & Zhou, 2015). Management choices and plans should be founded on the aftereffects of information examination rather than the emotional decisions of task chiefs. Also, to guarantee the quality and honesty of development project information, information the board should be assigned as a significant administration work (Bilal et al., 2016). Accordingly, BD advancements ought to be coordinated into and turn into a fundamental part of conventional venture the executives rehearses (Yang et al., 2017).

2.1.11.16 Data Sharing and Governance

Information sharing and administration have become basic issues that challenge BD use since information accessibility is an essential precondition for BD investigation (Katal et al., 2013; Rodríguez-Mazahua et al., 2016). Because of the divided idea of the development business, information sharing either among various partners or inside organizations isn't generally acknowledged by specialists (Bilal et al., 2016).Combined with worries about information security, copyright, and protection, there is an absence of successful information partaking in most development projects. Accordingly, the quality and uprightness of development project information has turned into a significant hindrance that restricts the adequacy and productivity of BD-related practices. Information administration, a term that alludes to an instrument that decides the independent direction and property privileges identified with an information resource, is a significant part of information sharing (Rodríguez-Mazahua et al., 2016). As per Janssen et al. (2017), authoritative and social administration approaches must be embraced to secure the freedoms of partners and energize information sharing. Authoritative administration is

a methodology that stresses the plan of sensible agreements to improve the shared arrangement of partners with respect to BD, increment information quality, and plainly recognize BD-related liabilities. Social administration, in contrast, centers around building trust among authoritative elements to work with information sharing and information trade.

2.1.11.17 Fragmented Nature of the Construction Industry

Since it obstructs information accessibility and network, the divided nature of the development business has been distinguished as a basic factor that unfavorably influences BD use (Bilal et al, 2016). On account of the isolation of development exercises, information exchange and information sharing are wasteful in most development projects (Zuofa et al, 2015), which can prompt the presence of data islands. This fracture essentially thwarts the advancement of ICTs like BIM (Sun et al, 2017). The use of BD requires inventive innovations and the board modes, yet entirely the divided nature of the development business addresses a significant hindrance to development advancements since it frustrates interorganizational research and development(R& D) cooperation(Ozorhon et al, 2014).

2.1.12 Implication of Big Data Analytics in Construction Industry

Upeksha Hansin Madanayake et al. (2017) in their published journal on Critical Analytics of Big Data studies in construction industry identified three main implications of big data analytics in project delivery in construction industry which is discuss in this research work to be Social, Economic and Environmental implications.

2.1.12.1 Social Implication

Ramifications of big data on the general public as referred to numerous individuals of the applicable analytics and are restricted to individuals' nature of living and their practices/mentality

for the post-inhabitance of structures. Not many consider large to be as an assembly of individuals, spot and innovation as it assists with improving understanding on normal data conditions (Cook, 2015) just as to control and additionally augment the social cooperations through online media (Tang et al., 2017). It went against the positive effect, the adverse consequence on human connections brought about by people's steady association with advanced data which winds up as a habit is an under-explored region in development. As a finding of Tang et al, (2017) study, it has been introduced for the most part tweeted words by development laborers, however the review doesn't address how this finding advantage to work on the wellbeing and prosperity of them. In this manner, it is prudent to embrace further exploration on how web-based media BDA can be utilized to forestall dangers like security, injury or dysfunctional behavior brought about by business related pressure. On adifferent measurement, Big data strategies have demonstrated to screen and investigate indoor nature of room, for example, air quality, commotion, light, and so on Such engages occupiers on helpful data on wellbeing and prosperity characteristics of spaces and it is indication of further developed maintainability to the general public. Considering same bearing, Zhu and Ge (2014) research the social effect of green structures zeroing in on client fulfillment of green structures utilizing a major information post-inhabitance assessment. Notwithstanding, large numbers of these investigations identified with green structure execution assessment does not have occupiers' emotional just as target assessment. Further, big data with its resource the board have huge potential for positive social ramifications as it takes into account significant business choices dependent on the existence pattern of building not restricted to the capital cost alone (Cook, 2015). In any case, the examinations do not have the strength of lifecycle concentrates as to how these information can be reused for future advantage. The ways of utilizing any drop of

information, is to utilize them again and again, before it becomes flat and that to be sure saves gigantic measure of time too. Akhavian and Behzadan (2015) affirm through portable sensor information quality and dependability of venture dynamic could be improved, Despite the benefits big data offers, a portion of the social ramifications like disturbance to social collaborations, quality affirmation, need for commonly concurred principles/rules, protected innovation, security and security issues are as yet not altogether tended to. At last, need for abilities, information and preparing is one more significant social ramifications rose up out of the audit. Presently there is a gigantic interest for information the board capacities among experts, assist with inserting utilization of new innovation across the assembled climate area and create new roads for esteem creation from the vast amounts of data available in construction industry as well as all other sectors that is linked into it.

2.1.12.2 Economic Implication

Cook (2015) in his paper dependent on the 2015 RICS/SPR Cutting Edge gathering indicates that there is significant change affecting from the ascent of computerized innovation to making esteem from big data. One of the fundamental spaces of effect as he proposed would be changes to work jobs and business structures, requiring persistent learning and more noteworthy adaptability and flexibility for monetary soundness of the development business as its more prominent potential to many add esteem and produce more pay. Once more, Big data with its potential for future expectation models flourishes longer term see on absolute life-cycle costs instead of present moment monetary ramifications, (Cook, 2015). Notwithstanding, the investigations that address the financial worth big data don't actually assess and state with regards to how huge information could be taken advantage of to flourish intensity. The viability of big data can't be estimated just by gathering enormous volumes of data, it is a greater amount

of the utilization cases or modern issues that direct the value of these innovations (Bilal, Oyedele, Akinade et al., 2016; Bilal, Oyedele, Qadir et al., 2016). Subsequently, an obviously demonstrated contextual investigation examination would assist experts with seeing how big data could augment strategic advantage to keep steady over the market. Progress expectation model delivered by Li (2017) and Shrestha et al. (2017) is genuine instances of how big data further develop assessment and offering process. Once more, how this file can be utilized to further develop offering achievement is an undiscussed region. Further, Cook (2015) accentuates, as a consequence of big data publicity, organizations are beginning to be quicker on gathering and sharing economies with momentary necessities like business ventures. On what complex and dynamic ways big data work with these sharing economies is as yet neglected. BDA upheld by portable innovation with its geospatial ability adds an important measurement (Akhavian & Behzadan, 2015) that is, as of now incredible interest for land and building engineers (Buffat et al., 2017; Shrestha et al., 2017). By getting data and large insightful methods, these organizations can more readily comprehend the current and future customer interest what's more, better objective their new likely customers, which is a huge ramifications for sectoral economy overall. By and by, customer conduct investigation is extremely normal in areas like retail yet very little in development. The expense ramifications of big data, considered among the low-overall revenue organizations (development industry) is one more under-investigated region. Chau et al. (2003) notice that reception of big data consolidates exorbitant undertakings, for example, server farm buys and programming authorizing, such exorbitant additional items to projects are more liable to be gone against hard to be shielded on low-overall revenues. Subsequently it would be more advantageous directing more "measured" research that presents the business case on the degree of monetary return for large information speculation which would help vital choice

producers for their venture choices. More examinations on money saving advantage investigation of utilizing big data advancements in development projects are needed to this end. Since BDA is frequently engaged with enormous informational collections, it would be valuable if these rates of income making could be analyzed in bigger scope (transcendently thinking about the whole development industry). The current assemblage of information overwhelmingly cutoff points to miniature levels concentrates on like project (Han and Golparvar-Fard, 2017; Zhang et al., 2015; An, 2014) level. It was recognizable that a significant number of the examinations utilized "Building Information Modeling-BIM" (Han also, Golparvar-Fard, 2017; Motawa, 2017) and "Web of things-IOT" (Akhavian & Behzadan, 2015) compatibility to clarify the use of huge information as there is a nearer connection between the innovations in wording information sharing. Be that as it may, considering the dynamic and serious climate of the present world, embrace inventive advances and their cooperative energies (Demirkesen & Ozorhon, 2017). Consequently, yet, no research has been embraced investigating the collaborations between them.

2.1.12.3 Environmental Implication

Various examinations have led resolving the issues with energy interest and introduced new methodologies for building stock displaying (Buffatet al., 2017; Fan et al., 2015, 2017; Moreno et al., 2016; Mathew et al., 2015; Yu et al., 2016; Sanyal et al., 2014) utilizing geological/spatial informational indexes, for example, building impressions and computerized height models and building robotization frameworks. The model aides controlling the structure heat interest for different environment conditions and further develops energy productivity and protection which shows a positive ecological effect of BDA. This works on comprehension of the effect of environmental change in later years and permits originators learn warming and cooling loads in

various regions of the planet which at last saves gigantic measure of energy. Further, anprecise assessment of future environment conditions upheld by an energy reenactment has the benefit of diminishing the broad organic market for energy without ignoring the limits and varieties of the conceivable environment changes (Nik, 2016; Nik et al., 2016). Notwithstanding, in a large portion of the energy studies evaluated, choosing a reasonable measure is an significant advance ordinarily a multi-standards dynamic system (Nik, 2016), influenced by a few components identified with economy, accessibility, and so on, which have not been considered in the vast majority of the work. It is likewise evident that more exploration needed to be delivered as answers for fiascos which is a significant impact of environmental change. Calamity versatility and coordination in helpful activities and supply chains, is a deficiency in existing collection of writing. One more review led by Chen and Lu (2017) examined to the utilization of big data sets to limit destruction squander in Hong Kong which had various natural suggestions including alleviating antagonistic effects for example land crumbling, asset exhaustion and different types of contamination like commotion, residue, air and release of harmful squander. It is beneficial taking note of that, large numbers of the recommended squander decrease devices are yet to be approved with use cases. Despite the fact that there are many examination concentrates on asserting how BDA empower effective cycle productivity and advancement (Motawa, 2017; Li, 2017) there is absence of association between how it really makes spry and versatile to dynamic business conditions. There is a hole recognized in the space of how BDA contributes production network plan by zeroing in on principle attributes of store network including nimbleness, versatility, arrangement and joining.

2.2 Theoretical Review

The Theoretical Framework is the blueprint for the whole exposition request. It fills in as the aide on which to fabricate what's more, support your review, and furthermore gives the construction to characterize how you will thoughtfully, epistemologically, strategically, and scientifically approach the paper in general. Eisenhart characterized a hypothetical system as "a design that guides research by depending on a conventional hypothesis developed by utilizing a laid out, cognizant clarification of specific peculiarities and connections" (1991.). Consequently, the hypothetical system comprises of the chosen hypothesis (or speculations) that undergirds your reasoning with respect to how you comprehend and want to investigate your subject, as well as the ideas and definitions from that hypothesis that are pertinent to your point. Lovitts (2005) observationally characterizes standards for applying or creating hypothesis to the exposition that should be proper, sensibly deciphered, surely knew, and line up with the current inquiry. We state that understudies should choose and explain a hypothetical structure from the time the paper point is at first conceptualized. Scholars like Dooyeweerd (as refered to in Sire, 2004.) have even ventured to such an extreme as to call for "pretheoretically responsibilities" by the analyst to recognize one's "perspective of the heart as opposed to the explicitly mind. We proclaim that the specialist's decision of hypothesis should be plainly expressed and unequivocally referenced ahead of schedule in the composing of the exposition. Mertens recognized that the hypothetical system has suggestions for each choice made in the exploration process (1998, p. 3), which upholds our conviction that the hypothetical structure for a review should be recognized at the origin of exposition work. We likewise accept that all examination is hypothetical. The significance of hypothesis driven thinking and acting ought to be stressed corresponding to the choice of a subject, improvement of exploration questions, focal point of the writing survey, the

plan approach, and investigation plan for the exposition study. Anderson, Day, and McLaughlin (2006) catch the need of remembering a sound hypothetical supporting for an exposition study with a quote from a thesis boss who expressed, "I don't have the foggiest idea about how you can do a decent piece of work that is atheoretical" (p. 154). Likewise, Sarter (2005, p. 494) tended to the "restricted handiness of discoveries and decisions" when a review isn't legitimate by a hypothetical structure. Proof across disciplines is certain that the unequivocal ID and incorporation of a hypothetical structure is a need of sound examination.

