

Business Intelligence Deployment and Firm Performance: Literature Review of Empirical Evidences

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Abstract: The main objective of this research is to empirically review recent studies on business intelligence deployment and its impact on firm performance based on two cardinal perspectives: (i) passage of time and themes, and (ii) research methodology adopted. The literature review took global dimension as it covered all geographical parts of the world. Twenty (20) empirically related studies were reviewed from 2004 – 2020 (17 years' period). In geographical bread, four (4) of the empirically reviewed researches (representing 20%) originated from African countries; six (6) of the empirically reviewed researches (representing 30%) originated from Asian countries; another six (6) of the empirically reviewed researches (representing 30%) originated from European countries; two (2) of the empirically reviewed researches (representing 10%) originated from North American country (USA); one (1) of the empirically reviewed researches (representing 5%) originated from South American country (Brazil); and another one (1) of the empirically reviewed researches (representing 5%) originated from Australia. The major findings of the study include the following: (i) there is dearth of research on secondary data collection instrumentation; (ii) there is dearth of theoretical backed business intelligence related studies; (iii) the number of quantitative and mixed researches in business intelligence as a whole is very small; and (iv) there is absence of comparative business intelligence studies incorporating technological, organizational, and environmental variables. It is the recommendation of the study that these observed gaps in literature be empirically bridged.

Keywords: Business Intelligence, Deployment, Empirical Evidences, Firm Performance, Literature Review

I. INTRODUCTION

Business Intelligence (BI) has multiplicity of definitions or meanings depending from the view point being looked at: technological, organizational, managerial, process, or product. The development and democratization of business intelligence software makes it possible for people that lack high level of technical competence to be able to analyze and have good understanding of data; and such persons only need little assistance from information technology units to have access to organizational reports that would aid them in data-driven decision making process (Lebied, 2017). The fundamental underpin of this empirical review is anchored on the premise that business intelligence (BI) technology brings about different processes of value creation in an organisation via the instrumentality of data-driven business decision-making (Fink, Yogev & Even, 2017). Business intelligence appears to

be among the most promising technologies in recent years in terms of value creation to organisations that deploy it (Kappelman, McLean, Luftman & Johnson, 2013). Despite the huge investment in business intelligence and the expected value perception originating there from, little empirical research has addressed the value creation processes unique to business intelligence systems (Eckerson, 2008; Wixom & Watson, 2001). Popovič, Turk and Jaklič (2015) stated that one major aim of information technology managers is how to quantify the added value through investment in new technologies (business intelligence inclusive); and Grover, Teng, Segars and Fiedler (1998) added that this has become a problematic issue to information technology researchers and managers as a result of different varieties of computing value added, presence of multiple intervening variables, productivity measurement challenges, and the treatment of business intelligence infrastructure investments as a lump sum. It is equally very worrisome that there seems to be very insignificant discussions on the benefits of business intelligence investments to business and non-business organisations (Davenport & Short, 2003; Dewett & Jones, 2001; Li & Ye, 1999; Williams & Williams, 2007).

Lonnqvist and Pirttimaki (2006) are of the opinion that deploying business intelligence cost huge resources (money, time, and energy) but that the benefits from such huge investment is not practically clear to businesses. One possible explanation for this is lack of empirical studies on cost-benefit analysis of business intelligence deployment in quantitative terms due to no suitable measurement methods and lack of resources (qualified personnel, fund, BI tools, and etcetera) for the exercise (Lonnqvist & Pirttimaki, 2006). According to reviewed literature, business intelligence quantification has two fundamental objectives: (i) it helps in establishing the worthiness of investing in business intelligence technology (Sawka, 2000); and (ii) it helps in managing the business intelligence process efficiently by ensuring that business intelligence products meet the needs of users (Herring, 1996). While it is easier to compute the costs of business intelligence systems, it is harder to compute its benefits because BI benefits cannot be measured in the market directly (Lonnqvist & Pirttimaki, 2006). Williams and Williams (2007) asserted that investments in business intelligence systems deliver greater value when its business value (economic importance)

is well factored-in prior to its deployment. Gibson, Arnott and Jagielska (2004) stated that a situation where the huge investment in business intelligence have not being linked to have significant effect on firm productivity is technically called “productivity paradox” while Willcocks (1992) regrets a situation where corporate managers cannot establish the returns made on business intelligence investment. Although some efforts have been made to capture how business intelligence creates business value, it is better to end by saying that there is much to know about the value creation capacity of business intelligence (BI) because its business value is yet to be fully studied (Fink, Yogev & Even, 2017).

