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**A Proposed Big Data Analytics Quality (BDAQ) Model for
Improving Firm Performance with a Case Study**

نموذج مقترح للجودة التحليلية للبيانات الضخمة لتحسين أداء الشركات مع دراسة حالة

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Abstract

Before the era of the Internet, data about customers were entered by Firm employees themselves into the system they had. In the age of the internet, users' usage of social media, applications, and exchange emails has arisen a distinct kind of data Created by the user community and then at later periods in the shadows of artificial intelligence and machine learning, the machines themselves have started to create the data. That was and still a terrifying amount of data around institutions and a true challenge to coop with. Due to that data characteristics including their volume, velocity, variety, and many more V's, these data were called "Big Data". Whatever the data volume, the most important is how that data could be monetized or processed given the quality of big data analytics to help improving firm's performance. The main purpose of the research is to analyze how Big Data Analytics Quality (BDAQ) impacts the performance improvements of businesses measured by indicators of firm financial and non-financial performance. A Case Study was conducted and the main field it applied up on is the Commercial International Bank (CIB) in Egypt. The targeted departments and bankers are not about anyone who worked for the bank, but specialized departments and bankers who deal with Big Data Analytics and its Quality were chosen.

Key Words: Big Data, Big Data Analytics, Big Data Analytics Quality, Quality, Firm Performance, Financial Performance, Non-financial Performance.

مستخلص

قبل ظهور عصر الإنترنت، كان موظفو الشركات هم من يقومون بإدخال البيانات الخاصة بالعملاء للنظام الموجود داخل الشركة وفي عصر الإنترنت، ادي استخدام المستخدمين لوسائل التواصل الاجتماعي، والتطبيقات، وتبادل الرسائل عن طريق البريد الإلكتروني الي وجود نوع مختلف من البيانات التي تم أنشاؤها من قبل مجتمع المستخدمين بأنفسهم ومن ثم في فترات لاحقة في ظل وجود التعلم الآلي والذكاء الاصطناعي، بدأت الآلات بنفسها في خلق البيانات. وكانت ولا تزال البيانات التي تم خلقها تمثل قدرًا مخيفًا بالنسبة للمؤسسات وتحديًا حقيقيًا لهم في كيفية التعامل معها. ونظرًا لخصائص هذه البيانات بما في ذلك حجمها وسرعتها وتنوعها والعديد من الخصائص الأخرى التي تبدأ بحرف V، فإن هذه البيانات تم تسميتها بالبيانات الضخمة. ومهما كان حجم هذه البيانات، فإن الأهم هو كيفية التعامل مع هذه البيانات أو معالجتها اخذا في الاعتبار تحقيق الجودة للتحليلات المستخدمة بالنسبة للبيانات الضخمة وذلك لتحسين أداء الشركات. ويتمثل الغرض الرئيسي من الدراسة في فحص تأثير الجودة التحليلية للبيانات الضخمة (BDAQ) على تحسين أداء الشركات مقاساً بمؤشرات الأداء المالي وغير المالي للشركة. ويقدم هذا البحث رؤى جوهرية حيث يعتبر مفيد للشركة نفسها حيث يمكن للشركة من تحديد مستوى BDAQ الخاص بها وعلاقته بالتحسينات في الأداء. وقد تم إجراء دراسة حالة حيث كان المجال الرئيسي الذي تم تطبيق الدراسة به هو البنك التجاري الدولي (CIB) في مصر. ولا تعتبر الأقسام والمصرفيين المستهدفين هو اي شخص عمل في البنك، ولكن تم اختيار الإدارات المتخصصة والمصرفيين المختصين الذين يتعاملون مع تحليلات البيانات الضخمة وجودتها.

الكلمات الأساسية: البيانات الضخمة، تحليلات البيانات الضخمة، الجودة التحليلية للبيانات الضخمة، الجودة، أداء الشركات، الأداء المالي، الأداء غير المالي.

1. Introduction

In every second spent in our lives, new data have been generated. When reading, listening, thinking, writing, and even playing, data are produced and generated. That data were referred to as "Big Data" (BD) due to their characteristics. They must be taken into consideration that, not only BD are found everywhere, but also their rate of generation are increasing as evolving.

As a result of globalization, increasing market competitions, and BD inspiration, with phrases like “data are the new oil” and “refine data to extract value” (Hartmann et al., 2014), a high percentage of enterprise firms has been motivated to start investing into big data related projects (Kwon et al., 2014). Regarding (Grover et al., 2018) BD captured is valueless until used in processing, providing to decision makers meaningful views and insights that can be used in the actual practice. Therefore, BDA techniques should be given the attention that they may drive huge benefits to businesses and improvements to organizations (Gunasekaran et al., 2017).