2.2.1 Theories of Big Data on Construction Industry

2.2.2 Schumpeter Theory of Innovation and Big Data

Joseph Schumpeter is one of the forebears of development and financial development sxspeculations. Schumpeter hypothesis of Development (Schumpeter, 1934, 2013), business cycle (Schumpeter, 1939) and business (Schumpeter, 1939) are situated in financial, political and authentic settings. The business cycle hypothesis recommends firms insight changes, for example, sadness and development because of both interior and outside drivers. By and by, firms' capacity to make changes to interior drivers through the hypothesis of developments can prompt monetary development because of the impact of a pioneer with pioneering characteristics. These hypotheses center around the life, financial development and creation capability of business substances. An adjustment of the creation capability, either hardly or completely can work on a company's financial execution (Schumpeter, 1934). It might incorporate changing the amount of materials, new gear, change in supply of wares and embracing unique administrative techniques. These progressions are named as development. Impliedly, development is changing functional schedules determined to further develop proficiency. Outside also, inward drivers can rouse associations to change its creation capability,

however Schumpeter hypothesis of advancement thought about inside factors. Since developments are not a reaction to the outside requests but rather the requirement for change in firms (Schumpeter,1934). In context, these drivers are inside the control of the firm and influences its creation capability. Notwithstanding, the creators accept outside drivers additionally impact process change in firms. Model is Revit and AutoCAD from Data Framework (IS) discipline, which are outside to the development business yet affected the plan of development projects. Likewise, the adequacy of BD in different areas can rouse the development business to return to the unfortunate treatment of information. Outside factors are included to the hypothesis in view of the previously mentioned reasons. Schumpeter hypothesis of Development is utilized in light of the fact that BD application can further develop development processes and financial development of firms using information. Moreover, the hypothesis becomes instrumental in figuring out the precursor for BD applications in the development industry. For the most part, the utilization of refined gadgets and the failure of conventional information insightful innovations to process voluminous and assortment of datasets are the fundamental drivers for BD applications (Prophet Enterprise, 2014). The development business is utilizing complex gadgets to create voluminous datasets like recordings and pictures, which customary innovations are unequipped for handling. The inward drivers for BD application in the development business remember the interest for changes for information Towards an Incorporated System of Enormous Information Abilities the board, utilization of refined gadgets, developments and the requirement for information driven the board of the development interaction. The advantages of these progressions are pushed down to clients (Schumpeter, 1934, 1939). Process improvement experienced in medical services (Wang & Hajli, 2017) and business processes (Wamba et al., 2017). As well as tensions from project

climate as seen from BIM (Petite et al.,2017) can rouse the development business to investigate BD application.

2.2.3 Dynamic Capabilities (DC) and Big Data

The datasets and BD innovations comprise BD application. Drivers for BD application were recognized through the Schumpeter hypothesis of advancement, but, it is fundamental to recognize the capacities expected for its execution. Eisenhardt and Martin (2000) characterized DC as the company's cycles that utilization assets - explicitly the cycles to coordinate, reconfigure, gain and delivery assets to match and try and make market change. The definition stressed the fitness and capacity of firms' to answer or make changes in the business climate. Step by step, the development business is becoming information driven, expecting firms to take on processes fit for tending to information blunder. Abilities are created to empower firms to work on its cycles to be cutthroat on the lookout (Wamba et al., 2017). Cycles, position and way are the fundamental components in characterizing abilities required in firms (Teece et al., 1997). Processes include the mix of exercises, learning and testing to know the best and speedier approach to reconfiguring and executing assignments to meet the dynamism in the market. Position contains the cycles and resources of the firm including innovative, monetary, institutional, firms' limits and the market. Way includes the past, present and future open doors accessible to a firm by surveying the company's skill and abilities. Eisenhardt and Martin (2000.) made three perception of DC. DC, right off the bat, is embracing the "prescribed procedures" normal among comparable firms. Also, DC includes the control of firms' assets to accomplish new worth. Thirdly, DC is created in light of market dynamism. The company's assets in that setting are rearranged and reconfigured to answer the evolving climate (Gajendran et al., 2014). For instance, the business world is seeing innovative headway like BD examination which

requires the control of association's assets or moving to accomplish information driven administration. The blend of the fundamental components of DC accordingly cycles, position and way show that wellsprings of information, BD foundation, BD examination and the worth from information are the essential abilities got from the meanings of BD. Examining further the fundamental jobs and significance of the previously mentioned parts highlight the abilities expected to take advantage of them. Amit and Schoemaker (1993) portrayed capacities as the capacity of a firm to accomplish its planned objectives through sensible use of assets. Creating abilities in firms will more often than not be propelled by request from clients, outlook changes in the business, outer trailblazers and the organizations want to influence change by tending to difficulties. Researchers from different disciplines have investigated abilities expected to run a compelling and productive BD (Mneney & Beauty, 2016) what's more, BD investigation (Gunasekaran et al., 2017). Various factors were viewed as in the different insightful pieces yet the creators accept every one of the factors can be subsumed into hierarchical procedure (Association), BD framework (Innovation), Information and Individuals (BD examiner). Through hierarchical abilities, the BD examiners process the datasets utilizing the enormous information advances to create information. In the interim, these information become immaterial until the executives experience is applied to comprehend, translate and decipher the information in getting to the next level business esteem (Bradlow et al., 2017). The decoded information help the executives in direction, working on the upper hand and cycles of firms (Wamba et al., 2017). Notwithstanding, the pertinence of these develops in development is still uncertain and to get a superior comprehension we have embraced a SLR philosophy to foster a hypothetical structure.

2.2.4 Diffusion of Innovation Theory

The diffusion of innovation Hypothesis is helpful in giving a record of how mechanical advancements, for example, Enormous Information move from the phase of development to far reaching use or not. A survey of writing on the Dissemination of Advancements Hypothesis created by demonstrates that it can act as a hypothetical rule for concentrating on factors molding the reception and use of enormous information in agricultural nations. As per a development is a thought, practice, or article that is seen as new by an individual or one more unit of reception, what's more, dispersion is the cycle by which an advancement is imparted through specific channels over the long run amongthe individuals from a social framework. Depicts reception as the choices that people make each time that they think about taking up an advancement. Also, characterizes reception as the choice of a person to make utilization of a development as the most ideal strategy that anyone could hope to find. The Developments of Dissemination Hypothesis is very extensive, and its ideas are extremely applicable to innovation reception in agricultural nations. The Dissemination of Developments is portrayed by four components to be specific an advancement, correspondence channels, time, and a social framework. Depicted a development as a thought, practice, or undertaking that is seen as new by an individual or other unit of reception. This implies that a development might have been concocted quite some time in the past, however if people see it as new, it could be a development to them. Enormous Information take-up in Kenya for example and numerous other non-industrial nations are new practices and such undertakings goals are to supplement reviews and customary data sets. Advancement of Huge Information according to the point of view of agricultural nations can be perceived as all the logical, innovative, hierarchical, monetary, and business exercises important to make, carry out, and market new or further developed Large Information items or cycles.

2.2.5 Resource Based Theory

Resource based theory gives a suitable hypothetical focal point to examine BDAC on the grounds that it is destined to be committed to making sense of the wellspring of endeavors' upper hands (Akter et al., 2016; Awan et al., 2021). In particular, the principal suspicion of the hypothesis is that an endeavor as a rule comprises of a progression of extraordinary assets and capacities because of asset fixed status and its presentation relies upon what assets it has and how the assets are coordinated and used (Wernerfelt, 1984; Barney, 2001). In the interim, abilities are immaterial and the subsets of assets focus on the elements of assets and working on the efficiency of assets (Barney & Clark, 2007; Akter et al., 2016). BDAC incorporates information asset distinguishing proof, information capacity, and information investigation, which addresses the advancement of hierarchical immaterial assets (Barney, 2001; Awan et al., 2021a). While, asset advancement and asset bricolage center around sending different assets, which plans to expand the efficiency of assets (Desa & Basu, 2013; Lu & Guo, 2018). They are the vital wellsprings of center seriousness in a major information climate and can bring cutthroat execution.

2.2.6 Random Matrix Theory

From definite information, mathematical extrapolation can be utilized to separate limited size impacts. In loud information, just enormous informational collections have little an adequate number of fluctuations that such extrapolation is attainable. The Riemann zeros from the hypothesis of indivisible numbers give an illustration of an accurate large informational collection which amazingly act like noising information. Albeit over 10^9 sequential Riemann zeros starting past zero number 10^{23} have been processed to high precision, limited size impacts are on the size of the logarithm of this number. Concentrates on finished on this

informational collection in 2015 (Forrester and Mays) and 2016 (Bornemann, Forrester & Mays) have exhibited the legitimacy of a speculation previously set forward by Keating &Snaith relating the main request limited size amendment to arbitrary grid hypothesis. Two lines of future work present themselves: how to deliberately figure huge N extensions in arbitrary grid hypothesis, and the examination of the hypothetical system behind the adjustment term for the Riemann zero measurements.

2.3 Empirical Review

As of late, enormous information has been talked about across different areas and is considered as a distinct advantage in significant businesses (Gaitho, 2017). For this explanation, numerous associations have found a way ways to change their arrangement of activity in using the huge information esteem successfully (Akbar, 2017). An overview made by Gartner in 2015 demonstrated that organizations have gradually expanded their interest in huge information to 75% from 58% recorded by a similar overview in 2012. The broad extent of huge information has given a huge size of potential and worth that can be created across various areas, for example, retail area, fabricating just as the upstream industry. Retail area is among the soonest to perceive the capability of large information. This follows from the upsurge of web based business during the large information time (Laney, 2001). During that time retail organizations utilized the force of essential web advances to build up a solid web presence followed by building their ability to deal with an enormous information which was helpful for their proficiency enhancements Provost and Fawcett(2013). The potential was additionally reached out in dissecting the tremendous measure of information to help choice to grow organizations, work on cost effectiveness and income anticipating (Meneer, 2015). Fabricating is one more

driving area that has moved towards enormous information investigation in upgrading their item quality, and at the equivalent time diminishing the functional expenses (Oracle, 2015). Outer information particularly from interpersonal organizations and providers' information joined with information from sensors and machines has given important bits of knowledge to the current data. In this regard, huge information was used to dissect assortments in improving the effectiveness of assembling and the functional process by providing the bird's eye view of the processes which led to a better decision making. Apart from retail and manufacturing sector big data has also been carried out in construction industry but none of the research carried out has talk about big data analytics for construction project delivery in Nigeria. Io annidis et al., 2015 research on big data with visual analytics used for comparism that leads to renovation and construction with low consumption. Likewise Sadhu, 2016 carried out research work on big data assist in project management to ensure the project is delivered on time. Also, Hafiz et al.(2015) research on big data generate system for construction businesses bankruptcy. Y. zhang et al.(2015) research on big data for construction through tender price assessment system. K.K. Han et al, 2017 research on visual big data to communication among project stakeholders. Bilal, Oyedele, Akinade et al. (2016) research on developing waste simulation tool using big data for construction waste management. Moreno et al, 2016 research on big data helps in generating a predictive model for energy consumption.(Koseleva and Ropaite, 2017) research on big data analysis used to understand energy consumption behavior thus help to improve energy efficiency in building. Nikolay et al.(2019) research on big data technology in construction industry. None of the previous reseachers has research on my research work big data analytics for construction project delivery in Nigeria which make my research work unique and standout among the previous research work. Most of the previous work are done outside Nigeria none has research

on big data analytics for construction project delivery in Nigeria also none has research or review any of my objectives which make my work unique and different from the previous research work. My research work will also look into the previous research and identify any gap and bring justice to the gap.

