INTERNATIONAL JOURNAL OF BUILT ENVIRONMENT AND SUSTAINABILITY
Published by Faculty of Built Environment, Universiti Teknologi Malaysia
Website: http://www.ijbes.utm.my
IJBES 5(3)/2018, 241-250

A contextual parsing of big data values to quantity surveyors

Zafira Nadia Maaz; Shamsulhadi Bandi and Roslan Amirudin
Department of Quantity Surveying, Faculty of Built Environment and Surveying
Universiti Teknologi Malaysia (UTM)
Email: zafiranadia22@gmail.com

History:
Received: 19 July 2018
Accepted: 22 September 2018
Available Online: 30 September 2018

Keywords:
Big data; Big data value; Construction Industry; Framework Analysis; Quantity Surveyors

Corresponding Author Contact:
zafiranadia22@gmail.com

DOI:
10.11113/ijbes.v5.n3.311

ABSTRACT

Big data is the new generation of technology designed for organizations to economically extract value from large volumes of a wide variety of data through high velocity capture, discovery, storage and analysis. Manifest as the frontier of 21st century technology, big data instigate superior business return. This lure businesses to zealously capitalize big data. In correspond, professionals too are charting their way to improve customer value with big data. Leading research in this area accede maximization on big data; revolutionized the norm of medical and accounting profession. Despite the substantial value, big data uptake from the quantity surveying profession recognized subtle. Contrarily, construction stakeholders swiftly embrace modern technology in their construction value chain. This invoke a change in data landscape thus, present an urgent call for professionals, especially quantity surveyors to recognize the change, embrace and reap the big data benefit. This paper aims to expand big data knowledge from the context of quantity surveying profession as an approach to soothe the big data and quantity surveying gap. This paper identifies generic big data value from professional perspective and explore big data value from the quantity surveying context. Aligning to the blurry big data paradigm in the quantity surveying context, this research adopts quantitative research with desk study on 28 papers and framework analysis through 15 semi-structured interviews with big data industry expert with quantity surveying background. This research found that big data values are consistent across profession albeit the difference on how big data is maximized. Other than that, the paucity of quantity surveying big data pursuance seen as repercussion of infancy big data state in the construction industry. However, this research insinuate quantity surveying profession are in strategic position to move forward with big data.

1. Introduction

The Industrial 4.0 revolution changes the overall ecosystem across different industry and as part of this movement, the ecosystem in the construction industry face challengers. While the benefit of IT is astounding and not limited to its previous role as an external input to solve technical problem (Benson, Bugnitz, & Walton, 2004), IT is indeed a double-sward edge. The application of modern technology such as internet of things causes industry plenary disruptive impact. Big data emerge in 1997 by researchers to portray the problem of large data volume (Addo-Tenkorang & Helo, 2016; Cox & Ellsworth, 1997).

In 2011, McKinsey & Company report disclose a peculiar big data gain across industries. Consistent with this report, big data spur organization's productivity improvement, customer experience, business cost reduction, expediting competitive advantage as well as driving new business opportunities to organizations (Forbes Insights, 2015; Groves, Kayyali, Knott, & Van Kuiken, 2013; McAfee & Brynjolfsson, 2012). Relating to this, Brown, Chui, & Manyika (2011) argues data-driven decision making as the main value of big data. This enables organizations to move towards proactive innovation, giving them more control on the industry's market to combat future risk occurrence while offering optimized solutions (Chen, Chiang, & Storey, 2012; Kiron, Prentice, & Ferguson, 2014; World Economic Forum, 2011). Pioneer report 'Big Data: The Next Frontier for Innovation, Competition and Productivity by McKinsey & Company discrete clarity towards big data across organizations. This report indicate positive uptake on big data in organizations of different industry such as healthcare, public sector administration, retail and manufacturing (Manyika et al., 2011). More importantly, this report postulate organizations are positioning themselves through maximization of transparency, experimentation to discover needs, supported decision making process and new business innovations through big data. Besides contextualizing correlation towards big data potentials mentioned, big data is a universal technology which can be applied across organizations.

To date, organizations are embarking on big data on an aggressive scale, globally. Big data hailed as the face of new technology revolution. The significant of big data do not rest upon mere connotation on forms of big data potential in organizations neither across industries. High profile news and magazines as well as industry leader and government reports declaring financial return on big data investment. Big data offers 5% to 6% higher profitability to organizations (McAfee & Brynjolfsson, 2012) and in the case of Amazon, big data recommendation engine secure 30% increase of overall total sale (The Economist, 2011). From a wider landscape, the Centre of Economics and Business Research (CEBR, 2012) publish an anticipated £24 billion revenue to the UK economy through big data. These serve concrete evidence on big data; reinforce organizations confidence and desire to strategically move forward with big data.

Over the years, IT governs changes among professionals. Interestingly, the post 2008 research shows that medical and accounting profession moved towards embracing the technological change and pursue big data. Medical profession evolved from being doctor dominance profession towards patient centered healthcare, personalized healthcare and ubiquitous healthcare. Accountants on the other hand, taking a leap towards maximizing non-financial information source for fraud detection and live auditing. Taking advantage on the surge of demand on big data, accounting profession are emerging towards professions role expansion as data valuator as we speak (Association of Chartered Certified Accountants, 2013; Chawla & Davis, 2013; Digital News Asia, 2013; Dynamic Markets, 2012; Groves et al., 2013b; IBM, 2012, 2013b; Knowledgent, 2014; Manyika et al., 2011; Murdoch & Detsky, 2013; Savage, 2012; Zenger, 2012). With big data, professionals can deliver more values to customer; moving passive, reactive and supportive roles towards proactive approach in delivering services.

Big data is seen as a double-sword technology; delighting customer needs while enriching organizational and professional value. From the perspective of the construction industry, current research indicates a positive adaptation of technological innovations by construction stakeholders. KPMG (2016) and Lasrado (2018) unveil computer aided design (CAD), virtual reality (VR), building information modelling (BIM), cloud computing as well as IoT lead technology; sensors, drones, radio frequency identification (RFID) and global positioning system technology usage trend post year 2000. Current technology is characterized by its capability to overcome human limitations and better understanding of work process. This shows that IT function has greatly moved from a communication medium and facilitating administrative work as emails and Windows application towards capitalizing IT in improving productivity and work process. Although agreeing positive potential streaming from current technological trend in the construction industry, from a second point of view, technological advancement changes the landscape on data generation and availability in the construction industry. This is argued to change the context of data; previously driven by documented data on papers, technology application in work processes generates data in digital format. Changes in data creation calls for perhaps, different approach on understanding the difference of what it means to the construction industry, managing and maximizing data.

Remain in the infancy stage, big data research in construction industry context pioneered by Bilal et al., (2016), Chen, Lu, & Liao (2017) and Hafiz et al., (2015). Academic research is exploring the context of big data from the construction industry perspective. More recent research explores on the potential of big data however, signalling an alarm for construction stakeholders, especially quantity surveying professionals to strategically manage and maximizing the value of big data (Ismail, Bandi, & Maaz, 2018; Maaz, Bandi, & Amirudin, 2018).