2. Research Problem

Witnessing more and more stories about analytics and the success of BD have got the consciousness and imagination of many business leaders. They represent new paths for measuring, understanding, and improving firm performance (Charles, 2016). Regarding (Ferraris et al. 2018) the benefits generated from data, they are not related to data quality only, but also a crucial and important element which is the quality of the diversified procedures where data are to be gathered, stored, and analyzed.

Focusing on the analytics quality, BDAQ can be illustrated as a model for the user-perceived quality of analytics that can be assessed thorough prerogative, superiority, or how well the BDA platform performs as a whole (Akhter et al. 2017). Although many firms are caring about data analytics, few of them have reached the optimal

performance of the firm (Davenport & Harris, 2007), Therefore Building blocks for illustrating, managing, and assessing BDAQ for improving firm performance is a challenge facing organizations.

Despite the significant growth in scholarly contribution in literature of BDA and BDAQ in the last few years, the concept BDAQ and how it can be defined, illustrated, and modeled is still not clear and how established firms can reach and exploit the best of BDAQ is a challenge facing many organizations, thus the main research problem in this research is to build a BDAQ model for improving firm's performance. This study will work on addressing such problem using RBV approach (Barney 1991,& 2001) and IS quality measures of IS success model (DeLone and McLean, 1992, 2003) along with using a firm strategy that is aligned with analytics quality.

Based on what have been illustrated, the research discusses the upcoming central research question:

Q1. What are the building blocks needed to reach BDAQ and what are their impact on firm performance?

In response to this question, the researcher proposes a model to illustrate the effect of BDAQ on improvements of firm performance in view of RBV approach and IS quality measures in IS success model along with using a firm strategy that is aligned with analytics quality.

3. Research Objectives

The primary research goal is to develop a Big Data Analytics Quality model that can improve the firm's performance. This objective can be achieved via the following sub-objectives:

- Determining the blocks that drive BDAQ.
- Explaining the role of each block of the blocks that drive BDAQ.
- Explaining the effect of each block of the blocks that drive BDAQ on improving firm performance.
- Indicating the realization that is achieved to the firm from using BDAQ to improve firm performance.

4. Research Methodology

To examine the applicability of this research, the researcher will implement a case study applied on Commercial International Bank (CIB) in Egypt. Data will be collected through internal and external sources, such as Questionnaires, documentary analysis, interviews, Applications such as Linked-In, twitter feeds and internal email correspondence.

The study will mainly be adhered to the flow of research process implied in the deductive approach. According to Collis and Hussey (2009), deductive approach is said to be adapted when a conceptual or theoretical structure is developed. For example, to deduce key blocks shaping BDAQ which can improve firm performance, the researcher will depend upon Resource-based view approach and IS quality measures of IS success Model along with using a firm strategy that is aligned with analytics quality.

Besides, in order to construct a data-driven model that depends upon the utilization of BDAQ for improving firm performance, constructive approach that belongs to normative approach will be used.

5. Research Importance

The importance of this research originates from:

First: Scientific Importance

The assessment of BDAQ on company performance is becoming more difficult. How established firms can reach and exploit the best of BDAQ is a challenge facing many organizations. Therefore the scientific importance stems from providing a theoretical framework for applying BDAQ and its blocks for improving firm performance.

Second: Practical Importance

The practical importance stems from the area of application, which is Commercial International Bank (CIB) as one of the topset banks in Egypt that people rely upon. For CIB People are the foundation upon which the bank is constructed, where each one of them enters all the daily transactions and operations to help all clients shape their financial

future, therefore providing and applying a model of BDAQ that can help in serving those clients better is of great importance to the firm, that is why more research should be dedicated to this sector to help improving its efficiency along with the quality of its output so that the overall goal of customer satisfaction improvement can be achieved.

6. Research Limitations

The research includes some limitations that have to be acknowledged, as the researcher will be limited by using only some indicators of financial and non-financial performance as a measure of firm performance. The direct effect of a group of BDAQ factors on company performance is also measured in this research. In addition, the study is not planned to capture the stability across time or settings.

7. Literature Review

Surveying literature, various researchers have explained the concept of Big Data. For example, (Manyika et al., 2011) illustrated the concept BD as having large data sets containing various types and amounts of information. Many studies for example (Demchenko et al., 2013) characterize BD by high volume, high velocity, and high variety of data generated. BD are found in terms of pictures, figures, papers, videos, recordings, tweets, emails, blogs, facts, feedback ratings, etc. Such kind of large amount data is called big data (Verma et al., 2021). Shortly, it was obvious to all of us that we live in the age of BD, that was a great hype pushing organizations toward making huge investments to get benefit from the data to create value (Constantiou & Kallinikos, 2015).