2.3.1 Research Gap

The size of data generated by construction industry in Nigeria has been increasing following an intense use of modern technologies (Ismail et al., 2018). According to Waal Montgomery (2015) predict, big data in construction industry rise at approximately 40% per year. Peiffer (2016) asserted big data as one of the important factor in configuring the direction which should lead toward improving the construction industry efficiency and Burger (2017), say the inefficiencies of data usage is due to the limited ability in dealing with unstructured data. The increase in data generated make it difficult for construction industry to analyze data using the right technique and approach. Using wrong technique and approach to analyze big data in construction industry in Oyo state, Nigeria is a great problem which need to be addressed and provide the most suitable technique to be use to analyze big data in construction industry in Nigeria because use of wrong technique and approach affect the end result of a project thereby prone problem to the construction industry. This research work underscores on the technique and approach to analyze big data in construction industry in Nigeria as a gap that need to be addressed.

2.3.2 Summary

Big Data refers to informational collections that are excessively huge or complex to be managed by conventional information handling application programming. Information with many fields (lines) offer more prominent measurable power, while information with higher intricacy (more

credits or segments) may prompt a higher misleading disclosure rate. Huge information examination challenges incorporate catching information, information capacity, information investigation, search, sharing, move, representation, questioning, refreshing, data protection, and information source. Large information was initially connected with three key ideas: volume, assortment, and velocity. The examination of huge information presents difficulties in testing, and consequently beforehand considering just perceptions and inspecting. In this manner a fourth idea, veracity, alludes to the quality or keenness of the information. Without adequate interest in aptitude for enormous information veracity, then the volume and assortment of information can deliver expenses and dangers that surpass an association's ability to make and catch esteem from huge data. Current use of the term big data will in general allude to the utilization of prescient examination, client conduct examination, or certain other high level information investigation strategies that concentrate esteem from huge information, and sometimes to a specific size of informational collection. "There is little uncertainty that the amounts of data now accessible are to be sure huge, however that is not the most applicable trait of this new information ecosystem. Examination of informational collections can track down new relationships to "spot business patterns, forestall sicknesses, battle wrongdoing thus on". Researchers, business chiefs, clinical experts, publicizing and legislatures the same routinely meet challenges with enormous informational indexes in regions including Web look, fintech, medical services examination, geographic data frameworks, metropolitan informatics, and business informatics. Researchers experience limits in e-Science work, including meteorology, genomics, connectomics, complex physical science reproductions, science, and natural research. This chapter discuss the conceptual framework such as descriptive analytics, diagnostic analytics, predictive analytics and prescriptive analytics. It also look into the big data synthesis seeing big data as an idea of being

big. It talk about big data analytics application and prospects. It explain big data analytics in construction industry and evaluate the extent to which big data has been deployed in construction project delivery in Nigeria and mapping ideas and analytics. It explain the determinants of big data analytics in construction industry such as customer satisfaction, post project evaluation, effect of big data on project performance, human resource and protection from change and also the implication of big data analytics in construction industry is being discuss in details. The theoretical framework is explain in details, explaining theories of big data on construction industry theory like Schumpeter theory of innovation and big data, dynamic capabilities and big data, diffusion of innovation theory, resource based theory and random matrix theory.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

The research will employ the field survey approach which took the researcher to several construction companies for the collection of data. The factors bearing on big data analytics in project construction industries in Nigeria will be analyzed to find out their individual and collective impacts using suitable analytical tools.

3.2 Study Population

Construction companies and projects in Oyo State will be target. These included project professionals of different backgrounds including project managers, architects, surveyors, engineers, and builders. The fraction of the target study population responding to the questionnaire constituted the sample size. A random sampling technique will be use, targeting skilled and very experienced project professionals in the middle and top hierarchies.

3.3 Sample Size Determination

Sample size, as defined by Singh and Masuku (2014), refers to a subset computed from the study population that ensures the evaluation of the characteristics of the entire population. A sample is a fraction of the study population. It is important to use a significant and suitable parameter size to enable a better chance that the outcome of the study will be interpreted with ease. The essence of sampling is to get an idea about some of the characteristics of the entire study population based on the sample's features. This is done by highlighting or identifying a subgroup from the entire study population such that these selected individuals or objects a representative of the

whole population. The sample size for this study was computed using Taro Yamane formulae for sample size calculation (Taro Yamane, 1967). This study used a 5% error margin (confidence interval) and a 95% confidence level in the evaluation for its sample size.

n= $\frac{N}{1+Ne^2}$ (Yamane, 1967)

Where

n= Sample size

N= Population size= 240

e= Margin of error= 0.05(based on this research condition)

Therefore, n= $\frac{240}{1+240(0.05)2} = \frac{240}{1.6}$

n= 150

3.4 Method of Data Collection

Data sources included both primary and secondary data sources. The primary data refers to firsthand information obtained from the surveys while the secondary data refers to already published information which were further applied to the research. The secondary data helped establish the theoretical background and modify the research questions and pointed out the limits of previous researches on related topics.

3.4.1 Secondary data

Secondary data sources included:

- Textbooks
- Journals articles
- Conference/Workshop papers and proceedings

3.4.2 Instruments for Data Collection

An Objective Evaluation Questionnaire (OEQ) will be used in primary data collection. The questionnaire will be distributed to a project professionals in construction project industry in Oyo State.

3.4.3 Structure of the Questionnaire

The questionnaire will be structure both close and open ended questionnaire format. This has the advantage of flexibility for several choice responses. Additionally, the respondents will be allow to include any other factors not captured in the questionnaire and which they deemed important towards big data analytics in construction industry in Nigeria.

3.4.4 Primary Sources of Data

The major sources of data used in this research included Project Managers, architects, Estate Surveyor, quantity surveyors, civil and structural engineers, and builders. Those included in the sample had post-qualification experience of 5 years at least.

3.4.5 Validity of Research Tool

This refers to the size to which the exploration instrument gauges what it is intended to gauge or how exact the device is (Heale&Twycross, 2015). The research result relies upon the accuracy and ramifications of the derivations drawn from the examination instrument utilized. For this exploration work, a duplicate of the poll was made accessible to my manager for survey to learn its reasonableness with the point of the review. Segments immaterial were taken out, while areas important and important to the goals of the review were added.

3.4.6 Reliability of Research Tool

The reliability of the examination apparatus alludes to how reliable the estimation of the exploration instrument utilized is with comparative outcomes over the long run (Heale&Twycross, 2015). Dependable estimations show consistency in its outcome when rehashed to such an extent that when one more specialist or a similar scientist does comparative tests with a comparable instrument, comparative outcomes will be gotten. The dependability test for this review was figured utilizing Cronbach's alpha. From a survey of a few past works, the dependability esteem satisfactory ought to be above 0.70 (Singh & Masuku, 2014).

3.5 Method of Data Analysis

The analysis of data utilized in this study would include factor analysis for illustrative investigation. This would be accomplished using the statistical package for social sciences (SPSS) software. Factor analysis is the act of consolidating numerous factors into only a couple, so your exploration information is more straightforward to work with. The hypothesis is that there are more profound elements driving the hidden ideas in your information, and that you can reveal and work with these as opposed to managing the lower-level factors that fountain from

them. Factor analysis is likewise at times called dimension reduction. You can lessen the aspects of your information into at least one super-factors, otherwise called unseen factors or dormant factors. These more profound ideas aren't promptly self-evident. They could address characteristics or inclinations that are difficult to quantify, like extraversion or level of intelligence. Likewise with any sort of cycle that improves on intricacy, there is a compromise between the precision of the information and that it is so natural to work with. With factor analysis, the best arrangement is the one that yields an improvement that addresses the real essence of your information, with least loss of accuracy. Factor analysis is definitely not a solitary procedure, yet a group of measurable strategies that can be utilized to distinguish the idle elements driving perceptible factors.One of the most important ideas in factor analysis is variance, how much your mathematical qualities vary from the normal. At the point when you perform factor analysis, you're hoping to comprehend how the different hidden factors impact the change among your factors. Each component will have an impact, however some will make sense of more fluctuation than others, implying that the element all the more precisely addresses the factors it's contained. How much difference an element makes sense of is communicated in an eigenvalue. In the event that a component arrangement has an eigenvalue of 1 or above, it makes sense of more change than a solitary noticed variable and that implies it very well may be valuable to you in chopping down your number of factors. Factor arrangements with eigenvalues under 1 record for less changeability than a solitary variable and are not held in the analysis. In this sense, an answer would contain less factors than the first number of factors. Another significant measurement is factor score. This is a mathematical measure that portrays how emphatically a variable from the first exploration information is connected with a given

component. One more term for this affiliation or weighting towards a specific variable is factor loading.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Demographic Analysis of Respondents

This study considered a total number of 124 stakeholders. In the initial part of the questionnaire, the respondent's characteristics with regards to their age, occupation, educational qualification and years of experience were presented.

Table 4.1 Age Group of Respondent

Age Group	FREQUENCY	PERCENTAGE
25-30	15	12.09
30-35	32	25.80
35-40	29	23.39
40-45	27	21.78
45-50	**21**	**16.94**
Total	**124**	**100**

Source: Analysis of Field Survey data, 2023.