Organizations need to realize that data has value (Livingston, 2017); and in order to quantify the success attributable to BI-induced decisions, it is imperative to establish a “statistically significant and incremental value” of BI-driven decisions with intrinsic measures that matter in determining organizational overall performance, growth and sustainability (Lyke-Ho-Gland, 2017). Wahua, Tsekpo and Anyamele (2018) also stressed the need for quantitative researches. Lyke-Ho-Gland (2017) developed three measures for capturing the value of BI-driven decisions by organisations (after observing how firms struggled to establish performance measures and return on investment of their BI deployment); and this is because best-practice firms mostly adopt a combination of measures in three primary categories:

- i. Behavioral change measures: shifting from a traditional decision-making approach to a BI-driven culture amounts to altering the norms and behaviors of staff; as such, firms should factor-in employees’ behavioral change in computing the value of data-driven decision making. This is because such approach helps in monitoring the adoption rates of new norms and practices. Relevant measures include: (a) action items and number/types of actions taken based on data analytics; (b) utilization/consumption to track the use/download of data analytics; (c) number of service requests (repeat and new) for data analytics; and (d) number of employees requesting training in the area of data analytics.
- ii. Analytics performance measures: Analytics performance measures focus on the efficacy of BI-driven decisions and how well they accomplish their goals. For many firms, the cost-benefit analysis or return on investment (ROI) computation is adequate to ascertaining the efficacy of data-driven decisions. Analytics performance measures typically include the following: (a) prediction or accuracy model: how does change in X affect Y? (b) A/B comparatives model: how does sample A differ from the whole B? (c) Cost/benefit analysis model: how does cost differ from returns on investment? (d) Stakeholder utility model: how does expectation differ from actual?

- iii. Business performance measures: In measuring BI-driven decisions, it is vital to use business performance indicators that decision-makers find appropriate and sound; such as valued added, profitability, revenue, cost, customer retention or cycle time.

Data for decision making come in two forms (qualitative and quantitative) and two of them are very important in making data-driven business decisions despite the fact that qualitative data are observed rather than measured while quantitative data are numbers (Lebied, 2017). Data driven business decisions, which is anchored on quality data, can make or break organisations; as such, decision makers should be very ‘intelligent’ in applying data in decision-making processes. Lebied (2017) identified nine tips for an enhanced data driven decision-making strategy in corporate world: (i) guarding against individual biases; (ii) defining objectives properly; (iii) gathering data in a timely manner; (iv) finding the unresolved questions; (v) finding the data needed to solve these questions; (vi) analyzing data and understanding outcomes; (vii) not being afraid to revisit and re-evaluate; (viii) presenting the data in a meaningful and professional way; and (ix) setting measurable goals for decision making. Data-driven-culture (or technically called an analytics-driven culture) is anchored on the premise that every business decisions should rely on data. Altexsoft (2017) adds that the following attributes of business intelligence should define a corporate culture that is data-driven: (i) opinions and assumptions can be changed based on data; (ii) organisations embrace improvements suggested by data; (iii) employees can manage data independently; (iv) data analysis for informed decisions is a part of everyone’s job; (v) data is organized, accessible, and of a high quality; (vi) each opinion is supported by numbers and data; (vii) every employee can access data that relates to them; and (viii) reports are replaced with interactive analytics tools. Sclater, Webb and Danson (2017) believe that data is the currency in research and knowledge-sharing; data digitalization offers immense opportunities for organisations to improve their decision-making through application of historical data or machine learning techniques in generating business predictive models for enhanced organizational sustainability; and that the future of data-based business decision making should promote enhanced real-time decision support, organizational efficiency and value for money, and enhanced integrated data innovation strategy.

Although BI has become a new information systems (IS) fashion since the late 2000s, there is a large discrepancy between the industry popularity of BI and the extent of academic research on BI. Empirical studies on BI are still scarce in academic research; the significance of business intelligence (BI) is also uncertain both in industry and in academic; and existing BI studies show inconsistent results of BI’s contribution to organizational performance (Watson, Goodhue & Wixon, 2002, Watson, Wixon, Hoffer,

Anderson-Lehman, & Reynolds 2006; Gessner & Volonino, 2005). Studies have shown that companies that invested in BI and matched it with scrupulous practices have seen increased revenue and enormous cost savings (Watson et al. 2006). Nevertheless, some other companies that invested in business intelligence (BI) did not reap the promised benefits (Watson et al. 2002; Gessner & Volonino, 2005; Lonnqvist & Pirttimaki, 2006). Jourdan, Rainer, and Marshall (2008) reviewed business intelligence (BI) literature up to 2006 and noted that although there had been much published BI researches, BI-related research was still in the early stage (that is, exploratory state). Although a BI-based organization has been proposed (Watson, 2009; Wixom & Watson, 2010), there is a lack of empirical studies on why organizations need to be BI-based and how other internal resources interact with BI to deliver a superior return on investment. There is also a paucity of empirical BI academic research on why BI is important. The lack of empirical research on why BI is important makes the rationale to invest in BI weak, especially when researches show inconsistent returns on investment in BI.

The main objective of this research is to empirically review recent studies on business intelligence deployment and its impact on firm performance based on two cardinal perspectives: (i) passage of time and themes, and (ii) research methodology adopted. The literature review took global dimension as it covered all geographical parts of the world.