In relation to the progress made by other professionals in medical and accounting, these research advert minimal amount of research is currently undertaken to guide quantity surveying profession to move forward with big data. Hence, compared to other professionals, this implies paucity on big data in the context of professionals in construction industry, especially, quantity surveying profession. Relating on the issues of paucity of quantity surveying profession on big data and the changing landscape of data in construction industry, this research aims to expand big data knowledge from the context of quantity surveying profession. The context of this paper is part of an on-going research; however, this paper adds to this knowledge by; 1) Identify generic big data value from professional perspective and 2) Exploring the value of big data for quantity surveyors.

2. Research Methodology

This paper is founded on no single perspective on idea of multiple realities ontological point of view. Due to the research context conducted in the infancy stage development of big data in construction context as well as paucity in big data research addressing to specific quantity surveying profession (QS), this research stems on interpretivistic epistemology and moderated qualitative approach is deemed suitable for this research to give emphasis on words instead of data computation (Bryman, 2004). This paper address on the importance of exploring big data from the QS perspective, not creating a final establishment on this area of research but instead, expanding the establishment of knowledge.

Data supporting the first objective in this paper is derived based on desk study research. To gain comprehensive data search, google scholar databased was used with 'Big Data Potential', 'healthcare' and 'accounting' keyword with Boolean OR. Specification on 'healthcare' and 'accounting' were based on initial readings in relation to the area of this research. It is found that among professionals, medical professionals were avid and advanced big data adopter while accountant are professionals with progressive pursuance on big data. Thus, selection of both professions believed to reflect differences (if any) and eradicating bias towards the findings on generic big data value. More importantly, both professions are seen similar to QS profession. During the early technology adaptation across sector, doctors, accountants and quantity surveyors were among the profession with less progressive technology adaptation.

Data were then filtered according to its relation to the research context and 28 sets of data discussion big data value were gathered. The second and final objective were conducted through in-depth, semi-structured interviews of 15 QS professionals involved in the big data initiative at national level through snowball sampling. The first respondent was identified during Statistics, Indices in Construction & Automation (SICA) Forum 2017. Data are transcribed and analysed using framework analysis, similar to priori objective.

Framework analysis was used to improve the transparency and robustness of this study (Ritchie & Spencer, 1994). Transcribe data are analysed throughout data collection period between May-July 2018. Data saturation was achieved during the tenth interview as respondents are constantly describing similar context identified in the previous interviews, however, the remaining five interviews were conducted to gain elicit understanding on big data. The five stage in framework analysis; familiarization, identifying thematic framework, indexing, charting and mapping and detail process interpretation in stages facilitated researcher flexibility in extracting critical insights while paving transparency credibility Braun & Clarke (2006). The first four stages of framework analysis were assisted by Nvivo and descriptive coding strategy popularized by (Saldaña, 2009) and detail process interpretation were conducted based researcher emerging thoughts supported by data findings and theoretical big data research analysis.

3. The generic big data value

Professionals across sectors are moving towards adopting big data to improve service to clients. Desk study findings on 28 sets of journal and whitepaper were analyzed and presented in Table 1. Table 1 presents the generic big data value based upon two profession currently maximizing on big data. Analysis reveals four big data value across the

Table 1 *Generic big data value from accounting and medical (doctor) professional*

Big Data Value	Area	Authors
		Accountant
Process improvement	Self-service data retrieval	Hathaway (2014) and Vasarhelyi, Kogan, & Tuttle (2015)
	Predicting risk management	Chan (2003) and Mittermayer (2004)
	Managerial accounting	Warren, Moffitt and Byrnes (2015)
Transforming or revolutionizing profession	Integrated and standardized reporting	Association of Chartered Certified Accountants (2013) and Hathaway (2014)
	Live auditing	Digital News Asia (2013)
New opportunities creation	Data value validation	Association of Chartered Certified Accountants (2013)
	New data source integration	Basoglu & Hess (2014), Cao et al, (2015), Elkins, Derrick, Burgoon, & Nunamaker (2012), Girshick, Donahue, Darrell, & Malik (2014), Holton (2009), Mayew & Venkatachalam (2012), Metaxas & Zhang (2013), Radhakrish-nan, Divakaran, & Smaragdis (2005), Torpey, Walden, & Sherrod (2009) and Torralba, Fergus, & W, (2008)
		Doctor
Process improvement	Patient-disease profiling	Groves, Kayyali, Knott, & Van Kuiken (2013), Knowledgent (2014), Murdoch & Detsky (2013) and Manyika et al, (2011)
	Healthcare standardization	
Creating better services	Ubiquitous healthcare	Groves et al, (2013) and IBM (2012)
	Personalized healthcare	Chawla & Davis (2013), IBM (2012, 2013b), Knowledgent (2014), Manyika et al, (2011), Murdoch & Detsky (2013), Savage (2012) and Zenger (2012)
Transforming/ revolutionizing profession	Proactive healthcare	Groves et al, (2013), IBM (2012, 2013b), Knowledgent (2014), Murdoch & Detsky (2013), Savage (2012) and Zenger (2012)
New opportunities creation	Data extension to pharmacy sector and medical claim	Raghupathi & Raghupathi (2014)

profession which includes process improvement, creating better services, transforming or revolutionizing profession and new opportunities creation.

Accountants and doctors share two common big data value which are process improvement and better services. In terms of process improvement, by connecting inventories with RFID, big data provide value through self-service data retrieval. This enable accountants to ensue inventory checking, improving work efficiency and productivity while reducing job repetition (Hathaway, 2014; Vasarhelyi et al., 2015). Furthermore, data analytics helps accountants to see the overall picture, generalize patterns and trends to provide better advice to organization managers and leaders and adds value to organizations (Cao et al., 2015; Warren et al., 2015). Moreover, trends and patterns assist accountants to prepare financial analysis based on non-financial data. Aligning to this, accounting report released by Association of Association of Chartered Certified Accountants (2013) attest task automation does not diminish the role of an accountant but instead, equips accountants with better capability to explore new roles such as advising the suitable non-financial data to be incorporated with strategic investment decisions for managers and leaders or exploring data sharing boundary within organizations and externally. Similarly, big data capability in handling large and various data sources enables healthcare standardization. Coupled with clinical information profiling based on patient's data delivered in real time, this guide coordinated approach for more reliable and affordable diagnosis (Groves et al., 2013a; Knowledgent, 2014; Murdoch & Detsky, 2013). Hence, findings infer towards maximization of automation in big data as well as capability in handling data with big data characteristics (large volume, variety and real time data) leads towards process improvement for professionals' service to client.