According to Diebold (2012), the origins of the term “Big Data” are not wholly clear, and the term has resisted any standard definition since its introduction and use across the academic literature. However, a common train of thought is the definition of the concept of the three (or more) Vs. The Vs of Big Data state the characteristics that make data “Big.” Clearly, there is no standard list of official Vs. of Big Data, starting by the original three Vs of BD, originally named as Volume, Variety, and Velocity, and thereafter extended to include many more Vs.: 4Vs. (Schroeck, et al., 2012; Thiyagarajan & Venkatachalapathy,

2014), 5Vs. (Beyer & Laney, 2012), 7Vs. (Khan et al., 2014), 9 Vs. (Owais & Hussein, 2016), 10 Vs. (Khan et al., 2018), 17 Vs. (Panimalar et al., 2017), and 42 Vs. (Shafer, 2017). As inflammation worsens, BD attributes (the number of Vs.) also developed, and with time, new Vs. are added. (Tiwari and Rana, 2021). The most important Vs illustrated were Volume, Variety, Velocity, Veracity, Value, Validity, Variability, Volatility and Visualization.

The concept of big data analytics initially was formulated by Chen as a group of business intelligence and analytics (BI & A), often interested in data mining and statistical analysis. BI&A refers to “the technologies, techniques, practices, systems, applications, and methodologies that analyze data that are crucial to firm, guiding the firm to better understand its own business and therefore making business decisions in time”. Although many definitions for BDA are expressed in literature, the general idea is the same (Chen et al. 2012, p. 1166). Many studies have explained what BDA can be used for and it can result to, for example, according to (Wamba, 2017) BDA can help firms to foster process and product innovation and improve firm decision making.

They meant to turn the focus to be on Big Data Analytics Quality. According to (Kiron et al., 2014), challenges are increased with respect to the assessment of BDAQ on firm performance. For example, according to Ransbotham et al. (2016), the use of analytics is growing quickly, but many firms are still having difficulty producing high-quality insights to maintain their competitive edge. According to (Wamba et al., 2018), BDA receives all the prominence currently, but also prominent—and perhaps even more and more prominent—is BDAQ.

Recently, majority of the articles focusing on BDAQ, and firm performance are based on RBV approach (Barney, 1991; Grant, 1991, 2002), IS success model (DeLone & McLean, 1992; DeLone, 2003), IT quality theory in IS (Nelson et al., 2005; Wixom & Todd, 2005) of the firm (Wamba et al., 2018). For example, (Wamba et al., 2018) Used the RBV and the IT quality theory in IS and proposed that Overall

BDAQ is influenced by talent quality, information quality, and perceived technology quality. This construct has a big impact on how well a company performs. That proposal was referred to as the BADQ model.

Regarding (Senthilkumar et al., 2018), Implementing efficient BD strategies is crucial and not even optional for firms since they may compete in how they use big data. In this vein (Shokri & Osman, 2016) noted that the aim of having a BD strategy is to use BD tools, technologies, and techniques to process that huge data volume to reach meaningful views. They proposed some mechanisms for successful implementation of BD, and increasing the potential benefits related to its adoption, with the ability to learn from professionals' skills and practices.

8. Research Gap

Literature on BD, BDA, BDAQ and even the exploitation of them by firms has predominantly focused on firm's potentials, capabilities, tools, techniques, and technological advances used. The thought around BD has been superfast across years. It is of great importance now for organizations that they should understand that if they can capture each crucial piece of data for them, having the analytical resources and strategies required, applying analytics in a good way, they defiantly can get noteworthy value from that data.

The gap in the body of literature can be concluded in that there is a call for future research that not only focuses on how firms address and identify big data, dealing with big data, and develop innovative business models based on big data to achieve firm performance, but also on how BDA and analytics quality drive the transition to new models. Also, there is still a literary gap regarding the main components that constitute BDAQ and its relationship with firm financial and nonfinancial performance.