II. EMPIRICAL REVIEW

Selected Studies on Business Intelligence and Firm Performance

This empirical review took global dimensions as it covered countries from all parts of the world. Twenty (20) empirically related studies were reviewed from 2004 – 2020 (17 years' period). In geographical bread, four (4) of the empirically reviewed researches (representing 20%) originated from African countries; six (6) of the empirically reviewed researches (representing 30%) originated from Asian countries; another six (6) of the empirically reviewed researches (representing 30%) originated from European countries; two (2) of the empirically reviewed researches (representing 10%) originated from North American country (USA); one (1) of the empirically reviewed researches (representing 5%) originated from South American country (Brazil); and another one (1) of the empirically reviewed researches (representing 5%) originated from Australia. The review of closely related empirical works to this study follows two cardinal perspectives:

- i. Passage of time and themes, and
- ii. Research methodology adopted

Empirical Review of Related Literature by Passage of Time/Themes

This sub-section of the empirical review covered related works from 2004 – 2020 (17 years' timeframe). In Brazil, a

South American country), Petrini and Pozzebon (2004) established that only few firms have adopted business intelligence as at 2004; and they recommended that further studies should consider the quantification of business intelligence's effect on the performance of businesses. In Australia (a country in the Oceania Australian continent), Yeoh, Koronios and Gao (2008) looked at the critical success factors for the implementation of business intelligence among engineering assets management organisations; and recommended that further studies should consider aligning business intelligence implementation to business performance. In European country of Slovenia, Popovič, Turk and Jaklič (2010) 'proposed' a conceptual model to measure the impact of business intelligence systems on companies' business value creation. Again, Slovenia, Popovič, Turk and Jaklič (2010) recommended that that further studies should empirically test the conceptual model the developed on how to quantitatively measure the impact of business intelligence deployment on business performance. In Italy (another European country), Lorenzetti (2010) also called for further studies to adopt predictive approach in measuring and establishing the impact/effect of business intelligence investment on financial sector performance. Lorenzetti (2010) was very specific that the financial sector should form the cardinal point for predictive BI studies because they are highly regulated, use large data, and provide online real time services to local and foreign customers. It is their expressed opinion that business intelligence application could help in detecting, mitigating, and managing banking risks/crises.

The critical business intelligence empirical issue raised by Petrini and Pozzebon (2004), Yeoh, Koronios and Gao (2008), Popovič, Turk and Jaklič (2010), Lorenzetti (2010) within 2004 – 2010 were answered by subsequent studies carried out from 2011 to 2020 by Brynjolfsson, Hitt, and Kim (2011), Ahmad (2011), Mohammad (2012), Felder (2012), etcetera. In the Unites States of America, a North American country, Brynjolfsson, et al. (2011) quantitatively examined the impact of business intelligence on firm performance; and established that established that firms that applied business intelligence technology have output and productivity that is 5 - 6% higher than what would be expected given their other investments and information technology usage. Brynjolfsson, et al. (2011) advised that the study should be replicated in other economies (emerging and developed) for generalization purpose. In similar work by Felder (2012) in the United States of America re-echoed the need for further investigation into the impact of business intelligence technology investments on organizations' performance. One salient point on the submission of Felder (2012) is the pin-pointing of BI technology investments. Continuing the discussion as started by Brynjolfsson, et al. (2011), Fink, Yogevev and Even (2017) in and attempt to bridge the gap between information technology (IT) value creation and business intelligence (BI), established that business intelligence (hardware, software, and BI employees) create business value for Israeli firms. Fink, Yogevev and Even (2017) also recommend that further studies

should objectively use longitudinal data, specific industry/firm factors, and more sample size. Fink, Yogev and Even (2017) separated business intelligence technology investments into hardware, software and other personnel related hardware-software costs (training and other human-related costs).

In the South-East Asian country of Malaysia, Ahmad (2011) quantitatively investigated the impact of business intelligence deployment on sustainable competitive advantage of telecommunication firms in the country. Ahmad (2011) established that there is a direct positive relationship between business intelligence deployment and use of knowledge in sustaining competitive advantage by Malaysian telecommunication companies. The demand by Ahmad (2011) that further studies should investigate the moderating roles of organizational culture, business strategy and business intelligence tools on firm performance is still unresolved. Cardinals of business intelligence tools are hardware, software, and people (Lonnqvist & Pirttimaki, 2006; Fink, Yogev & Even, 2017). Johansson and Nilsson (2013) aligned with Ahmad (2011) somewhat, and specifically suggested that there is need to empirically integrate external variables in investigating the impact of business intelligence on business performance. One critical external factor that should be incorporated in studying financial sector's business intelligence impact is the internationalization of banking operations (this is because banking operations cut across countries and international boundaries). In Jordan, an Arab country in Western Asia, Mohammad (2012) investigated the impact of business intelligence on the quality of decision making using data from sample firms in the country; and observed that business intelligence has a significant positive effect on quality of decision because it results to quality information. This is supported by the works of Přikrylová (2016) and Al-ma'aitah (2013). Mohammad (2012) did not actually study firm performance; but firm decision-making output. Mohammad (2012) and Al-ma'aitah (2013) recommended that further studies should measure the impact of business intelligence in achieving competitive performance. The work of Brynjolfsson, et al. (2011) somewhat bridged this gap since output and productivity are strong indicators of competitive performance.