The context of creating better services is further addressed through big data capability to revamp conventional healthcare methods and skew towards ubiquitous (Groves et al., 2013a; IBM, 2012) and healthcare (Chawla & Davis, 2013; IBM, 2012, 2013; Knowledgent, 2014; Manyika et al., 2011; Murdoch & Detsky, 2013; Savage, 2012; Zenger, 2012). Instead of retroactive practice approach, doctors can analyse real time patient's data and predict patient's healthcare status remotely through ubiquitous healthcare. This increase healthcare system efficiency. For example, patient's body temperature and electrocardiogram can be monitored virtually through wearable device signal without having to stay admitted which mitigate problems such as hospital cramp. On the other hand, personalized healthcare is the way forward as doctors can tailor best treatment options according to patient's biological needs. This enables doctors to deliver better service and taking a leap change from the traditional practice. In other words, professionals can move towards delivering better service through big data because big data facilitate instant data access as well as comprehensive data access in early decision-making stage. However, none of the data sets analysed address the context of creating better service from the accounting perspective.

Consistent themes were found in the literature describing big data as a form of technology which invites profession transformation or revolution. From the accounting perspective, Bourmistrov and Kaarbøe (2013) argues traditional budgeting techniques are pinned upon an inward focus and lack of creativity. New data sourced exploration through big data allows the development of integrated and standardized reporting. New forms of data such as user experience input of using accounting technics or format can be further accessed. This provides a clearer perspective on company performance, better indicator for growth and value creating as well as transparency. Next, big data is seen to improve audit process through live auditing. Pricewaterhouse Coopers Malaysia (PwC) uses big data to review transactions in micro perspective digitally instead of reviewing transaction documents which are prone to accuracy problems. Various data source enable accountants to easily spot anomalies and focus on the root cause (Digital News Asia, 2013). Chan (2003) and Mittermayer (2004) discuss the ability of predictive analytics to assist accountants in analysing positive and negative risks to address accurate future investment opportunity risks. On a similar stance, Manyika et al, (2011) proffers that data analytics helps to promptly detect healthcare pattern locally and globally. By this, doctors are well informed on the local need of healthcare services analyzing patient's data and hospital records. Therefore, delivering proactive healthcare service and transforming the healthcare services. However, few authors offer an alternative interpretation from the patient's perspective. Big data allows patients to be proactive in tailoring their lifestyle towards a better healthcare management as patients are equipped with information on their health status (by using sensor technologies) while doctors monitor in virtual. This transforms healthcare quality through patient empowerment (Groves et al., 2013a; IBM, 2012, 2013; Knowledgent, 2014; Murdoch & Detsky, 2013; Savage, 2012; Zenger, 2012).

With regards to creating new opportunities, research on big data has shown that professions are likely to form new roles, providing a significant differentiation towards the conventional services and practices. One noticeable new role for the accounting profession that would create a new revenue stream as well as skill expansion is data valuation. Research on data valuation practice becomes relevant as more companies are appreciating data as an asset and compete based on data (Association of Chartered Certified Accountants, 2013). In 2012, 20% companies are incorporating data as an asset in their balance sheet and data valuation service becomes more relevant for big corporations (Dynamic Markets, 2012). Hence, data valuation service is relevant to the current as well as future market and most importantly, the numbers show that there is a potentially large demand and optimistically, an unsaturated market. However, Raghupathi & Raghupathi (2014) raised a significant supposition where big data enables doctors to share patient's health details to improve research and development of new drug. The integration of healthcare data and research data from pharmacist reduces trail failure, increases treatment match and adverse effect detection. Another aspect on new opportunities being brought forward through integration of real time data and patient's healthcare record, enabling health insurers to have a better overview in understanding and resolving claim as well as minimizing fraud claim (Raghupathi & Raghupathi, 2014). The advancement of big data does not only create new opportunities but creates a value-added chain for medical profession such as pharmacist and medical insurer. Through data integration and analytics, the process of drug development by pharmacist and health insurer is further revamped enabling speedy and safe drugs development as well as delivering right value to patients while improving transparency.

This section concludes by offering four common opportunities of big data for professionals which are process improvement, offering better services, transforming or revolutionizing the profession and creating new opportunities. While detailed research by Comuzzi & Patel (2016), Du, Li, & Zhang (2014) and New Vantage Partners (2012) on big data from organizational context argues that decision making being the biggest impact of big data, this section expands the context of big data value in generic without any emphasis of criticality on any.

4. The big data value for quantity surveying profession

While findings generic big data value from the profession context value were addressed in the previous section, this section implies findings on big data value in specific to QS profession perspective. Descriptive and pattern coding analysis indicates four consistent dominant codes describing big data value from the understanding of delivering comprehensive insights, data driven decision making, productivity improvement and data commercialization. Figure 1 represent word cloud visualization on the dominant codes' findings.

4.1 Comprehensive insights

Analysis on exploring the value of big data for QS profession avulse descriptive codes describing value derived upon insights comprehensiveness. Based on second layer coding analysis, findings indicate a consistent pattern in the codes. These codes were re-coded based upon the understanding of 'data centralization', 'true reflection' and 'visualization'.

Analysis of 'data centralization' code describes the big data as a technology with allows QS professionals to access large volume of data. Big data is viewed as a system which hosts large volume of data, accessed on a single platform and can be accessed virtually across time and geographical expansion. Codes analysis indicates several big data characteristics based on interviewee's perspective such as platform hosting large volume of different data forms and sources. The list below indicates current available data types in the construction industry.

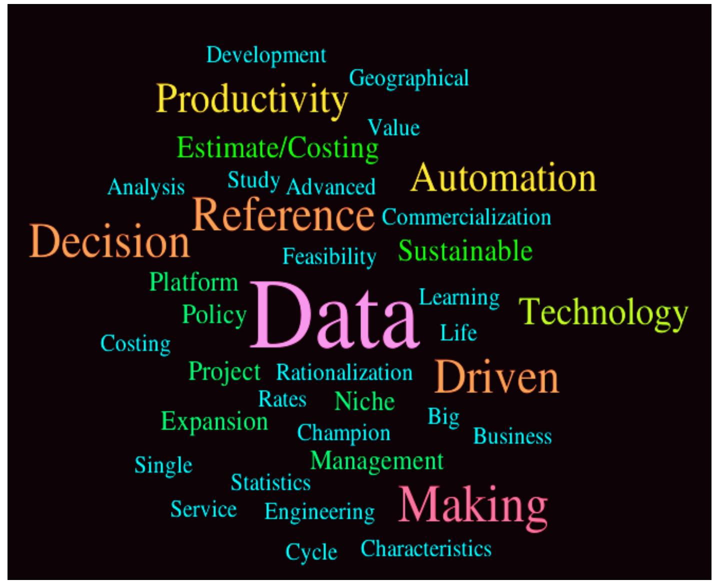

Figure 1 *Dominant codes for big data value from QS profession context*

- Bill of quantities (BoQ)
- Operational cost
- Maintenance cost
- Construction project data (project type, project detail, contractor data)
- Procurement data
- Construction waste data
- Building information modelling data
- Sensor data
- Land cost
- Advertisement cost
- Authority requirement and policy
- Construction index
- Productivity data