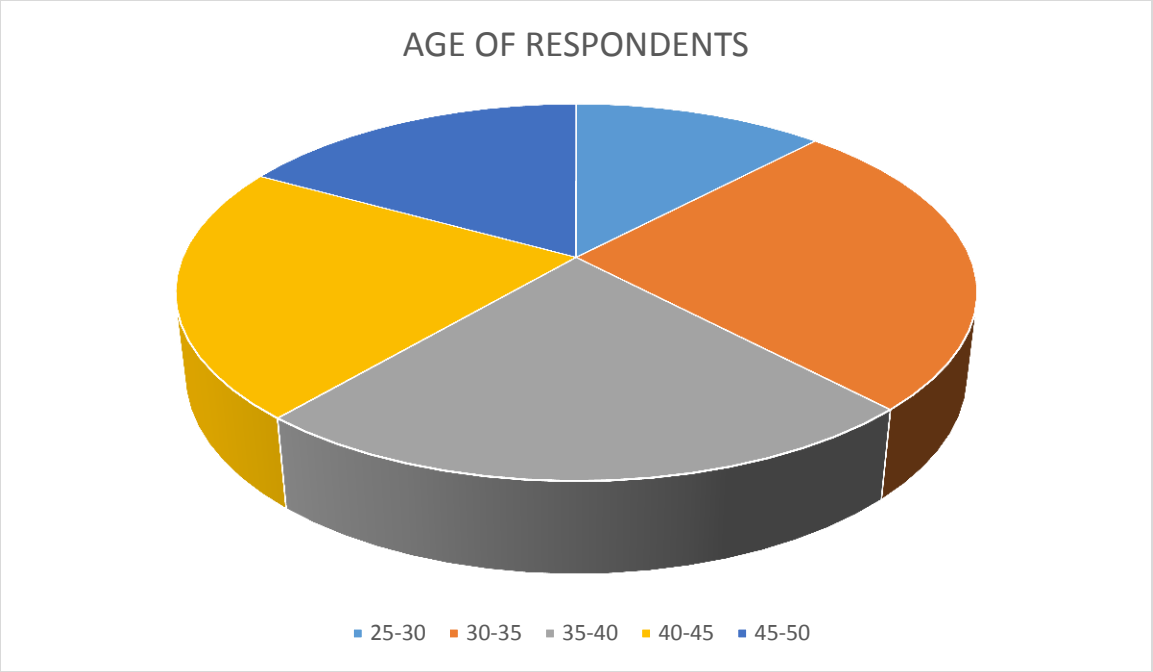

Figure 4.1: Pie chart showing age of Respondents

Base on the demographic analysis of the firms surveyed the result on figure 4.1 indicated that, 12.09% of the respondents are of the age group of 25-30 while 25.80% are 30-35 age group 23.39% are 35-40 and 21.78% represent those having an age of 40-50 and 16.94 are those who are 50 years and above.

Table 4.2 Occupation of Respondent

POSITION	FREQUENCY	PERCENTAGE
Project Manager	26	20.96
Quantity Surveyor	15	12.09
Builders	20	16.12
Engineer	39	31.45
Technologist	24	19.35
Total	**124**	**100**

Source: Analysis of Field Survey data, 2023.

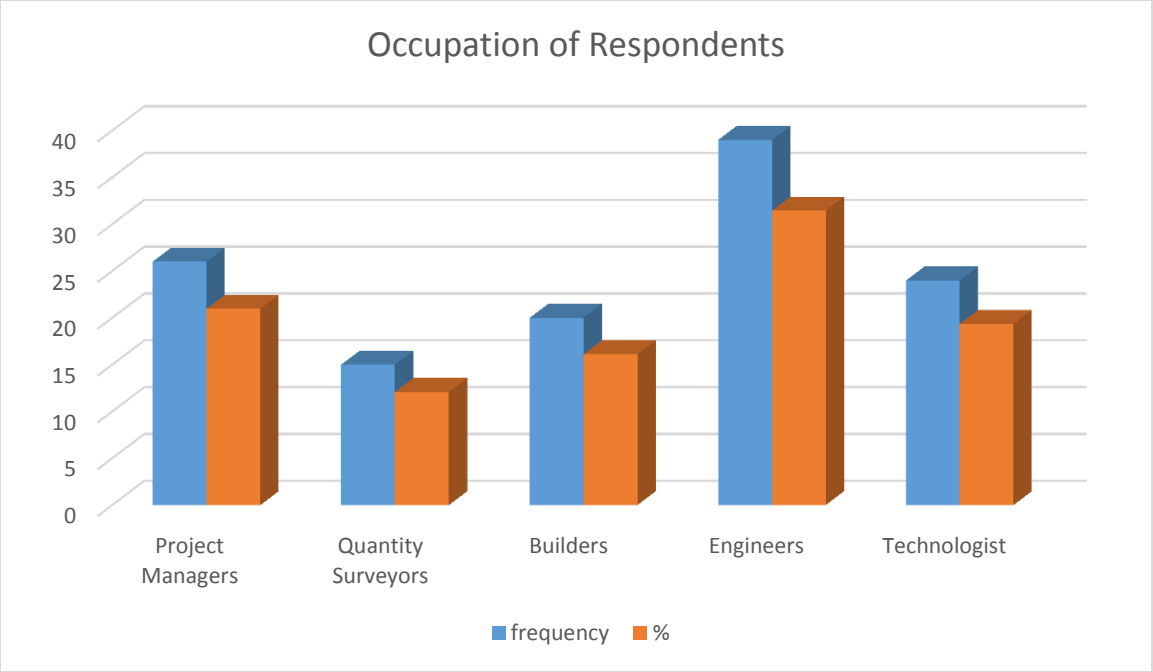

Figure 4.2: showing Bar chart showing Occupation of respondents

Base on the demographic analysis of the firms surveyed the result on figure 4.5 revealed that (26) 20.96% of the respondents are project managers, (15) 12.09% are quantity surveyors,(20) 16.12% are builders while (39) 31.45% are engineers and (24) 19.35% are technologist.

Table 4.3: Educational Qualification of Respondent

Educational Qualification	FREQUENCY	PERCENTAGE
HND/OND	26	20.96
B.SC	36	29.03
M.SC/MBA	28	22.58
PhD	12	9.67
Trained professional	22	17.74
Total	124	100

Source: Analysis of Field Survey data, 2023.

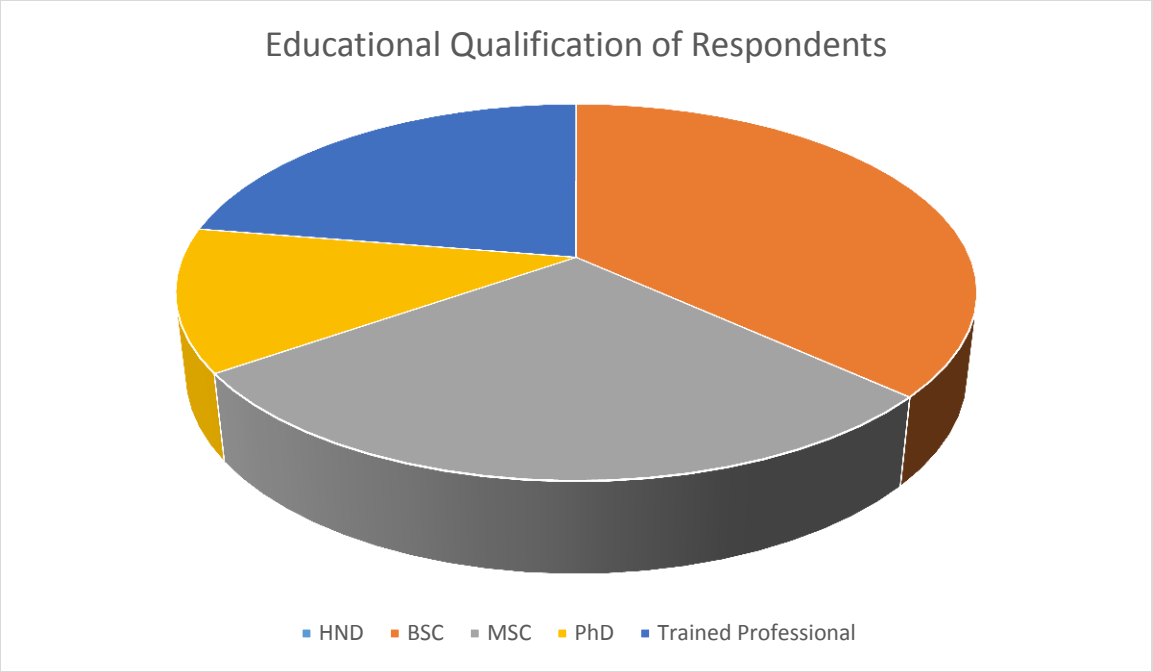

Fig. 4.3: Showing Pie chart of educational qualification of respondents

Base on the demographic analysis of the firms surveyed the result on figure 4.3 indicated that, 24.96% of the respondent possesses an OND/HND qualification while 29.03% possess B.Sc, 22.58% possess M.Sc/MBA, 9.67% possess a Ph.D. and 17.74% are trained professionals.

Table 4.4 Years of Work Experience of Respondent

Work Experience	**FREQUENCY**	**PERCENTAGE**
1-5	15	12.09
6-10	44	35.48
11-15	29	23.38
16-20	16	12.90
21 Above	20	16.12
Total	**124**	**100**

Source: Analysis of Field Survey data, 2023.

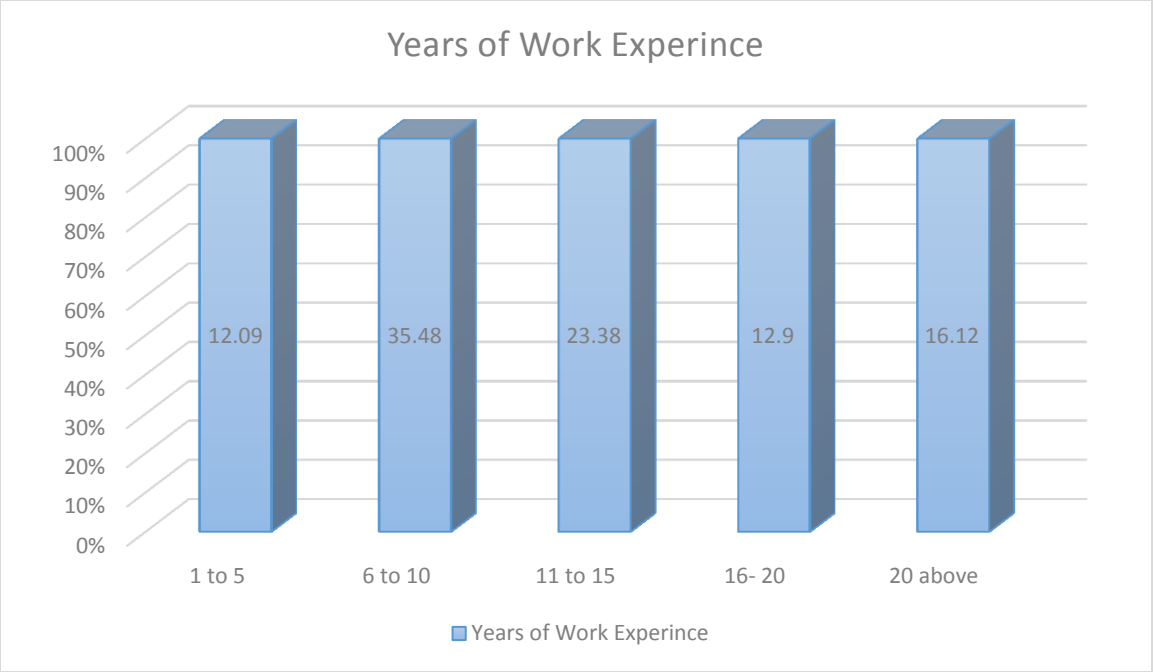

Fig. 4.4 Bar Chart Showing Years of Work Experience of the Respondent

Base on the demographic analysis of the firms surveyed the result on figure 4.4 indicated that, 15 of the respondents representing 12.09% have a working experience of 1-5 years while 44 of the respondents representing 35.48% have a working experience of 6-10 years while 29 of the respondents representing 23.38% have a working experience of 11-15 years, 16 of the respondents representing 12.90% have a working experience of 16 – 20 years and 20 of the respondents representing 16.12 are having 20 years and above working experience.

Mean Ranking Main Determinants of Big Data in Construction Project Delivery in Nigeria.