Research Gaps from empirically Reviewed works by Passage of Time/Theme

In concluding this segment of the research, the demand by Brynjolfsson, et al. (2011) that the impact of business intelligence on firm performance should be replicated in other emerging and developed economies was attended to by Wahua and Yonney (2020) using only Nigerian banks with international operating license as case studies. The study by Wahua and Yonney studied single economy alone; and it did not cover the whole commercial banks in the country. Therefore, there is need to integrate other countries in a comparative study in order to ascertain holistic empirical findings. The demand by Ahmad (2011) that further studies should investigate the moderating roles of organizational

culture, business strategy and business intelligence tools on firm performance is still unresolved. The demand by Johansson and Nilsson (2013) that there is need to empirically integrate external variables is still outstanding. The demand by Fink, Yogev and Even (2017) that further studies should use objective longitudinal data, specific industry/firm factors, and more sample size is yet to be filled.

Review of Related Literature by Research Methodology Adopted

This section of the research takes a critical and analytical look at the research methodologies adopted in related studies. It applies worldwide overview covering twenty (20) related articles spanning from 2004 – 2020 (17 years' timeframe). In an examination of the factors influencing the use of business intelligence and data-driven decisions (analytics) within organisations in South Africa, Lautenbach, Johnston and Adeniran-Ogundipe (2017) adopted quantitative research methodology. The study made use of survey (questionnaire) in gathering data; applied technology-organisation-environment (TOE) theoretical framework. Fink, Yogev and Even (2017) equally applied quantitative research technique in bridging the gap between information technology value creation and business intelligence among Israeli firms. The research anchored on resourced-based theoretical framework; and data was collected using survey questionnaire and interview. To bridge the limitations in the study, the authors advised that further studies should be objective and use longitudinal data, specific industry/firm factors, and more sample size. Objective data are prone to quantitative studies; and longitudinal data relates to secondary data; firm/industry factors are mostly quantitative in nature. In essence, Fink, et al. (2017) is calling for more quantification of BI studies. Přikrylová (2016) also applied qualitative research approach in analyzing selected scientific research papers (which are related to business intelligence framework) in order to establish the role of BI in marketing decision-making processes in Czech Republic. The study had no theoretical underpin; and applied qualitative content analysis-research instrument or mode of interpretation. The use of content analysis as an instrument for data collection is supported by Mayring (2002).

The work of Rama, Zhangb and Koroniosc (2016) which examined the role and implication of Big Data analytics on business intelligence among selected Chinese firms used questionnaire as a data collection tool. The study applied qualitative research technique and is not based on any specific theoretical framework. To forestall the shortcoming of qualitative research method, Rama, et al. (2016) suggested that further studies should apply quantitative approach and longitudinal data to empirical investigate the impact of business intelligence on organizational performance in quantitative terms. In Micheni (2015), qualitative research approach was equally applied in examining the adoption of cloud computing teaching technique (a business intelligence component) among institutions of higher learning in Kenya.

The study applied the technology-organisation-environment (TOE) theoretical model, and used content analysis research instrument (literature review) in gathering relevant data. In an investigation into the factors that determine acceptance of operational business intelligence by organisations in Netherlands, Oei (2014) used qualitative research approach and the Unified Theory of Acceptance and Use of Technology (UTAUT) theoretical framework. Oei (2014) concluded by advocating the testing of the Unified Theory of Acceptance and Use of Technology (UTAUT) theoretical framework empirically (quantitatively) in order to establish its relevance in business intelligence studies. The study applied content analysis (literature review as a data collection instrument). The work of Amoako (2013) which investigated the impact of adoption of business intelligence systems on the Electricity Company of Ghana's strategic decision-making adopted qualitative research; interview as a research instrument; and based on no specific theoretical framework.

Johansson and Nilsson (2013) also adopted qualitative research approach in assessing business intelligence practices in large Swedish organizations. Interview served as the data collection instrument. The study was not theoretically grounded. The study further called for the application of quantitative research technique to empirically establish the values of business intelligence adoption to businesses and other organisation. An attempt by Al-ma'aitah (2013) to reveal the impact of using business intelligence strategy on the decision making process among selected firms in Jordan adopted mixed research technique (qualitative and quantitative research techniques); and data were collected with the aid of interview and secondary analysis. The research has no theoretical underpin. Sabbour, Lasi and Tessin (2012) equally adopted qualitative research technique in exploring business intelligence's visual interactive simulations as decision support tool for strategic decision making among selected firms in Germany. The study is not grounded in any theory and data were basically collected via interviews. It is the recommendation of the study that further studies should incorporate business intelligence in the line of cost (quantification and secondary data) and strategic perspective. The seminal work of Mohammad (2012) applied quantitative research technique in investigating the impact of business intelligence and decision support on the quality of decision making using data from sample firms in Jordan. Questionnaire and secondary data analysis techniques were adopted as the research instruments, but the study was not based on any theoretical underpin. Felder (2012) used qualitative research approach; and adopted interview as a research instrument in an exploration of the perceptions of pastoral leaders concerning the potential usefulness of business intelligence in church organizations. The study lacks theoretical underpin. The study suggested that further studies should be carried out to quantitatively measure the impact of BI technology cost on non-profit making entities.