Detail analysis on 'data centralization' code elucidate several issues in the construction industry. The construction industry is known as a silo practiced industry. As an effect to this, construction stakeholders across construction industry do not confront towards data sharing. 'Private and confidential' in-vivo codes consistently recognized across transcribes. Most construction organizations react negatively to 'data sharing' culture and shy upon the idea of data privacy and confidentiality. While this conjures towards the understanding of data as a valuable commodity among construction stakeholders, most quantity surveyors result towards capitalizing personal relationship to access data. Reflecting to this issue, big data value is seen to derived upon data centralization benefit to quantity surveyors. Codes analysis further emphasize on alternative for data access whereby big data facilitate QS professionals to access data which were previously hard or seems impossible to access. From the perspective of work process, data centralization allows accessibility across time and geographical horizons. Hence, analysis indicates that QS professionals are facilitated by early data access in addressing construction projects. For instance, a respondent interviewed (code: Q) mentioned on current estimating and project financial planning pursuance is limited up to delivery of construction building. Estimates rarely incorporate costings on building facilities management costs reason being; limited data access. However, with big data, data across construction life cycle can be accessed in a centralized platform, hence, enabling access on data of latter project stage. In short, delivering more comprehensive insights as well as better service value to construction stakeholders.

Next, detail analysis on 'data centralization' codes in emphasised consistent interpretation of national data standard. Big data enables QS professionals to have a national data standard. A respondent (code: B) had highlighted on the issues of inconsistent and data misinterpretation across construction stakeholders, even within QS professionals. Based on the respondent's experience as an academic as well as an industry practitioner, the respondent observed differences on simple interpretation such as gross floor area (GFA). Respondent B had further indicated that the value of big data can be understood through data centralization and standardization of data context managed throughout data processing stage. This allows QS professionals as well as construction stakeholders to have a universal understanding, encouraging smooth communication between those parties.

Next, detail analysis on 'true reflection' pattern coding interprets the understanding of big data allowing QS professionals to access data that are trustworthy, free from perspective bias; representing current industry context authenticity. Respondents were seen to describe this value in relation to the issue of current data access are of clouded genuinely. With an experience working with a contractor and consulting firms, respondent F had noticed bias between a quotation submitted to contractor and consultants by suppliers over the same materials or work items. Thus, data received by QS professions perhaps, depends on sector position influence and were not the true reflection of industry context. However, big data is supported by strict data processing and management ethics. Data management process allows standardization on data as mentioned above while data filtering process allow data context to address any 'off' data or data that do not conferred to the current data accumulation value or understanding. This allow insights generation to be free or with minimal bias. Other interviewees postulate similar respond where bias in data tempers QS professional's capability to address comprehensive advice during tendering stage. Thus, this implies that the value of big data to QS professionals can be further understood through improvement on analysis capability such as accessing contractor's tendering strategy. Moreover, genuine data helps constitute towards setting 'par' data values on construction resources believed to channel healthy competition culture in the construction industry.

Findings on 'visualization' consistent codes addressed that the value of big data is rooted upon big data technological features. Albeit all interviewees described on the importance of technological element within the context of big data pursuance, only those with deep big data knowledge such as interviewees with exposure on technological and statistical knowledge mentioned on data visualization value. For instance, taking from big data initiative mentioned by respondent Q, PCE-PREMO system provides data interpretation in the form of comparison take and percentage differences. This allows fast and better comprehensibility of insights context. Respondent H further describe graphical presentation on insights on system interface or big data dashboard allows simplification on data representation.

Pattern coding facilitates researcher capability to analyse data according to framework analysis especially during charting and mapping stage. 'Data centralization', 'true reflection' and 'visualization' codes expand and increase deep contextual understanding on our early findings based on descriptive coding strategy. This research ratifies the value of big data to QS profession in delivering comprehensive insights. Pattern coding interprets comprehensive insights value driven through the capability of QS professionals to access large and variety data across time and geographical horizons in genuine context with universal interpretation across construction stakeholders and simple yet engaging data insights representation.

4.2 Data driven decision making

Initial scoping on the value of big data for QS profession indicate consistent findings on codes describing analytical decision making driven by solid data basis. Codes were further addressed with 'Data driven decision making'. Analysis indicates that this value is consistently described along with 'guesstimate' issue highlighted by interviewees. Currently, QS professionals are reported to practice 'guess-timate' or several other terms such as rule of thumb', 'magic wand' and 'experience' to manage or predict uncertainty as part of decision-making process prior to delivering services. These terms express the understanding of QS professional practicing gut-feeling decision making. Consistently, respondent D, H, M and F argue the need for this profession to skew away from 'guess-timate' as decisions are made based on personal opinion, secluded upon grey areas of decision-making process. 'Guess-timate' decision making implies risks towards service output such as advice to clients as decisions are derived based on dubious basis and desultory understanding.

The context of big data, managing uncertainty further expanded with perspective of respondent I, Q, B, N and G. The respondent's understanding on uncertainty resides on 'variables' that differs according to project peculiarity, constantly changing and are not within QS's control during the process of decision making in completing job scope. They highlight on 'variables' (or also known as factors) which are known as 'constants' in big data analysis process. While previously most QS practice guess-timate, respondent H excerpt indicates 'variables' function in big data system helps QS professionals to have analytical computational degree of uncertainty, leading them to better manage uncertainty areas which are prone to guesstimates practice, thus, reducing QS professionals favouring guesstimates practice.

Consistent pattern code on 'integrative system' were found as part of respondent's discussion on 'data driven decision making' context. This can be further understood by respondent's discussion on two big data initiative; PCE-PREMO and Construction Cost Modelling (CCM). Detail analysis on indicates both initiatives indicates three dominant components big data initiative function in Figure 2.

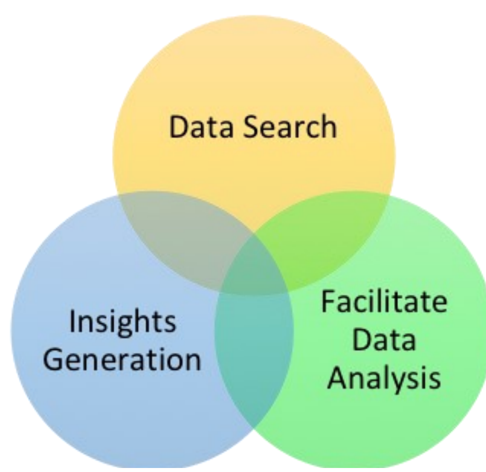

Figure 2 *Big data dominant components*

Data search describe the process of QS searching for similar cost data through data mining process while analysis process describes adjustment on cost data to suit current project needs. Insights generated is the auto generated output on which instantly support QS professional decision making. It is viewed that this process connotes the idea of data driven decision making as stage of work process is supplemented by analytical form of analysis. Further supported by respondent F and C discussing on the properties of data management which secures ensure data quality and reliability. Moreover, data analysis process is conducted through standardized methodology. This implies that each of the three big data process in producing are corroborated with credible data and process clarity; connoting the idea of data driven decision making at each layer. Thus, the increase the quality of decision making by QS professionals.