In descending order, Table 4.5 reveals the mean ranking of the seventeen main determinants of Big Data in construction project delivery in Nigeria. The table reveals that more than half (68%) of the hypothesised factors are significant ($p < 0.05$) based on a one-sample t-test. The mean scores of the main determinants of Big Data in construction project delivery in Nigeria range between 3.20 and 4.30.

Table 4.5: Ranking Main Determinants of Big Data

S/N	Determinants	MS	SD	t-value ($\mu = 3.5$)	*df*	Sig. (2-tailed)	R
1	Customer Satisfaction	3.31	1.17	0.65	124	0.22	
2	Post Project Evaluation	3.34	1.23	0.60	124	0.35	
3	Effect of Big Data on Project Performance	4.30	0.83	9.56	124	0.00*	
4	Human Resource	4.20	0.80	7.38	124	0.00*	
5	Protection from Change	3.27	1.28	0.79	124	0.42	
6	Availability of Big Data Technology	4.28	0.82	9.53	124	0.00*	
7	Organization Structure and Culture	4.24	0.77	7.33	124	0.01*	
8	Stakeholder Management and Collaboration	3.20	0.39	0.46	124	0.55	
9	Accessibility of Big Data Facilities	4.26	0.82	8.80	124	0.00*	
10	Guidelines, Handbooks or Guidance for using Big Data	3.78	1.67	0.78	124	0.18	
11	Ethics and legal Mechanism of Copyright, Privacy and Security	4.23	0.75	8.34	124	0.00*	
12	Power, Effectiveness and Efficiency of Big Data	4.19	0.78	10.33	124	0.01*	
13	Exemplary Projects	4.09	0.69	9.34	124	0.00*	
14	Incentive Policies	3.20	0.61	0.98	124	0.12	
15	Top Management Support and BD-Oriented Management Modes	4.17	0.80	7.09	124	0.00*	
16	Data Sharing and Governance	3.98	0.75	6.83	124	0.00*	
17	Fragmented Nature of the Construction industry	3.88	0.70	5.90	124	0.00*	

Note: R = Rank; Sig. = Level of significance; SD = Standard Deviation; MS = Mean score of the factors hindering BIM adoption in the FM industry where 5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree as done in Olanrewaju et al. (2020b). The higher the mean score the more severe the factor; *df*= degrees of freedom, *Significant at the 95% level ($p < 0.05$)

Effect of Big Data on Project Performance (mean = 4.30; SD = 0.83; t (124) = 9.56; p = 0.00 < 0.05) which ranked first to Availability of Big Data Technology (mean = 4.28; SD = 0.82; t (124) = 9.53; p = 0.00 > 0.05) ranked second while Accessibility of Big Data Facilities (mean = 4.26; SD = 0.82; t (124) = 8.80; p = 0.00 > 0.05) ranked third and Stakeholder Management and Collaboration mean = 3.20; SD = 0.39; t (124) = 0.46; p = 0.55 > 0.05) ranked last. The factors were streamlined to only the significant ones based on the p-value level of significance (p < 0.05) as done in Olanrewaju et al. (2020). As a result, only twelve (12) factors are significant out of the seventeen (17) factors identified in the literature. The significant main determinants are: Effect of Big Data on Project Performance, Availability of Big Data Technology, Accessibility of Big Data Facilities, Human Resource, Organization Structure and Culture, Ethics and legal Mechanism of Copyright, Privacy and Security, Power, Effectiveness and Efficiency of Big Data, Exemplary Projects, Top Management Support and BD-Oriented Management Modes, Top Management Support and BD-Oriented Management Modes, Data Sharing and Governance and Fragmented Nature of the Construction industry**.**

Principal Component Analysis

To further classify the significant factors into a manageable group for a streamlined problem-solving aimed at enhancing the main determinants of Big Data in construction project delivery in Nigeria, Principal Component Analysis (PCA) was applied to achieve this categorisation.

Table4.6 : KMO and Bartlett Test for Main Determinants of Big Data

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.79
Bartlett's Test of Sphericity	Approx. Chi-Square	386.92
	Df	78
	Sig	0.00

KMO and Bartlett Test for Main Determinants of Big Data in Construction Project Delivery in Nigeria

Table 4.6 shows the appropriateness of the data test, which includes the Bartlett Test of Sphericity (BTS) and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA). These two tests provided a benchmark to support the factorability of the questionnaire data. KMO values range from zero to one, and Field (2013) recommended 0.5 as the minimum for social science research. On the other side, BTS shows the degree of difference between correlation and identity matrix. BTS is very critical in PCA as it determines the minimum requirement for data factorability (Field, 2013). This study revealed a KMO value of 0.79, and BTS was found to be significant ($p = 0.00$), which supports the factorability of this research data.

Comp	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared		
	Total	% of Vari-Ance	Cumula-tive %	Total	% of Vari-ance	Cumula-tive %	Total	% of Vari-ance	Cumul a-tive %
1	4.14	31.87	31.87	4.14	31.87	31.87	2.93	22.50	22.50
2	1.72	13.22	45.10	1.72	13.22	45.10	2.18	16.78	39.28
3	1.36	10.43	55.53	1.36	10.43	55.53	2.11	16.25	55.53
4	1.10	10.06	60.32						
5	0.96	7.39	62.92						
6	0.92	7.09	70.01						
7	0.86	6.36	73.00						
8	0.82	6.04	74.10						
9	0.78	5.96	75.97						
10	0.70	5.10	79.56						
11	0.66	5.06	81.03						
12	0.59	4.53	85.56						
13	0.46	3.56	89.12						
14	0.41	3.13	92.24						
15	0.40	3.04	95.29						
16	0.34	2.65	97.93						
17	0.27	2.07	100.0						
Extraction Method: Principal Component Analysis									
Comp. = Component									

Table. Total Variance Explained for main determinants of Big Data.

Table 4.7 shows the total variance explained for factors hindering main determinants of big data in construction project delivery in Nigeria. The table shows the percentage of variance for initial Eigenvalues, Extraction sums of squared loadings and Rotation sums of squared loadings. For initial Eigenvalues, the percentage of variances from components 1 to 3 are 31.87, 13.22, and 10.43, respectively.

Table 4.6: Rotated Factor Matrix

S/N	Factors	Component			Rank
		1	2	3	
Component 1: Data and Technology Systems Factor					1st
F1	Effect of Big Data on Project Performance	0.90			
F2	Availability of Big Data Technology	0.90			
F3	Accessibility of Big Data Facilities	0.90			
F4	Power, Effectiveness and Efficiency of Big Data	0.81			**0.877**
Component 2: Human Resource Factor					3rd
F2	Human Resource (Skills and Knowledge)		0.90		
F3	Ethics and legal Mechanism of Copyright, Privacy and Security		0.79		**0.845**
Component 3: Organisation Resource Factor					2nd
F1	Top Management Support and BD-Oriented Management Modes			0.90	
F2	Organization Structure and Culture			0.85	
F3	Exemplary Projects			0.96	
F4	Data Sharing and Governance			0.78	
F5	Fragmented Nature of the Construction industry			0.81	**0.860**
Rotation Method: Varimax with Kaiser Normalization. Extraction Method: Principal Component Analysis.					
Rotation converged in 5 iterations.					

Table 4.7: Guide to degree of Significance

Degree of Significance	Rating
Very Significant	0.76 above
Significant	0.67-0.75
Fairly Significant	0.45-0.66
Not Significant	0.44 below

Source: Vanduhe (2012)

Also, Table 4.8 shows the Rotated Factor Matrix for the main determinants of big data in construction project delivery in Nigeria. The PCA was performed following Principal Component Solution with a Varimax Rotation (Kaiser, 1958). The data utilised included data obtained from the one hundred and twenty four (124) participants of the questionnaire survey.

Three components were extracted from the thirteen significant main determinants of big data in construction project delivery in Nigeria. The cutting point of eigen values that were accepted as equal to one. The component factors were rotated based on the varimax solution. The result discussion has been based on the varimax rotated factor matrix. Only the factor loading of 0.5 and above are considered in this study. However, the factor loading (except those less than 0.5) is categorized based on components. Component 1 (Data and Technology Systems Related) consists of four significant factors with loadings between 0.81 and 0.90, Component 2 (Human Resource Factors) consists of two significant factors with loadings between 0.79 and 0.90, and Component 3 (Organisational Factors) consists of five significant factors with loadings between 0.78 and 0.90. Furthermore, based on the significant value ranking the result of the analysis showed that *Data and Technology Systems Factor* (*Component 1*) ranked first with 0.877, *Organisation Resource Factor (Component) ranked second with 0.860 and Human Resource Factor (Component 2) ranked third with* 0.845. Similarly, based on the guide to degree of significance according to Vanduhe (2012) rating of 0.76 above are very significant thus, the three components captured in this study *Data and Technology Systems Factor* (0.877), *Organisation Resource Factor (0.860) and Human Resource Factor (*0.845*)* are collectively very significant.

Scree Plot for Main Determinants of Big Data in Construction Industry

Figure 4.5 shows the scree plot for factor analysis for the main determinants of big data in construction project delivery in Nigeria. Again, it can be seen that components one to three are within the elbow region of the line, making them reliable.

Table 4.8 Descriptive Statistics of Application of Big Data in Construction Project Application

Big Data Application	**Mean**	**Std. D**	**Rank**
Communication information management	3.75	0.879	4th
Knowledge Management	3.84	0.962	2nd
Data security	3.86	0.971	1st
Project Control & Monitoring	3.66	0.855	5th
Risk Management	3.79	0.944	3rd

Source: Analysis of Field Survey data, 2023

Table 4.9 Descriptive Analysis of the Application of Big Data in Construction Project Application

S/N		5 Very well	4 well	3 Neutral	2 Not well	1 Not at all
1	Communication information management	32	28	18	24	20
2	Knowledge Management	37	30	19	26	12
3	Data security	41	35	12	23	13
4	Project Control & Monitoring	28	29	22	19	26
5	Risk Management	35	26	25	23	20

Source: Analysis of Field Survey data, 2023.

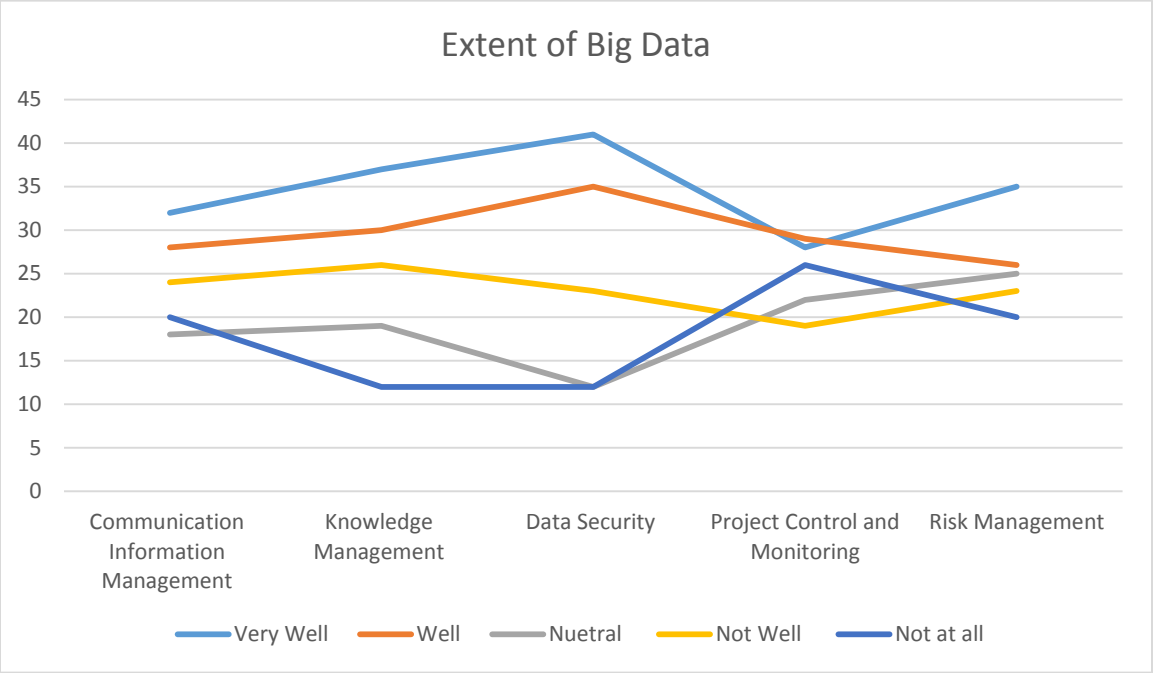

Figure 4.6: Chart Showing the extent of Application of Big Data in Construction Project Management.