Ahmad (2011) applied mixed research approach to empirically examine the association between business intelligence deployment and sustainable competitive advantage of selected Malaysian telecommunication firms. Three theoretical frameworks (resource-based, diffusion of innovation, and information system success theories) guided the research; and data were collected with the aid of interview and questionnaire. In an examination to ascertain if United States of America's firms that emphasize data driven decision making (or DDD) show higher performance, Brynjolfsson, et al. (2011) applied quantitative research method based on two theoretical frameworks (information theory and economic theory); and the research instrument comprised of questionnaire and secondary data analysis. The study called for more quantification of business intelligence studies with broader comparative economies. An attempt by Lorenzetti (2010) to measure the importance of business intelligence data analysis in Italian financial sector used mixed research approach (quantitative and qualitative research methods). The study lacks a clearly defined theoretical framework and used both survey and secondary analysis as research instruments for data collection. It is the suggestion of the study that further studies should adopt predictive approach (that is, quantitative method) in measuring the impact of business intelligence investment on financial sector performance. The work of Popovič, Turk and Jaklič (2010) adopted qualitative research method in proposing a conceptual model to assess business value of business intelligence systems using selected Slovenia companies. The study used the following research instruments: content analysis (literature review), interviews, and case studies. It lacked a clearly defined theoretical framework even though it discussed multiple theories. Popovič, et al. (2010) recommended that further studies on business intelligence and business valuation should adopt quantitative mechanism to empirically if BI adds any significant value to businesses.

Qualitative research method was adopted by Yeoh, Koronios and Gao (2008) in investigating the critical success factors for effective implementation of business intelligence in selected engineering assets management organisations in Australia. The Delphi questionnaire approach served as the research instrument; but the work was not grounded in any specific theoretical framework. Yeoh, Koronios and Gao (2008) further recommended that there is need to align business intelligence implementation to business success (performance) using quantitative research method. The qualitative research method was adopted by Petrini and Pozzebon (2004) in examining the degree of implementation of business intelligence among Brazilian companies. Semi-structured telephone interview served as the research instrument for data collection. The study was not based on any specific theoretical framework. It is the opinion of Petrini and Pozzebon (2004) that further research should measure the impact of business intelligence technology on firm performance using quantitative approach. Wahua and Yonney (2020) used quantitative research method in investigating the impact of

business intelligence cost on the performance on selected Nigerian banks. The study used secondary data analysis technique as the research instrument, and it was grounded on economic theoretical framework (a measure of cost benefit analysis of business intelligence cost). The need to replicate this study in different economies was stressed. Roozitalab and Sayadi (2018) applied quantitative research approach in investigating the effect of business intelligence on business value creation among Iranian firms. The study used survey questionnaire as an instrument for data collection; but, it was not hinged on any specific theory. The study called for more quantification of BI studies in order to ascertain its usefulness to businesses and organisations in concrete terms.

Research Gaps from Empirically Reviewed Works by Methodology Adopted

Three cardinal items come up under this sub-review of methodological approaches adopted by previous studies: qualitative or quantitative or mixed research design; theoretical grounding; and research instrumentations.

i. Qualitative or quantitative or mixed research design:

A detailed analysis of the twenty (20) empirically reviewed related literature across the world reveals that six (6) studies (representing 30%) adopted quantitative research approach; eleven (11) studies (representing 55%) adopted qualitative research technique; and three (3) studies (representing 15%) adopted mixed research technique. The studies that adopted quantitative research techniques are Lautenbach, Johnston and Adeniran-Ogundipe (2017), Mohammad (2012), Brynjolfsson (2011), Sabbour, Lasi and Tessin (2012), Wahua and Yonney (2020), and Roozitalab and Sayadi (2018). The studies that applied qualitative research technique are Fink, Yogeve and Even (2017), Příkrylová (2016), Rama, Zhangb and Koroniosc (2016), Micheni (2015), Oei (2014), Amoako (2013), Johansson and Nilsson (2013), Felder (2012), Popovič, Turk and Jaklič (2010), Yeoh, Koronios and Gao (2008), and Petrini and Pozzebon (2004). The studies that applied mixed research technique (blend of qualitative and quantitative approaches) are Al-ma'aitah (2013), Ahmad (2011), and Lorenzetti (2010). It is important to add that Wahua (2020) also stressed the need for quantitative researches in social and management sciences. These empirical descriptions expose the need for more quantitative and mixed researches.