Data driven decision making supports the ability to replace experience based and subjective judgment to soothe human errors in work scope and move towards data driven analytical approach decision making. This further implies that big data offer QS professionals with tangible and analytical path in making job scope decision.

4.3 Productivity

Analysis of descriptive data in identifying thematic framework indicates an emerging understanding of productivity improvement in QS professional services. Transcribed data are coded with 'productivity' code describing two consistent and dominant patterns on the understanding of prompt and easy data reference and automation. Both patterns further conjure towards (process) and time improvement.

Findings on prompt an easy insights generation centres around the terms 'click', 'drag', 'click and drag' 'automization', 'easy' and 'simple' mentioned by respondent E, P, I, D and Q. Emphasis on the terms reflects towards the significance of technology features of big data. Big data technological features allow simple maneuver on big data systems for QS professionals. Extending to the findings of three dominant components of big data initiative mentioned above, data indicates second layer of interpretation related to process and time improvement. While previously findings were discussed along the line of facilitating data driven decision making, the same understanding paved Interviewee's perspective on productivity.

Through big data, data search process is simplified as QS professionals can access a single platform encompass variety of data. Upon data access, QS professionals can then straight away analyze the available data according to project or client's needs in the same platform. Duplication such as data extraction from big data platform to normal excel sheets prior to manual analysis can be eradicated. Adjustment on data according to QS professional's peculiarity can be done while each of analysis steps can be traced. Finally, big data allows automated insights generation whereby, final output can be access instantly for each adjustment made during data analysis. In short, insights generated are the reflection of data adjustment and analysis. Most importantly, these findings evoke upon process facilitation leading towards time savings throughout overall process.

Respondent C further connotes technological features bolstering clarity on data analysis process. Respondent C discussed on the common issue faced in a consultancy practice whereby, not only that normal estimating practice requires long duration of 1 to 2 weeks, lengthy time were taken by superiors or subordinates to check on work done supporting QS services. This is because superiors or subordinates needs to understand on how decision or conclusions were made. With big data, estimating process time can be reduced up to 60% whereby, QS professionals in Public Works Department Malaysia can now generate estimate within 1 to 2 days with big data initiative.

Similar to findings on visualization, analysis on 'automation' codes were discussed by respondents which are more familiar with big data and statistics with better technology knowledge. Respondent Q, H and J describes big data as an intelligent and self-regulating system. Findings further indicates a correlation on 'automation' codes to 'BIM' codes whereby, respondents suggest on BIM maximization allows automated data sourcing for big data initiatives. From a second point of view, this implies BIM as a foundational pursuance prior to big data. Besides the understanding of automated data sourcing, respondent Q and H gives emphasis towards the overall big data context; advanced big data initiative founded by system intelligence through the application of advance statistical based technology increases the insights value in terms of accuracy, reliability. For instance, both respondents described Machine Learning and Artificial Intelligence as forms of advanced statistical based technology allowing the system to self-regulate and improve its intelligence capacity. Respondent H explicitly described that the accuracy and reliability of insights generation of any big data initiative depends on the quality, accuracy and reliability of data supporting big data analysis process. Data supporting big data analysis are known as factors or variable which are adjusted by QS professionals during data analysis process to reflect project or client's needs. To achieve such quality, accuracy and reliability of data supporting big data analysis, constant updates were needed to ensure data capture are robust and are the true industry reflection.

All other respondents however, highlighted on the paucity on current big data pursuance. Current big data pursuance such as Construction Cost Modelling, Tender Price Index and Life Cycle Costing were not planned with the application of advanced statistical technology except for PCE-PREMO. Artificial intelligence adopted in PCE-PREMO allows this system to access large data from different system, changing the analytical computation structure of origin system to cater towards analysis needs in PCE-PREMO. For instance, change of concrete price is PCE-PREMO is dependent on the price fluctuation of sand, crusher run and cement. Should QS professional changes the quantity of concrete needed in PCE-PREMO by 10%, data is automatically linked to another system which will compute cost difference based on the suitable mixing constant incorporating price fluctuation of sand, crusher run and cement. This form of extensive and large data analysis requires advanced statistical technology adaptation such as artificial intelligence. However, in relation to current big data initiative pursuance, none of the big data initiative mentioned embodies automated self-regulating and intelligent system properties. This implies an adaptation paucity on advanced statistical technology of big data. With big data, maintenance of big data initiative does not require technical experts as systems are governed automatically.

Findings indicate understanding on productivity value to QS professionals entails further clarity on data driven decision making context, whereby, analogical understanding on data driven decision making core process instigate understanding on productivity value. Hence, productivity can be understood from the understanding of improvement on work process, specifically on time context. Despite issues on technological paucity limiting the capability of QS profession to maximize productivity value on work process, respondent's perspective which recognized the potential of BIM and advanced statistical technology implementation to improve productivity big data value reflects towards positive big data growth for QS profession in the near future.

4.4 Data commercialisation

Further analysis based on the understanding of data silo, confidentiality and accessibility issue as well as non-data sharing culture. Discussion convolutes towards the value of big data facilitating prompt and easy alternative for QS profession to access data. From business context, respondents view these issues as gaps to be addressed. These gaps were also specifically mentioned by respondent M and C. Hence, adjourn to the understanding of data demand from QS profession. Data coded with 'Data commercialization' further relate to interpretation of data embodies competitive value in the construction industry. Based upon respondent's perspective, this implies that the value of big data for QS profession can be seen from opportunity of data commercialization.

Findings based upon respondent J, Q, G, K and F excerpt indicates data as a valuable commodity where big data offers technological capability to maximize the value of data while allows QS professionals to acquire construction data through subscription basis. Data commercialization through subscription basis allows QS profession to found new revenue stream. From business perspective, this indicates big data pave QS profession new business opportunity.

5. Discussion

This study reported in this paper emphasize on the importance of understanding the value of big data from QS professional context and what it means in relation to the generic big data value addressed by other profession. Understanding big data value from both generic and specific context is believed to allow comprehensive big data understanding for audience, especially, quantity surveyors. This discussion is founded based on comparison analysis between findings on objective 1 and objective 2 allowing critical context integration from both theoretical and industry stand. Besides addressing towards completing the final stage of framework analysis this discussion moderate on internal validity and reliability on the research finding. Table 1 adopts findings on big data opportunities addressed in Table 2 with findings from respondent's perspective described. In general, comparison analysis shows theoretical and industry perspective are found to be consistently addressing similar context. However, transforming or revolutionizing big data value yet to be addressed from the QS professional perspective.