Table 4.10 revealed that the Descriptive Analysis of the Application of Big Data in Construction Project Application based on the result majority of the construction project stakeholders use Big Data in construction project delivery more significantly for data security, knowledge management, risk management, communication information management and project control and monitoring in order of significant application.

Table 4.10 : Evaluation of method of Big Data Deployment in Construction Project

Perception Statement	**N**	**S.A**	**A**	**N**	**D**	**SD**
Frequency of BDA deployment in productive environment and re-training procedure.	124	58 (46.77%)	22(17.75%)	18(14.51%)	16(12.9%)	10(8.064%)
Frequency of a deployment procedure and deployment time.	124	49(39.51%)	24(19.35%)	24(19.35%)	12(9.67%)	15(12.096%)
Deployment procedure, methodology and frequency.	124	44(35.48%)	31(25%)	26(20.96%)	18(14.51%)	5(4.03%)
Appropriation level and deployment time.	124	38 (30.64%)	28 (22.58%)	23 (18.54%)	19 (15.322%)	16(12.90%)
Appropriation level and deployment procedure.	124	40 (32.25%)	26 (20.967%)	21 (16.93%)	14 (11.290%)	23(18.54%)

Source: Analysis of Field Survey data, 2023.

Table 4.10 above shows the evaluation of method of Big Data Deployment in Construction Project using methods such as Frequency of BDA deployment in productive environment and re-training procedure, Frequency of a deployment procedure and deployment time, Deployment procedure, methodology and frequency, Appropriation level and deployment time and Appropriation level and deployment procedure.

4.2 Result Discussion

From the literature review there are main seventeen determinant of big data analytics in project construction but my research show that only twelve out of the seventeen are significant. The significant main determinants are: Effect of big data on project performance, Availability of big data technology, Accessibility of big data facilities, Human Resource, Organization Structure and Culture, Ethics and legal mechanism of copyright, privacy and security, power, effectiveness and efficiency of big data, Exemplary projects, Top management support and BD-oriented management modes, data sharing and governance and Fragmented nature of the construction industry. Bilal et al.(2016), Zhang et al. (2015) and Yang et al.(2017) in their research state that effect of big data on project performance as a determinant is significant to big data analytics in project construction which my research work agree with it and also Frankova et al.(2016) and Kharrazi et al. (2016) also agreed with my research work by identifying human resource as a main determinant significant to big data analytics in project construction. Alharthi et al.(2017), Bilal et al.(2016) and Yang et al. (2017.) also agreed with my research work by identifying Availability of big data technology as the main determinant significant to big data analytics in project construction. Schroeder (2016) identify guideline, handbooks or guidance for using big data as a significant determinant of big data which does not agree with my research work, my research work does not identify it as a significant determinant of big data analytics in project construction also Kharrazi et al.(2016) does not agree with my research work, in their research work they identified incentive policies as a significant determinant of big data while in my research work it is not a significant determinant of big data analytics in project construction. The second objective is to evaluate the extent to which big data has been deployed in construction project delivery in Nigeria. My analysis show that 80% of the respondent review that they have

used big data in productive environment and retaining procedure while 73% have used big data analytics in the deployment procedure and deployment time according to Easterbrook et al,(2010). Also 75% of the respondent agreed that they have used big data in the deployment procedure, methodology and frequency and 66% of the respondent agreed that they have review big data in relationship with the appropriation level and deployment time also 66% of the respondent review that they have used appropriation level and deployment procedure as method of big data deployment in construction project.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

This study aimed at big data application in project delivery in construction industry in Oyo state. This research was guided with research questions comprising of (1) what are the determinants of big data in construction industry in project delivery in Nigeria? (2) To what extent is big data been deployed in project delivery in construction industry in Nigeria? (3) What are the recommendation to be provided for big data deployment project delivery in construction industry in Nigeria? The summary of findings revealed that the determinants of big data have a significant relationship and effect on construction project in Oyo state. It also revealed that the extent in which big data has been deployed have a significant relationship on project delivery and big data application. The summary of findings revealed that the recommendation have a significant relationship on project delivery in construction industry.

5.2 Conclusion

This study investigated big data application and analyses in project delivery in construction industry in Oyo state. From the result obtained, analysed and discussed based on the first objective to examine the sources of big data in construction industry in Oyo state, the research conclude that it enhance construction project in Oyo state. Based on the second objective to evaluate the factor affecting the application of big data in construction industry in Nigeria, the research conclude that it has a significant effect on project delivery in Oyo state. Based on the third objectives to appraise the techniques in use for analysing generated big data in construction project delivery, the research conclude that it enhance project delivery in construction industry in

Oyo state. Based on the fourth objective to evolve appropriate technique for analysing big data in construction project delivery, the research conclude that it enhance project delivery in construction industry in Oyo state. This research conclude that the following are the problems of big data analytics in construction industry in Oyo state. They do not usually start with data available in the enterprises. It also conclude that they do not usually start with customer-centric outcomes. It conclude that they do not develop business case based on measurable outcomes and they do not identify business priorities and build the strategy on that. Finally, this research work conclude that the following technique and approach should be used to analyze big data Predictive analysis, Exploratory data analysis, Casual analysis, Inferential statistics and Prescriptive analysis.

5.3 Recommendation

As a result of the above discussion and findings, the study hereby concluded that big data in construction industry in Oyo state help to examine the sources of big data in construction project delivery in Oyo state and also to evaluate the factor affecting the application of big data and to appraise the techniques in use for analysing generated big data in construction project delivery and also applied to the following management function which are communication information management, knowledge management, data security, project control and monitoring and risk management. It also identified methods of big data deployment in project delivery which are frequency of big data analytics deployment in productive environment and re-training procedure, frequency of a deployment procedure and deployment time, deployment procedure, methodology and frequency, appropriation level and deployment time, appropriation level and deployment procedure. The study recommended the following:

1. Start with data that is already available in the enterprises.

2. Start with customer-centric outcomes.
3. Develop business case based on measurable outcomes.
4. Identify business priorities and build the strategy on that.
5. Predictability of resource requirement on a project.
6. Project timeline accuracy.
7. Project bidding.

5.4 Contribution to Knowledge

This research has added to knowledge by establishing that big data analytics has a significant relationship with project delivery in construction industry. This research work also clarifies relevant concepts in the examination of big data analytics in project delivery in industry. This study further practical proof that can help construction industry in handling big data within the organization. This research work will add to the economy and the overall population in light of the fact that it will give arrangement defying construction industry utilizing big data analytics, distinguish the effect whether positive or negative and give answer for the adverse consequence. Likewise this research will help the experts by and by in light of the fact that it will empower them to realize what and how to deal with project utilizing big data analytics comparable to project delivery in construction industry in Nigeria. Finally, this research provides work present an approach to research into construction industry by highlighting the relationship between project delivery and big data application and also filled the gap that underscores on the technique ana approach to analyze big data application in construction industry in Oyo state, Nigeria.

5.5 Suggestions for Further Studies

This study focused on the employees working in construction industry in Nigeria, Oyo state. The sample for this study was done from employees of construction industry in Oyo state, Nigeria. Similar research can be carried out in other construction industries to assess the applicability of study results from other perspectives. More analysis may be performed using construction industries in other regional areas and studies may also be carried out using more than one construction industry in a region as a sample.

REFERENCES

Addo-Tenkorang, R., &Helo, P. T. (2016). Big data applications in operations/supply-chain management*: A literature review. Computers &Industrial Engineering,* 101, 528-543.

Akbar, S. (2017). Is big data the most trending thing in construction now. *Retrieved from https://geniebelt.com/blog/big-data-in-construction*

Akhavian, R., &Behzadan, A. H: (2015). Construction equipment activity recognition for simulation input modeling using mobile sensors and machine learning classifiers. *Advanced Engineering Informatics,* 29(4), 867-877. doi:10.1016/j.aei.2015.03.001

Aouad, G., Kagioglou, M., Cooper, R., Hinks, J., & Sexton, M. (1999).Technology management of IT in construction*: a driver or an enabler? Logistics Information Management*, 12(1/2), 130-137.

Augur, H. (2016). Big Data is Transforming commercial construction. *Retrieved from http://dataconomy.com/2016/07/big-data-is-transformingcommercial-construction/*

Azhar, S. (2011*).* Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadership and management in engineering, 11(3), 241-252.*

AzzeddineOudjehane, &Moeini, S. (2017). Big data in construction projects risk and opportunity management.

Barista, D. (2014). The big data revolution, *How Data-Driven Design is Transforming Project Planning. Building Design+Construction.*

Bello-Orgaz, G., Jung, J. J., & Camacho, D. (2016). Social big data: recent achievements and new challenges*. Information Fusion,* 28, 45-59.

Benedict, A. (2022). Challenges of the implementation of big data on construction project in Nigeria. *In proceedings of the 6th research conference of NIQS, 771-785*

Bernstein, P. (2017). How big data and VR in architecture will greatly improve design. *Retrieved from https://www.autodesk.com/redshift/bigdata-vr-in-architecture/*

Bilal, M., Oyedele, L. O., Akinade, O. O., Ajayi, S. O., Alaka, H. A., Owolabi, H. A., Bello, S. A. (2016). Big data architecture for construction waste analytics (CWA): A conceptual framework. *Journal of Building Engineering,* 6, 144-156.

Bilal, M., Oyedele, L. O., Qadir, J., Munir, K., Ajayi, S. O., Akinade, O. O., Pasha, M. (2016). Big data in the construction industry: A review of present status, opportunities, and future trends. *Advanced Engineering Informatics, 30(3), 500-521. doi:10.1016/j.aei.2016.07.001*

Bleby, M. (2015). Big data boosts construction. *Retrieved from http://www.afr.com/real-estate/commercial/big-data-boosts-constrcution20150109-12l8xx*

Booth, A., Sutton, A., &Papaioannou, D. (2016). Systematic approaches to a successful literature review: sage.

Bryman, A. (2008). Mixed methods research: combining quantitative and qualitative research. *Social research methods*, 3, 608-626.

Bughin, J., Chui, M., &Manyika, J. (2010*).* Clouds, big data, and smart assets: ten tech-enabled business trends to watch. *McKinsey Quarterly*, 56(1), 75-86.

Burger, R. (2017). How the construction industry is using big data.

Caron, F. (2015). Data management in project planning and control. *International Journal of Data Science*, 1(1), 42-57.