ii. Theoretical grounding:

This study empirically reviewed twenty (20) related works in order to establish the research gaps in literature. In theoretical terms, only seven (7) studies (representing 35%) are theoretically grounded while thirteen (13) of the works (representing 65%) are not theoretically underpinned. These results reveal the critical need to embark on more theoretical backed business intelligence related studies. To bridge this observed gap in literature, this study adopts the technology-organisation-environment (TOE) theoretical framework. The

theoretical frameworks covered in the empirically reviewed literature are: technology-organisation-environment theory (Lautenbach, Johnston & Adeniran-Ogundipe, 2017; Micheni, 2015), economic theory (Brynjolfsson, 2011; Wahua & Yonney, 2020), resourced-based theory (Fink, Yogeve & Even, 2017; Ahmad, 2011), unified theory of acceptance and use of technology (Oei, 2014), diffusion of innovation theory (Ahmad, 2011), and information system success theories (Ahmad, 2011; Brynjolfsson, 2011).

iii. Research instrumentations

The twenty (20) empirical reviewed related literatures also revealed that majority of the works used primary research instruments (questionnaire, interview, and content analysis). In specific terms, fifteen (15) studies (representing 75%) used primary instrument in collecting data; one (1) study (representing 5%) used secondary data analysis instrumentation technique in collecting data; and four (4) studies (representing 20%) used both primary and secondary data collection instrumentation. The dearth of research on secondary data collection instrumentation is very glaring as revealed herein; and the need to bridge the gap cannot be overemphasised. Secondary data are aggregate data of quantities on a higher macro-level (Wagschal & Jackle, 2011); and it is the use of existing quantitative data gathered by others for another purpose (Statistics Netherlands, 2012). The advantages of using secondary data analysis as research instrumentation include the following according to The California State University (secondary data, n.d.): it is unobtrusive research; it may allow the researcher to cover a wider geographic or temporal range; it can allow for larger scale studies on a small budget; it does not exhaust people's goodwill by re-collecting readily available data; secondary data analysis saves time in quantitative data collection; provides larger and higher quality data sets based on availability and easy access; and it captures informative and relevant past changes and developments. Some other contemporary studies that adopted the secondary data analysis technique in data collection include Al-Tamimi and Obeidat (2013), Aspal and Nazneen (2014), and Abusharba, Triyuwono, Ismail and Rahman (2013).

Summary of Research Gaps Extracted from Empirical Review

At the early part of the 21st Century (which started on January 1, 2001), business intelligence was at adoption stage across many countries of the world. The field of business intelligence and its impact on both organizational decision-making and performance is evolving across the world in general and Africa in particular (Al-ma'aitah (2013); and overall business intelligence research is still at its developing phase (Pirttimäki, 2007). Since scholars have established that business intelligence research is an evolving phenomenon, studies on business intelligence research papers mostly adopted surveys with strong focus on western corporations (Johansson & Nilsson, 2013). Very important for consideration is the fact that many business intelligence

publications are linked to institutions with commercial interest in BI (example BI consultancy firms or vendors); as such, these publications majorly focus on the description and promotion of business intelligence applications, techniques, and systems; and not on the quantification of the impact of business intelligence on firm performance (Johansson & Nilsson, 2013).

- i. Pirttimäki (2007) is of the strong opinion that the contents of most write-ups on business intelligence serve business (commercial) interests of originators much more than that of academics; and that there is continues shortage of academic research and theoretical frameworks in business intelligence.
- ii. There is clear absence of pure quantitative investigations into the impact of business intelligence deployment on firm performance. It is very worrisome that despite the huge investment in business intelligence, there is abysmal lack of justifiable quantification of its impact on decision making cum firm performance (Fink, Yogev & Even, 2017; Eckerson, 2008; Wixom & Watson, 2001).
- iii. Majority of the reviewed works are exploratory, qualitative, and lack specific theoretical frameworks. The import of these is that researchers are still struggling to understand what business intelligence is in the first place in order to understand how best to look at it.
- iv. Researchers in Africa and other developing countries seem not to appreciate the need to investigate the importance of business intelligence to business sustainability; and this is because majority of reviewed contemporary works on the twin topics of business intelligence and data-driven decision making are from advanced or western countries.
- v. It is empirical clear that the role of business sustainability in the banking sector is acutely understudied despite the fact that the banking sector is one of such industries with high deployment of business sustainability tool. The study by Lorenzetti (2010) on Italian banking sector points to the importance of business intelligence in detecting, mitigating, and managing banking risks/crises.
- vi. Yeoh, Koronios and Gao (2008) wants business intelligence to be aligned to business success; Lorenzetti (2010) wants a predictive investigation into the impact of business intelligence investment on financial sector performance; Mohammad (2012), and Petrini and Pozzebon (2004) wants a study on the impact of business intelligence technology on firm performance in general.
- vii. Sabbour, Lasi and Tessin (2012) want business intelligence to be measured using cost; Prikrylová (2016) suggests that external variables should be incorporated in business intelligence researches; Fink, Yogev and Even (2017) want objective BI studies with specific industry/firm factors and

reasonable sample size; Johansson & Nilsson (2013) recommended that there is need to empirically establish business intelligence values and tangible benefits while integration external variables; and Lautenbach, Johnston and Adeniran-Ogundipe (2017) want studies that would empirically test the impacts of BI infrastructure and external market influence on organizational performance.