Analysis indicates process improvement big data value from theoretical perspective correlates towards comprehensive insights, data driven decision making and productivity big data value from the QS profession perspective. Correlation between process improvement and comprehensive insights value can be understood from the context of equipping professionals with capability to handle large data from various format and sources with emphasis of standardization throughout big data process. With big data, medical professionals now handle large and various form of patient and clinical data facilitated by standardized medical system across organizations. Groves et al., (2013a), Knowledgent (2014) and Murdoch & Detsky (2013) indicates that these form of capability increases the quality of treatment delivered by doctors. As for QS professionals, big data eradicates issues relating to data access, confidentiality and non-data sharing through centralization access of construction data sourced from multiple perspective. Data such as Bill of Quantities can be sourced from both contractor and consultants allowing QS professional to grasp decisions based upon multi-perspective interpretation. Extending to this, big data allows accountants to promptly spot generalized pattern, trends as well as overall picture on financial status (Cao et al., 2015; Chan, 2003; Mittermayer, 2004; Warren et al., 2015) while industry findings indicates QS profession easy access to genuine data from multiple perspective through data centralization.

Table 2 *Comparison analysis on big data value*

Big Data Value	Service Area	Findings
Process improvement	Self-service data retrieval	Comprehensive Insights
	Predicting risk management	Productivity
	Managerial accounting	
	Patient-disease profiling	Data Driven Decision Making
	Healthcare standardization	
	Firm management efficiency	
	Strategize case handling	
Creating better services	Case handling and firm management	Data Driven Decision Making
	Ubiquitous healthcare	
	Personalized healthcare	
	Client-lawyer relationship	
Transforming/ revo-lutionizing profession	Integrated and standardized reporting	Not addressed
	Live auditing	
	Proactive healthcare	
New opportunities creation	Data value validation	Data Commercialization
	New data source integration	

Comparison analysis in Table 2 indicates data driven decision making value from industry perspective consistently address similar context towards process improvement and creating better services of the theoretical stand. Interrelation of context between data driven decision making and process improvement can be seen from Cao, Chychyla, & Stewart (2015) and Warren et al, (2015) Groves, Kayyali, Knott, & Van Kuiken (2013), discussion on predicting risk management, strategize case handling and patient disease profiling services areas. With big data, accountant and medical professionals confers towards more accurate prediction on financial management and trading risks as well as better forecast on patient's treatment success risks. This is because big data skew professionals toward decision making based upon vast information access. Not only that, their decisions are based upon risks and opportunities that are analytically founded, enabling them to increase clarity in predicting the results output as well as increasing decision making quality through accuracy and reliability. In terms of creating better services big data value from theoretical perspective, context of similarity can better be addressed through Chawla & Davis (2013), IBM (2012, 2013b), Knowledgent (2014), Manyika et al, (2011), Murdoch & Detsky (2013), Savage (2012) and Zenger (2012) discussion on personalized healthcare. Authors discussed on big data facilitating doctors with detail diagnosis on patient and carefully suggest forms of treatments based on patient's biological needs. From the QS profession context, similar context was addressed through the discussion of variable significance in data driven decision making section which allows QS professionals to offer more accurate and reliable advice to clients.

Thirdly, big data help professionals to improve work productivity. Hathaway (2014) and Vasarhelyi et al., (2015) mentioned on self-service data retrieval. She described the usage of modern technology such as RFID for accountant to automatically manage inventory. However, from the QS perspective, the same is understood from the context of QS professional's ability to instantly access data and manage data analysis on a single platform, resulting 60%-time improvement on work process. Both processes describe on the value of productivity through big data whereby, professionals can eradicate repetitive of duplication of work as well as strategically improve and shorten overall work process. Nonetheless, discussion on productivity are commonly entangled with elements of automation while from the QS perspective, automation discussion scope is addressed as part of data driven decision making context. However, this does not convolute towards understanding bias but the opposite, it clarifies the context of productivity in relation to profession's progress in big data pursuance. Perhaps, accounting profession is much more advanced in terms of big data pursuance whereby accountants adopt and assimilate modern technology as part of their work process chain, enabling larger work scope area to be automatically replaced hence, greater output value in terms of productivity.

Next, findings reflect that big data value is not limited towards better understanding on work context, transparency and analytical analysis on decision making, but expands towards creating alternative in boosting professional's value; financially. Theoretical findings indicate that professionals commonly generate value strictly towards traditional services such as book keeping on financial management or treating patient. However, with big data, accountant and doctors can expand towards new revenue generation stream. Association of Chartered Certified Accountants (2013) and Dynamic Markets (2012) discussed on the advancement of big data adaptation in the financial sector allow accountants to grow towards new service such as data valuation; ciphering data monetary worth. Medical profession seen to share their data to pharmaceutical companies to allow faster and effective drugs development and diagnosis (Raghupathi & Raghupathi, 2014). In similar, findings in section 4 indicates the potential of construction data commercialization for QS profession, not only geared towards improving overall QS professionalism service credibility but, adding towards new revenue steam.

Finally, no correlation was made to transforming or revolutionizing big data value from the theoretical stand as findings from transcribed indicates none of the respondents mentioned or described this context. However, this conjures towards issues highlighted by respondents in productivity section. While discussion indicates that some interviewees have deep understanding on big data by postulating the possibility of BIM connection and adaptation of advanced statistical technology to improve the productivity value, research position on technology paucity is further clarified through this discussion. Discussion on auditing and proactive healthcare indicates that professionals require maximization of modern technology as part of big data pursuance. Both cases show that optimum value of big data can be achieved when both parties; insights from big data champion (initiator) and big data users collide. For instance, live auditing and proactive healthcare is founded upon big data system which understand user's data pattern. Anthology of user data will then be further analysed with current real-time user data using advanced algorithm to generate valuable insights. In short, it can also be deduced that new data stream such as user's data allows transformation or revolutionizing big data value.

This research further agrees with Ahmed et al (2017), Chen, Lu, & Liao (2017) and Singh (2017) connoting big data research in construction industry is at infancy. Extending to this, the infancy stage of big data leads towards limitation of QS professional's pursuance on big data. Nonetheless, this does not mean that there is minimal capability for QS professionals to maximize big data. Instead, this indicates that progressive call towards modern technology implementation and understanding of big data is critical for QS profession to move forward with big data. Hence, this section expands the context of understanding big data value specifically from QS profession point of view. Analysis posit consistent big data value across professions despite differences in context on how value is derived. This is because context or service area depend upon professional's work sector. The findings further adjourn towards big data as a universal form of technology (Manyika et al., 2011) and maximization of big data value owed to professional's capability and strategic pursuance.

6. Conclusion

This paper aims to expand big data knowledge from the context of QS profession. Rapid pursuance on big data research across industry and professional sectors creates a gap to delineate big data from QS profession perspective. The criticality of this study is further emphasized by the modern technology wave uptake in the construction industry which results towards change in data landscape. This calls for professionals, especially QS profession to be equipped with capabilities to reap the advantage of this technological wave. Big data is here and not something of the future thus QS profession must be prepared.