Chen, C. P., & Zhang, C.-Y. (2014). Data-Intensive applications, challenges, techniques and technologies*: A survey on Big Data. Information Sciences*, 275, 314-347.

Chen, C., & Cook, D. J. (2012). Behavior-Based home energy prediction. *IEEE Internet of Things Journal.*

Chen, H., Chiang, R. H., &Storey, V. C. (2012). Business intelligence and analytics: from big data to big impact. *MIS quarterly*, 36(4).

Choudhry, H., Mohammad, A., Tan, K. T., & Ward, R. (2016). The next frontier for digital technologies in oil and gas. *Retrieved from https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-next-frontier-fordigital-technologies-in-oil-and-gas*

Creswell, J. (2005). Planning, conducting, and evaluating quantitative and qualitative research: educational research: Prentice Hall: Upper Saddle River, NJ Creswell, JW (2007): Research method: Qualitative, quantitative and mixed methods approaches (2nd ed.). Thousand Oaks, CA: Sage.

Cukier, K. (2010). Data, data everywhere: a special report on managing information*: Economist Newspaper*.

Curry, E., O'Donnell, J., Corry, E., Hasan, S., Keane, M., &O'Riain, S. (2013). Linking building data in the cloud: Integrating cross-domain building data using linked data. *ADVANCED ENGINEERING INFORMATICS*, 27(2), 206-219.

D., Fotiadou, A., Krinidis, S., Stavropoulos, G., Tzovaras, D., & Likothanassis, S. (2015). Big data and visual analytics for building performance comparison. Paper presented at the IFIP International Conference on Artificial Intelligence Applications and Innovations.

Davis, D. (2015). How data is transforming architecture.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., &McNiff, S. (2013).BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction,* 36, 145-151.

Elo, S., &Kyngas, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing,* 62(1), 107-115.

Faure, A. (2016). Big data is revolutionizing business: the construction industry in general and building sites in particular. *Retrieved from https://blog.serenacapital.com/big-data-is-revolutionizing-business-the-constructionindustry-in-general-and-building-sites-in-de7a53a20516*

Fellows, R., & Liu, A. (2008*).* Research methods for construction (3rd. ed.). Oxford: Wiley-Blackwell.

Ferkoun, M. (2014). Cloud computing and big data: an ideal combination. *Retrieved from https://www.ibm.com/blogs/cloud-computing/2014/02/cloud-computing-and-big-data-an-ideal-combination/*

Gaitho, M. (2017). How applications of big data drive industries. *Retrieved from https://www.simplilearn.com/big-data-applications-in-industries-article*

Gartner. (2014). Glossary.(2013): Big data

Gartner. (2015). 6.4 billion connected "Things" will be in use in 2016, up 30 percent from 2015. Gart. Inc.

Guo, S., Ding, L., Luo, H., & Jiang, X. (2016). A big-data-based platform of workers' behavior: *Observations from the field. Accident Analysis & Prevention,* 93, 299-309.

Guo, S., Luo, H., & Yong, L. (2015). A big data-based workers behavior observation in china metro construction. *Procedia Engineering,* 123, 190-197.

Hafiz, A., Lukumon, O., Muhammad, B., Olugbenga, A., Hakeem, O., & Saheed, A. (2015). Bankruptcy prediction of construction businesses: towards a big data analytics approach. *Paper presented at the Big Data Computing Service and Applications (BigDataService), 2015 IEEE First International Conference on.*

Hammer, C., Kostroch, D. C., &Quiros, G. (2017). Big data; potential, challenges and statistical implications.

Hampton, T. V. (2015). Big data boosts safety in brazil. *Retrieved from https://www.enr.com/articles/9640-big-data-boosts-safety-in-brazil? v=preview*

Han, K. K., &Golparvar-Fard, M. (2017). Potential of big visual data and building information modeling for construction performance analytics*: An exploratory study. Automation in Construction*, 73, 184-198.

Han, S., Lee, S., & Peña-Mora, F. (2012). A machine-learning classification approach to automatic detection of workers' actions for behavior-based safety analysis Computing in Civil Engineering (2012) (pp. 65-72).

Harenberg, M. (2017). 5 ways to boost construction productivity. *Retrieved from https://www.planradar.com/construction-productivity/*

Hart, C. (1998*).* Doing a literature review: releasing the social science research imagination: sage.

Humphreys, R. (2016). How big data complements information management. *Retrieved from https://sourceable.net/how-big-datacomplements-information-management/Ioannidis*,

Janda, K. B., Patrick, J., Granell, R., Bright, S., Wallom, D., &Layberry, R. (2015). A wicked approach to retail sector energy management. *Paper presented at the Proceedings of ECEEE Summer Study.*

Jiao, Y., Wang, Y., Zhang, S., Li, Y., Yang, B., & Yuan, L. (2013). A cloud approach to unified lifecycle data management in architecture, engineering, construction and facilities management: Integrating BIMs and SNS. *Advanced Engineering Informatics*, 27(2), 173-188.

Jiao, Y., Zhang, S., Li, Y., Wang, Y., & Yang, B. (2013). Towards cloud augmented reality for construction application by BIM and SNS integration. *Automation in Construction*, 33, 37-47.

Khan, A., &Hornbæk, K. (2011). Big data from the built environment. *Paper presented at the Proceedings of the 2nd international workshop on Research in the large*.

Knight, W. (2015). New boss on construction sites is a drone: MIT technology review.

Koseleva, N., &Ropaite, G. (2017). Big data in building energy efficiency: understanding of big data and main challenges. *Procedia Engineering*, 172, 544-549.

Laney, D. (2001). 3D data management: controlling data volume, velocity and variety. META Group Research Note, 6, 70.

Lee, I. (2017). Big data dimensions, evolution, impacts, and challenges. *Business Horizons*, 60(3), 293-303.

Lu, W., Chen, X., Ho, D. C., & Wang, H. (2016). Analysis of the construction waste management performance in Hong kong: the public and private sectors compared using big data. *Journal of Cleaner Production, 112, 521-531.*

Lu, W., Chen, X., Peng, Y., & Shen, L. (2015). Benchmarking construction waste management performance using big data. *Resources, Conservation and Recycling,* 105, 49-58.

Martínez-Rojas, M., Marín, N., & Vila, M. A. (2015). The role of information technologies to address data handling in construction project management. *Journal of Computing in Civil Engineering, 30(4), 04015064.*

Mathew, B. (2016). How big data is reducing costs and improving performance in the upstream industry. *Retrieved from http://www.worldoil.com/news/2016/12/13/how-big-data-is-reducing-costs-and-improvingperformance-in-the-upstream-industry*

Mathew, P. A., Dunn, L. N., Sohn, M. D., Mercado, A., Custudio, C., & Walter, T. (2015). Big-data for building energy performance: *Lessons from assembling a very large national database of building energy use. Applied Energy, 140, 85-93.*

Meneer, D. (2015). How big data is transforming construction businesses. *Retrieved from https://www.constructionmonitor.com/blog/2015/06/26/how-big-data-is-transforming-construction-businesses/*

Meola, A. (2016). What is the internet of things (IoT)? *Retrieved from http://www.businessinsider.com/what-is-the-internet-of-things-definition-2016-8/?IR=T*

Moreno, M. V., Dufour, L., Skarmeta, A. F., Jara, A. J., Genoud, D., Ladevie, B., &Bezian, J.-J. (2016). Big data, the key to energy efficiency in smart buildings. *Soft Computing, 20(5), 1749-1762.*

Oracle. (2015). Improving manufacturing performance with big data: architect's guide and reference architecture introduction. *Retrieved from http://www.oracle.com/us/technologies/big-data/big-data-manufacturing2511058.pdf*

O'Reilly. (2014). *Big Data Now: 2014 Edition: O'Reilly Media, Incorporated. Olshannikova, E., Ometov, A., Koucheryavy, Y., & Olsson, T. (2015):*Visualizing big data with augmented and virtual reality: challenges and research agenda. *Journal of Big Data, 2(1), 22.*

Oudjehane, A., &Moeini, S. (2017*).* Big data in construction projects: risk and opportunity management.

Özköse, H., Arı, E. S., &Gencer, C. (2015). Yesterday, today and tomorrow of big data. Procedia-Social and Behavioral Sciences, *195, 1042-1050. Pal, K. (2015):* The impact of the internet of things on big data. *Retrieved from http://data-informed.com/the-impact-of-internet-of-things-on-big-data/*

Peiffer, E. (2016). 3 concepts that will shape the future of construction. *Retrieved from https://www.constructiondive.com/news/3-concepts-thatwill-shape-the-future-of-construction/417049/*

Perera, C., Zaslavsky, A., Christen, P., &Georgakopoulos, D. (2014). Sensing as a service model for smart cities supported by internet of things. *Transactions on Emerging Telecommunications Technologies, 25(1), 81-93.*

Portela, F., Lima, L., & Santos, M. F. (2016). Why big data? towards a project assessment framework. *Procedia Computer Science, 98, 604-609.*

Porwal, A., &Hewage, K. N. (2013). Building information modeling (BIM) partnering framework for public construction projects. *Automation in Construction, 31, 204-214.*

Provost, F., & Fawcett, T. (2013). Data science and its relationship to big data and data-driven decision making. *Big Data, 1(1), 51-59.*

Qubole. (2017). Big data cloud database & computing. *Retrieved from https://www.qubole.com/resources/big-data-cloud-database-and-computing/*

Redmond, A., El-Diraby, T., &Papagelis, M. (2015). Employing an exploratory research stage to evaluate green building technologies for sustainable systems. submitted to international journal; under review.

Reiners, D., Stricker, D., Klinker, G., & Müller, S. (1998). Augmented reality for construction tasks: doorlock assembly. *Proc. IEEE and ACM IWAR, 98(1), 31-46.*

Rijmenam, M. v. (2015). Big data can help construction companies deliver projects on time. *Retrieved from https://datafloq.com/read/big-dataconstruction-companies-deliver-projects-t/143*

Rubin, H. J., & Rubin, I. S. (2011). Qualitative interviewing: the art of hearing data: sage.

Sadhu, R. (2016). Big data for construction: how it can help you deliver your project on time. *Retrieved from https://www.planacademy.com/bigdata-construction/*

Santiago Castagnino, Christoph Rothballer, &Gerbert, P. (2016). What's the future of the construction industry? *Retrieved from https://www.weforum.org/agenda/2016/04/building-in-the-fourth-industrialrevolution/*

Shamsulhadi, B., &Fadhlin, A. (2016). Documenting its application in quantity surveying research: *A Review. International Journal of Built Environment and Sustainability, 3(1), 10-17. doi:10.11113/ijbes.v3.n1.105*

Shamsulhadi, B., Fadhlin, A., &Hamimah, A. (2015). Research into the bills of quantities: where can it be focused. *The Malaysian Surveyor Journal, 50(3), 15-24*

Shrestha, J. (2013). Big data, predictive analytics, and data visualization in the construction engineering. CCEE graduate student research showcase and poster competition.

Skibniewski, M., &Golparvar-Fard, M. (2016). Toward a science of autonomy for physical systems: construction. arXiv preprint arXiv:1604.03563.