III. CONCLUSION

This empirical review took global dimensions as it covered countries from all parts of the world. Twenty (20) empirically related studies were reviewed from 2004 – 2020 (17 years' period). In geographical bread, four (4) of the empirically reviewed researches (representing 20%) originated from African countries; six (6) of the empirically reviewed researches (representing 30%) originated from Asian countries; another six (6) of the empirically reviewed researches (representing 30%) originated from European countries; two (2) of the empirically reviewed researches (representing 10%) originated from North American country (USA); one (1) of the empirically reviewed researches (representing 5%) originated from South American country (Brazil); and another one (1) of the empirically reviewed researches (representing 5%) originated from Australia. It followed two cardinal perspectives: (i) passage of time and Themes, and (ii) research Methodology Adopted. The study established the following fundamental facts: (i) dearth of research on secondary data collection instrumentation; (ii) dearth of theoretical backed business intelligence related studies; (iii) poor number of quantitative and mixed researches in business intelligence as a whole; and (iv) dearth of comparative business intelligence studies incorporating technological, organizational, and environmental variables. The need to bridge these observes gaps in literature were strongly recommended.

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Appendix

Related Empirical Reviews on Business Intelligence

Author/Year	Objective	Methodology	Theory	Instrument(s)	IV(s)	DV	Finding(s)	Further Studies
Wahua & Yoney (2020): Nigeria	to investigate the impact of BI costs on the performance of selected top banks in Nigeria	descriptive-quantitative	economic theory	secondary data using checklist	Computer yearly depreciation charge; Software yearly amortization charge, and aggregation of the two (BI cost)	profitability, value added and productivity	(i) hardware cost has significant negative effects on value added and productivity; (ii) software cost has significant negative effect on profitability, and significant positive effects on value added and productivity of sampled banks; (iii) overall BI cost has significant negative effect on profitability	Further studies should include more countries and banks, and should adopt other measure of cost like net book value (NBV)
Roozitalab & Sayadi (2018): Iran	to investigate the effect of business intelligence on business value creation	descriptive-survey quantitative study	none	questionnaire	knowledge management, BI operational capabilities, and BI technical capabilities,	business value creation	(i) Operational and strategic BI capabilities have significant positive effects on business value creation; (ii) knowledge management has a significant positive mediating effect on the relationships b/w operational capabilities BI and business value creation, and (iii) knowledge management has a significant positive mediating effect on the relationship between strategic BI capabilities and business value creation.	(i) future studies can rely on population size that is more than 90 participants; (ii) other business value creation methods could be incorporated in further studies; and (iii) other statistical analyses techniques such as hierarchical regression among others

Source: The Author

Related Empirical Reviews on Business Intelligence (continued)

Author/Year	Objective	Methodology	Theory	Instrument(s)	IV(s)	DV	Finding(s)	Further Studies
Lautenbach, Johnston & Adeniran-Ogundipe (2017) (South Africa)	to examine factors influencing BI and analytics (BI &A) use within organisations	positivist & quantitative	technology-organisation-environment (TOE)	survey questionnaire	data Infrastructure, data mgt, top mgt, talent mgt, external market, regulatory compliance	BI &A Usage Extent (BIAUE)	data Infrastructure, top management, external market have significant impact on BIAUE	the impact of data Infrastructure, top management support, and external market influence on organizational performance should be empirically tested
Fink, Yogev & Even (2017) (Israel)	to bridge the gap between information technology (IT) value creation and business intelligence (BI)	exploratory quantitative research	resourced-based	interview & survey	general IT asset & specific BI assets (physical & human)	value creation	BI assets and BI capabilities create business value	further studies should be objective and use longitudinal data; specific industry or firm; & sample size greater than 3
Přikrylová (2016) (Czech Republic)	to analyse scientific research papers related to business intelligence framework and its place in marketing decision-making processes;	qualitative	None	Content Analysis	BI	marketing decisions	well-structured BI models support effective marketing decision-making processes.	further studies should incorporate external variables in studying BI implementation for effective decision-making
Rama, Zhangb & Koroniosc (2016) (China)	to examine the role and implication of Big Data analytics on business intelligence	exploratory & qualitative	None	questionnaire	Big Data analytics	BI	Big Data analytics offers multitude of opportunities to enhance business value and productivity	A quantitative approach to this study using longitudinal data is called for.
Micheni (2015) (Kenya)	to discuss cloud computing in institutions of higher learning in Kenya	exploratory & qualitative	technology-organisation-environment (TOE)	literature review	na	na	TOE Framework is appropriate for the	Further studies should combine the TOE framework with other existing theories on