Findings of this research indicates four generic big data value across professions. Those are process improvement, creating better services, transforming or revolutionizing profession and new opportunities creation. Data based on 15 interviews with QS profession big data experts reveals generic big data values were addressed in similar context despite differences in the way big data values were described and established. Specific big data values such as comprehensive big data insights, data driven decision making, productivity improvement and data commercialization opportunity correlates towards the generic findings except for transforming or revolutionizing profession. In relation to previous research, this research believes that the paucity is reasoned to the infancy stage of big data adaptation in the construction industry.

Most importantly, findings indicate that the specific big data value recognized are related towards improving current services offered by QS professionals. This can be clearly seen through discussion on big data value in presented in the foregoing section. Each big data value is discussed concurrently or emerged in relation to embodied issues in the construction industry. From a second point of view, big data is seen to soothe or offer alternative to limitations faced by QS professional in delivering paramount service to client. This infer that each specific big data value is targeted towards managing QS professional's core service hence, strategic positioning for this profession to capitalize big data. Despite rests upon infancy stage, should big data continuously embrace by QS profession, this profession is geared with impetuous leap in advancing big data.

This study has shown that big data is relatable and can be further maximized by QS professionals. However, with an eye moving forward with big data, future research should address the potential areas of big data application in QS profession context. In relation to the above, development of big data in the construction industry context, specifically adaptation on modern technology in construction value chain is deemed to furnish synergistic impact on QS profession big data maximization. It is also critical to note that the application of five analysis stages of framework analysis facilitate data coding process in the sense that it gives a structure to enable concurrent weaving of generic big data value based on theoretical point of view and data gathered from the respondents. Other than that, framework analysis method helps to provide transparency in qualitative analysis.

References

Addo-Tenkorang, R., & Helo, P. T. (2016). Big Data Applications in Operations/Supply Chain Management: A Literature Review. *Computers and Industrial Engineering*, *101*, 528–543. https://doi.org/10.1016/j.cie.2016.09.023

Ahmed, V., Tezel, A., Aziz, Z., & Sibley, M. (2017). The Future of Big Data in Facilities Management: Opportunities and Challenges. *Facilities*, *35*(13/14), 725–745. https://doi.org/10.1108/F-06-2016-0064

Association of Chartered Certified Accountants. (2013). *Big data : its power and perils*. Retrieved from http://www.accaglobal.com/content/dam/acca/global/PDF-technical/futures/pol-afa-bdpap.pdf

Basoglu, K. A., & Hess, T. J. (2014). Online Business Reporting: A Signaling

Theory Perspective. *Journal of Information Systems*, *28*(2), 67–101.

Benson, R. J., Bugnitz, T. L., & Walton, W. (2004). *From Business Strategy to IT Action: Right Decisions for a Better Bottom Line*. Hoboken, New Jersey: John Wiley & Sons.

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. https://doi.org/10.1016/j.aei.2016.07.001

Bourmistrov, A., & Kaarbøe, K. (2013). From comfort to stretch zones: A field study of two multinational companies applying "beyond budgeting" ideas. *Management Accounting Research*, *24*(3), 196–211. https://doi.org/10.1016/j.mar.2013.04.001

Braun, V., & Clarke, V. (2006). Using Thematic Analysis is Psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.

Brown, B., Chui, M., & Manyika, J. (2011). Are you Ready for the Era of Big Data. *McKinsey Quarterly*, (October).

Bryman, A. (2004). *Social Research Methods* (2nd ed.). New York: Oxford University Press.

Cao, M., Chychyla, R., & Stewart, T. (2015). Big data analytics in financial statement audits. *Accounting Horizons*, *29*(2), 423–429. https://doi.org/10.2308/acch-51068

CEBR. (2012). *Data equity Unlocking the Value of Big Data*. *Centre for Economics and Business Research*. https://doi.org/10.1108/MIP-05-2012-0055

Chan, W. C. (2003). Stock price reaction to news and no-news: Drift and reversal after headlines. *Journal of Financial Economics*, *70*(2), 223–260. https://doi.org/10.1016/S0304-405X(03)00146-6

Chang, R. M., Kauffman, R. J., & Kwon, Y. (2014). Understanding the Paradigm Shift to Computational Social Science in the Presence of Big Data. *Decision Support Systems*, *63*, 67–80. https://doi.org/10.1016/j.dss.2013.08.008

Chawla, N. V, & Davis, D. A. (2013). Bringing Big Data to Personalized Healthcare:Patient-centered framework. *Journal of General Internal Medicine*, *28*(3), 660–665. https://doi.org/10.1007/s11606-013-2455-8

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. *MIS Quarterly*, *36*(4), 1165–1188. https://doi.org/10.1145/2463676.2463712

Chen, X., Lu, W., & Liao, S. (2017). A Framework of Developing a Big Data Platform for Construction Waste Management: A Hong Kong Study. *Proceedings of the 20th International Symposium on Advancement of Construction Management and Real Estate*, 1069–1076. https://doi.org/10.1007/978-981-10-0855-9_94

Comuzzi, M., & Patel, A. (2016). How Organisations Leverage Big Data: A Maturity Model. *Industrial Management & Data Systems*, *116*(8), 1468–1492. https://doi.org/10.1108/IMDS-12-2015-0495

Cox, M., & Ellsworth, D. (1997). Managing Big Data for Scientific Visualization. *ACM Siggraph, MRJ/NASA Ames Research Center*.

Digital News Asia. (2013). Big Data Spells Big Opportunity for Finance Profession: ACCA. Retrieved November 18, 2017, from https://www.digitalnewsasia.com/tech-at-work/big-data-spells-big-opportunity-for-finance-profession-acca

Du, D., Li, A., & Zhang, L. (2014). Survey on the applications of big data in Chinese real estate enterprise. *Procedia Computer Science*, *30*, 24–33. https://doi.org/10.1016/j.procs.2014.05.377

Dynamic Markets. (2012). Data and the CFO: A Love/Hate Relationship. Retrieved October 19, 2017, from www.sas.com/reg/gen/uk/big-data?page=dynamic%3E

Elkins, A. C., Derrick, D. C., Burgoon, J. K., & Nunamaker, J. F. (2012). Predicting users' perceived trust in Embodied Conversational Agents using vocal dynamics. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 579–588. https://doi.org/10.1109/HICSS.2012.483

Forbes Insights. (2015). Betting on Big Data: How the Right Culture, Strategy and Investments Can Help You Leapfrog the Competition. *Forbes Insights*, 30. Retrieved from http://images.forbes.com/forbesinsights/StudyPDFs/Teradata-BettingOnBigData-REPORT.pdf

Girshick, R., Donahue, J., Darrell, T., & Malik, J. (2014). Rich feature hierarchies for accurate object detection and semantic segmentation. *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 580–587. https://doi.org/10.1109/CVPR.2014.81