Stankovic, J. A. (2014). Research directions for the internet of things. *IEEE Internet of Things Journal, 1(1), 3-9.*

Teizer, J., Cheng, T., & Fang, Y. (2013). Location tracking and data visualization technology to advance construction ironworkers' education and training in safety and productivity. *Automation in Construction, 35, 53-68.*

Travis, D. (2016). Desk research: the what, why and how. *Dostupnona http://www. userfocus. co. uk/articles/desk-research-the-what-why-and-how. html, pristupljeno, 10, 2017.*

Viktor, M.-S., & Kenneth, C. (2013). Big data: A revolution that will transform how we live, work, and think. houghton mifflin harcourt.

Waal-Montgomery, M. d. (2015). World's data volume to grow 40% per year & 50 times by 2020: Aureus. Retrieved Syyskuu, 28, 2016.

Webster, J., & Watson, R. T. (2002*).* Analysing the past to prepare for the future: writing a literature review. *MIS Quarterly, 26(2), 1-11*.

Wei, C., & Li, Y. (2011). Design of energy consumption monitoring and energy saving management system of intelligent building based on the internet of things. Paper presented at the electronics, communications and control (ICECC), 2011 International Conference on.

Wood, C. (2016). Betting on big data: how construction firms are leveraging digitized job sites. *Retrieved from https://www.constructiondive.com/news/betting-on-big-data-how-construction-firms-are-leveraging-digitized-jobsi/431047/*

Yang, J., Park, M.-W., Vela, P. A., &Golparvar-Fard, M. (2015). Construction performance monitoring via still images, time-lapse photos, and video streams: Now, tomorrow, and the future. *ADVANCED ENGINEERING INFORMATICS, 29(2), 211-224.*

Zafira, N. M., Shamsulhadi, B., &Roslan, A. (2018). Potential opportunities and future directions of big data in the construction industry. Paper presented at the 12th SEATUC Symposium 2018, UniversitasGadjahMada, Yogyakarta.

Zhang, S., Teizer, J., Lee, J.-K., Eastman, C. M., &Venugopal, M. (2013*)*. Building information modeling (BIM) and safety: automatic safety checking of construction models and schedules. *Automation in Construction, 29, 183-195.*

Zhang, Y., Luo, H., & He, Y. (2015). A system for tender price evaluation of construction project based on big data. *Procedia Engineering*, *123, 606-614.*

Zikopoulos, P., Parasuraman, K., Deutsch, T., Giles, J., & Corrigan, D. (2012). Harness the power of big data the IBM big data platform: McGraw Hill Professional

Appendix 1

Letter of Introduction

I am a student at federal university of Technology Owerri, pursuing master's degree in project management technology. As part of the prerequisite of completing my programs, I am researching on "Big data application and analyses in construction project delivery in Oyo state, Nigeria"

I humbly request that you disclose the necessary information needed to complete this study. The information provided is mainly for academics and all responses will be confidential.

Please, kindly take note that participation is voluntary and you can withdraw from the exercise at any time.

Thank you.

Yours Faithfully,

Oluwayomi Adeyeri.

Appendix 2

DEPARTMENT OF PROJECT MANAGEMENT TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

IMO STATE, NIGERIA.

QUESTIONNAIRE

Dear Sir/Ma,

This questionnaire is aim to examine a research work on "**Big Data application and analyses in Construction Project Delivery in Oyo state, Nigeria**" Please give appropriate answer to the questions below. All information collected will be used mainly for this research purpose.

SECTION A

Name: ----------

Name of Firm: ----------

Age: 25-30 ( ) 30-35 ( ) 35-40 ( ) 40-45 ( ) 45-50 ( )

Occupation: project managers ( ) Quantity Survey ( ) Builders ( ) Engineers ( ) Others ( )

Post Held: ----------

Years of Experience in the industry: 1-5 ( ) 6-10 ( ) 11-15 ( ) 16-20 ( ) Above 20 ( )

Qualification: HND ( ) Bsc ( ) Msc ( ) Phd ( )

Professional Qualification Body: NIOB ( ) NIQS ( ) NIA ( ) NIESV ( ) Others ( )

How do you analyze big data in your company: ----------

SECTION B

1. Determinants of Big Data (Please Tick Appropriately)

S/N	Determinants of Big Data Analytics in Project Construction	5 SA	4 A	3 N	2 D	1 SD
1	Customer Satisfaction					
2	Post Project Evaluation					
3	Effect of Big Data on Project Performance					
4	Human Resource					
5	Protection from Change					
6	Availability of Big Data Technology					
7	Organization Structure and Culture					
8	Stakeholder Management and Collaboration					
9	Accessibility of Big Data Facilities					
10	Guidelines, Handbooks or Guidance for using Big Data					
11	Ethics and legal Mechanism of Copyright, Privacy and Security					
12	Power, Effectiveness and Efficiency of Big Data					
13	Exemplary Projects					
14	Incentive Policies					
15	Top Management Support and BD-Oriented Management Modes					
16	Data Sharing and Governance					
17	Fragmented Nature of the Construction industry					

2. How often has big data in construction project applied in the following management function.

S/N		5 Very well	4 well	3 Neutral	2 Not well	1 Not at all
1	Communication information management					
2	Knowledge Management					
3	Data security					
4	Project Control & Monitoring					
5	Risk Management					

3. To what extent do you agree that big data has been deployed through the following methods in construction project delivery in Nigeria.

S/N	Method of Deployment	5 SA	4 A	3 N	2 D	I SD
1	Frequency of BDA deployment in productive environment and re-training procedure.					
2	Frequency of a deployment procedure and deployment time.					
3	Deployment procedure, methodology and frequency.					
4	Appropriation level and deployment time.					
5	Appropriation level and deployment procedure.					

4. What are the recommendation to be provided for big data deployment project delivery in construction industry in Nigeria?----------

Appendix 3

Ranking Main Determinants of Big Data

S/N	Determinants	MS	SD	t-value ($\mu = 3.5$)	*df*	Sig. (2-tailed)	R
1	Customer Satisfaction	3.31	1.17	0.65	124	0.22	
2	Post Project Evaluation	3.34	1.23	0.60	124	0.35	
3	Effect of Big Data on Project Performance	4.30	0.83	9.56	124	0.00*	
4	Human Resource	4.20	0.80	7.38	124	0.00*	
5	Protection from Change	3.27	1.28	0.79	124	0.42	
6	Availability of Big Data Technology	4.28	0.82	9.53	124	0.00*	
7	Organization Structure and Culture	4.24	0.77	7.33	124	0.01*	
8	Stakeholder Management and Collaboration	3.20	0.39	0.46	124	0.55	
9	Accessibility of Big Data Facilities	4.26	0.82	8.80	124	0.00*	
10	Guidelines, Handbooks or Guidance for using Big Data	3.78	1.67	0.78	124	0.18	
11	Ethics and legal Mechanism of Copyright, Privacy and Security	4.23	0.75	8.34	124	0.00*	
12	Power, Effectiveness and Efficiency of Big Data	4.19	0.78	10.33	124	0.01*	
13	Exemplary Projects	4.09	0.69	9.34	124	0.00*	
14	Incentive Policies	3.20	0.61	0.98	124	0.12	
15	Top Management Support and BD-Oriented Management Modes	4.17	0.80	7.09	124	0.00*	
16	Data Sharing and Governance	3.98	0.75	6.83	124	0.00*	
17	Fragmented Nature of the Construction industry	3.88	0.70	5.90	124	0.00*	

Note: R = Rank; Sig. = Level of significance; SD = Standard Deviation; MS = Mean score of the factors hindering BIM adoption in the FM industry where 5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree as done in Olanrewaju et al. (2020b). The higher

the mean score the more severe the factor; *df*= degrees of freedom, *Significant at the 95% level ($p < 0.05$)

Comp	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared		
	Total	% of Vari-Ance	Cumula-tive %	Total	% of Vari-ance	Cumula-tive %	Total	% of Vari-ance	Cumul a-tive %
1	4.14	31.87	31.87	4.14	31.87	31.87	2.93	22.50	22.50
2	1.72	13.22	45.10	1.72	13.22	45.10	2.18	16.78	39.28
3	1.36	10.43	55.53	1.36	10.43	55.53	2.11	16.25	55.53
4	1.10	10.06	60.32						
5	0.96	7.39	62.92						
6	0.92	7.09	70.01						
7	0.86	6.36	73.00						
8	0.82	6.04	74.10						
9	0.78	5.96	75.97						
10	0.70	5.10	79.56						
11	0.66	5.06	81.03						
12	0.59	4.53	85.56						
13	0.46	3.56	89.12						
14	0.41	3.13	92.24						
15	0.40	3.04	95.29						
16	0.34	2.65	97.93						
17	0.27	2.07	100.0						
Extraction Method: Principal Component Analysis									
Comp. = Component									

Rotated Factor Matrix

S/N	Factors	Component			Rank
		1	2	3	
Component 1: Data and Technology Systems Factor					1st
F1	Effect of Big Data on Project Performance	0.90			
F2	Availability of Big Data Technology	0.90			
F3	Accessibility of Big Data Facilities	0.90			
F4	Power, Effectiveness and Efficiency of Big Data	0.81			**0.877**
Component 2: Human Resource Factor					3rd
F2	Human Resource (Skills and Knowledge)		0.90		
F3	Ethics and legal Mechanism of Copyright, Privacy and Security		0.79		**0.845**
Component 3: Organisation Resource Factor					2nd

F1	Top Management Support and BD-Oriented Management Modes			0.90	
F2	Organization Structure and Culture			0.85	
F3	Exemplary Projects			0.96	
F4	Data Sharing and Governance			0.78	
F5	Fragmented Nature of the Construction industry			0.81	**0.860**
Rotation Method: Varimax with Kaiser Normalization. Extraction Method: Principal Component Analysis.					
Rotation converged in 5 iterations.					

Guide to degree of Significance

Degree of Significance	**Rating**
Very Significant	0.76 above
Significant	0.67-0.75
Fairly Significant	0.45-0.66
Not Significant	0.44 below

Descriptive Statistics of Application of Big Data in Construction Project Application

Big Data Application	**Mean**	**Std. D**	**Rank**
Communication information management	3.75	0.879	4th
Knowledge Management	3.84	0.962	2nd
Data security	3.86	0.971	1st
Project Control & Monitoring	3.66	0.855	5th
Risk Management	3.79	0.944	3rd

Descriptive Analysis of the Application of Big Data in Construction Project Application

S/N		**5 Very well**	**4 well**	**3 Neutral**	**2 Not well**	**1 Not at all**
1	Communication information management	32	28	18	24	20
2	Knowledge Management	37	30	19	26	12
3	Data security	41	35	12	23	13
4	Project Control & Monitoring	28	29	22	19	26
5	Risk Management	35	26	25	23	20

Evaluation of method of Big Data Deployment in Construction Project

Perception Statement	**N**	**S.A**	**A**	**N**	**D**	**SD**
Frequency of BDA deployment in productive environment and re-training procedure.	124	58 (46.77%)	22(17.75%)	18(14.51%)	16(12.9%)	10(8.064%)
Frequency of a deployment procedure and deployment time.	124	49(39.51%)	24(19.35%)	24(19.35%)	12(9.67%)	15(12.096%)
Deployment procedure, methodology and frequency.	124	44(35.48%)	31(25%)	26(20.96%)	18(14.51%)	5(4.03%)
Appropriation level and deployment time.	124	38 (30.64%)	28 (22.58%)	23 (18.54%)	19 (15.322%)	16(12.90%)
Appropriation level and deployment procedure.	124	40 (32.25%)	26 (20.967%)	21 (16.93%)	14 (11.290%)	23(18.54%)