							technological adoption of cloud computing in institutions of higher learning	technology adoption.
Oei (2014) (Netherlands)	to find factors that determine acceptance of operational BI in organisations	qualitative	unified theory of acceptance and use of technology (UTAUT)	literature review & case study	na	na	operational core, techno-structure & middle management are the key influencers of OpBI acceptance	further studies should empirically apply this model in order to establish generalization from its results
Amoako (2013) (Ghana)	to investigate if the adaptation of BI systems can help in an organisation's strategic decision-making in the context of Electricity Company of Ghana	qualitative	None	interview	BI adoption	strategic decision-making	BI, or a similar system, has never been adapted by E.C.G, though the company creates huge data through its operations	BI implementation at E.C.G and its influence on decision-making and work culture of users should be studied.
Johansson & Nilsson (2013) (Sweden)	to assess business intelligence practices in large Swedish organizations	qualitative	None	interviews	na	na	a Business Intelligence Assessment Framework (BIAF) was developed; large Swedish organisations are generally at fair in implementing BI best practices	there is need to empirically establish BI values and tangible benefits while integration external variables
Al-ma'aitah (2013) (Jordan)	to reveal the impact of using business intelligence strategy on the decision making process	mixed research	None	interview & secondary data	BI application	decision-making	There is a significant effect of using business intelligence tools on decision making process.	This study should be replicated in other countries.

Source: The Author

Related Empirical Reviews on Business Intelligence (continued)

Author/Year	Objective	Methodology	Theory	Instrument(s)	IV(s)	DV	Finding(s)	Further Studies
Sabbour, Lasi & Tessin (2012) (Germany)	to explore visual interactive simulations and BI as a decision support tool for strategic decision making	exploratory & qualitative	None	interview	BI visual interactive simulation	supply chain related strategic decisions	the use of simulation for supporting supply chain related strategic decisions is still in its infancy	further studies should incorporate BI in the line of cost and strategic perspective
Mohammad (2012) (Jordan)	to explore the impact of BI and decision support on the quality of decision making	Descriptive research (mixed)	None	questionnaire & secondary data	BI & decision support	quality of decision making	BI has a significant positive effect on quality of decision because it results to quality information.	Research should be conducted to measure the impact of BI in achieving competitive performance.

Felder (2012) (USA)	to explore the perceptions of pastoral leaders concerning the potential usefulness of BI in church organizations	exploratory & qualitative	None	interview	na	na	pastoral leaders perceived that BI can be a useful technology in church organizations.	Church BI adoption should measure the impact of BI technology investments.
Ahmad (2011) (Malaysia)	to empirically examine the association between BI deployment and sustainable competitive advantage.	positivist paradigm & mixed research	resource-based, diffusion of innovation, & information system success theories	interview & questionnaire	BI deployment	sustainable competitive advantage	There is direct positive relationship between BI deployment and use of knowledge in sustaining competitive advantage.	further studies should investigate the moderating roles of organizational culture, business strategy and BI tools on BI
Brynjolfsson, E. (2011) (USA)	to examine if firms that emphasize data driven decision making show higher performance	Quantitative	information & economic theories	questionnaire & secondary data	DDD making; & information technology investments	output, productivity & profitability	Firms that adopt DDD have output that is 5-6% higher than normal	this study should be replicated in other economies
Lorenzetti (2010) (Italy)	to theoretical and practical measure the importance of BI data analysis in the financial sector.	mixed research	None	survey & secondary analysis	BI Tools	financial crises	BI could help in detecting, mitigating, and managing banking risks/crises	further studies to adopt predictive approach in measuring BI investment and financial sector performance
Popovič, Turk & Jaklič (2010) (Slovenia)	to propose a conceptual model to assess business value of business intelligence systems	exploratory & qualitative	None	literature review, interview & case study	BI systems	business value	a good BIS should produce good data for quality decision-making to enhance business performance	Further studies should empirically test the conceptual model developed in this study.
Yeoh, Koronios & Gao (2008) (Australia)	to identify critical success factors for the implementation of BI in an engineering assets management organisations	interpretivist & qualitative	None	Delphi questionnaire	organizational, process, and technological factors	BI implementation	organizational & process factors are more critical in implementing BI in engineering assets organization than technological factors	there is need to align BI implementation to business success (performance) approach
Petrini & Pozzebon (2004) (Brazil)	to examine the degree of implementation of BI amongst Brazilian companies	qualitative study	None	semi-structured telephone interviews	na	na	few Brazilian firms have adopted BI with an absence of well-defined methodologies	Research should measure the impact of BI technology on firm performance.

Source: The Author