Groves, P., Kayyali, B., Knott, D., & Van Kuiken, S. (2013a). *The "big data" revolution in healthcare: accelerating value and innovation*. *McKinsey Global Institute*. https://doi.org/10.1145/2537052.2537073

Groves, P., Kayyali, B., Knott, D., & Van Kuiken, S. (2013b). *The Big Data Revolution in Healthcare*. *McKinsey & Company*. Retrieved from https://www.ghdonline.org/uploads/Big_Data_Revolution_in_health_care_2013_McKinsey_Report.pdf

Hafiz, A., Lukumon, O., Muhammad, B., Olugbenga, A., Hakeem, O., & Saheed, A. (2015). Bankruptcy Prediction of Construction Businesses: Towards a Big Data Analytics Approach. In *2015 IEEE 1st International Conference on Big Data Computing Service and Applications* (pp. 347–352). https://doi.org/10.1109/BigDataService.2015.30

Hathaway, S. (2014). ACCA Comment: Why big data matters for accountants. Retrieved October 16, 2017, from http://www.cityam.com/article/1397690791/acca-comment-why-big-data-matters-accountants

Holton, C. (2009). Identifying disgruntled employee systems fraud risk through text mining: A simple solution for a multi-billion dollar problem. *Decision Support Systems*, *46*(4), 853–864. https://doi.org/10.1016/j.dss.2008.11.013

IBM. (2012). IBM big data platform for healthcare.

IBM. (2013). *Data-Driven Healthcare Organizations Use Big Data Analytics for Big Gains*. Retrieved from http://www03.ibm.com/industries/ca/en/healthcare/documents/Data_driven_healthcare_organizations_use_big_data_analytics_for_big_gains.pdf

Ismail, S. A., Bandi, S., & Maaz, Z. N. (2018). An Appraisal into the Potential Application of Big Data in the Construction Industry. *International Journal of Built Environment & Sustainability*, *5*(2), 152–161. https://doi.org/10.11113/ijbes.v5.2.274

Kiron, D., Prentice, P. K., & Ferguson, R. B. (2014). Raising the Bar With Analytics. *MIT Sloan Management Review*, *55*(2), 28–34.

Knowledgent. (2014). *Big Data and Healthcare Payers*. Retrieved from https://knowledgent.com/wp-content/uploads/2014/07/Big-Data-and-Healthcare-Payers-Whitepaper.pdf

KPMG. (2016). *Building a Technology Advantage. Harnessing the Potential of Technology to Improve the Performance of Major Projects*. *Global Construction Survey 2016*. Retrieved from https://assets.kpmg.com/content/dam/kpmg/tr/pdf/2016/11/tr-global-construction-survey-2016.pdf

Lasrado, J. (2018). Five Technologies That Are Changing The Construction Industry. Retrieved September 18, 2018, from https://www.forbesmiddleeast.com/en/five-technologies-that-are-changing-the-construction-industry/

Maaz, Z., Bandi, S., & Amirudin, R. (2018). Potential Opportunities and Future Directions of Big Data in The Construction Industry. In *South East Asian Technical University Consortium 2018* (pp. 1–8). Yogjakarta: IEEE.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). *Big data : The next frontier for Innovation , Competition, and Productivity*.

Mayew, W. J., & Venkatachalam, M. (2012). The power of voice: Managerial affective states and future firm performance. *Journal of Finance*, *67*(1), 1–44. https://doi.org/10.1111/j.1540-6261.2011.01705.x

McAfee, A., & Brynjolfsson, E. (2012). Big Data: The Management Revolution. *Harvard Buiness Review*, *90*(10), 61–68. https://doi.org/10.1007/s12599-013-0249-5

Metaxas, D., & Zhang, S. (2013). A review of motion analysis methods for human nonverbal communication computing. *Image and Vision Computing*, *31*(6–7), 421–433. https://doi.org/10.1016/j.imavis.2013.03.005

Mittermayer, M.-A. (2004). Forecasting Intraday stock price trends with text mining techniques. *37th Annual Hawaii International Conference on System Sciences, 2004. Proceedings of The*, *00*(C), 1–10. https://doi.org/10.1109/HICSS.2004.1265201

Murdoch, T. B. T. B., & Detsky, A. S. A. S. (2013). The inevitable application of big data to health care. *Jama*, *309*(13), 1351–1352. https://doi.org/10.1001/jama.2013.393

New Vantage Partners. (2012). *Big Data Executive Survey 2012*. *Big Data Executive Survey*.

Radhakrishnan, R., Divakaran, A., & Smaragdis, P. (2005). Regunathan Radhakrishnan , Ajay Divakaran and Paris Smaragdis Mitsubishi Electric Research Labs. *Signal Processing*, 158–161.

Raghupathi, W., & Raghupathi, V. (2014). Big data analytics in healthcare: promise and potential. *Health Information Science and Systems*, *2*(1), 3. https://doi.org/10.1186/2047-2501-2-3

Ritchie, J., & Spencer, L. (1994). Qualitative Data Analysis for Applied Policy Research. In *Analyzing Qualitative Data* (pp. 173–194). London: Routledge.

Saldaña, J. (2009). *The Coding Manual for Qualitative Researchers*. London: SAGE Publications.

Savage, N. (2012). Digging for drug facts. *Communications of the ACM*, *55*(10), 11. https://doi.org/10.1145/2347736.2347741

Singh, P. (2017). Big Data Can Transform The Construction Industry. Here's How. Retrieved July 12, 2018, from https://analyticsindiamag.com/big-data-can-transform-construction-industry-heres/

The Economist. (2011). Building With Big Data.

Torpey, D., Walden, V., & Sherrod, M. (2009). Fraud Triangle Analytics. *Fraud Magazine*.

Torralba, a, Fergus, R., & W., F. (2008). 80 Millions Tiny Images: a Large Dataset for Non-Parametric Object and Scene Recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *30*(11), 1958–1970. https://doi.org/10.1109/TPAMI.2008.128

Ularu, E. G., Puican, F. C., Apostu, A., & Velicanu, M. (2012). Perspectives on Big Data and Big Data Analytics. *Database Systems Journal*, *III*(4), 3–14. https://doi.org/10.5406/jaesteduc.46.4.iii

Vasarhelyi, M. A., Kogan, A., & Tuttle, B. M. (2015). Big data in accounting: An overview. *Accounting Horizons*, *29*(2), 381–396. https://doi.org/10.2308/acch-51071

Warren, J. D., Moffitt, K. C., & Byrnes, P. (2015). How big data will change accounting. *Accounting Horizons*, *29*(2), 397–407. https://doi.org/10.2308/acch-51069

World Economic Forum. (2011). *Personal Data : The Emergence of a New Asset Class*. *World Economic Forum*. Retrieved from http://www.weforum.org/reports/personal-data-emergence-new-asset-class

Zenger, B. (2012). Can Big Data Solve Healthcare's Big Problems?