9. Difference between BD, BDA, and BDAQ

A lot of researchers define BD as having huge volumes of data to deal with. In light of our research big data for a firm could not be big or as big as to another firm, which could open the door for having different levels for the big of that data for different firms, the less understanding, technologies, tools the firm have, the more complexity the firm will face in managing and analyzing the data and therefore the more big the data the firm can deal with. The researcher defines each of the three concepts and differentiates between them as follows:

Big data are massive volumes of data that are difficult to analyze and deal with them to get insights as a firm with the existed resources, capabilities, tools, and techniques. That situation clarifies the failure as a firm to deal with the big data they have, while the success of getting insights from the big data the firm has, eliminates the big characteristic of that data.

Big Data Analytics is the processing stage of big data in which tools, techniques, applications and even any other analytical resource is used to get insights from big data that in turn will benefit the firm in the future. Therefore, if a firm faces the problem of having a big data and seeks differentiation from its competitors in the market, it must invest in having analytical resources, tools, and techniques.

Big Data Analytics Quality is not just about using analytical methods and techniques to get insights but in much more detail: it's the best use of tools, techniques, applications, and any other analytical resource that could achieve the analytics quality of big data.



Figure 1: Difference between BD, BDA, & BDAQ

The researcher distinguishes between BD, BDA, and BDAQ in that research as having three levels each one is more detailed, specified or even more limited than the other, starting with big data as level one which is a more general area or topic, limiting level one to be more specific as focusing on the analytics of big data (denoted as level two), further more limiting BDA as focusing on BDAQ (denoted as level three) which will be the primary consideration in that research as shown in figure 1 above:

10. Technologies and Techniques of BDA

There are a lot of technologies, and techniques related to BDA that can be used to obtain appropriate results. BDA technology is a disposition of a huge number of approaches and processing methods. There are diverse technologies related to usage of BDA such as Apache Hadoop, R that is a distinguished code-writing language of the science of data, NoSQL Databases which are built to run a huge amount of information, Hive that is related to Apache Hadoop, MapReduce which is used to process loads of data simultaneously, and XQuery which works as a conversion engine (Hoque, 2018). There are many techniques as well related to BDA that are used for analyzing datasets. Some of these techniques are Association Rule Learning which is in assistance for monitoring system logs, Machine Learning which could be used to distinguish between legitimate and scam email messages,

Time Series Analysis, Supervised Learning, Data Mining which are to discover setups in massive datasets (Hoque, 2018).

11. The Conceptual Framework of BDAQ

The theoretical foundation is a necessary part of any research. It defines and classifies the research thoughts, concepts, models, theories used and how relationships between them are demonstrated in the research (Collins & Stockton, 2018). The aim of the research theoretical foundation is to illustrate how the concept of BDAQ is driven starting from a more general topic which is Big Data, then limiting the focus to Big Data Analytics, and then our most important concept which is BDAQ. Which blocks could constitute BDAQ concept is also of great researcher proposes a research model to discuss the effect of BDAQ on firm performance in view of RBV approach and IS quality measures in DeLone & McLean IS success model along with using a firm strategy that is aligned with analytics quality

11.1 BDAQ in View of IS Quality Measures of IS Success Model.

In IS Success Model (DeLone & McLean 1992, & 2003), IT-driven value and performance have been found as being significantly influenced by system, information, and service quality.

The first quality factor "System Quality" refers to the processing quality of the information itself, which featured by use of state-of-the-art technique, a system with essential features and functions (referred to as IS excellence) and user-friendly, simple-to-learn, and readily maintainable software (referred to as IS value).

Table 1 below illustrates the determinants of system quality used by the researcher in this study compared to determinants used in various studies.

importance and for sure its integration with firm performance. Thus, the

Table 1: Subset of Determinants of System Quality Used in the Study Compared to Various Studies (Source: The Researcher)

Determinant	Study									
	DeLone & McLean, 2003	Nelson et al., 2005	Wixom & Todd, 2005	Gorla, et al., 2010	Petter et al., 2013	Popović et al., 2014	Hackney et al., 2015	DeLone & McLean, 2016	Ji-fan Ren et al., 2016	Used in the Study
Accessibility		X	X				X		X	
Availability								X		
Data Quality	X							X		
Ease of Learning					X					
Ease of Use	X				X	X		X		X
Flexibility	X	X	X	X	X	X	X	X		X
Functionality	X							X		
Importance	X							X		
Integration	X	X	X		X		X	X	X	X
Intuitiveness					X					
Personalizable								X		
Portability	X							X		
Reliability	X	X	X		X	X	X	X	X	X
Response Time		X				X	X	X	X	X
Interactivity								X		
Security								X		
Timeliness			X							
Sophistication				X						
Adaptability									X	
Privacy									X	
Unexpected hang downs										X

X: is the determinant used in the related study

The second quality factor "Information Quality," is concerned with the quality of the outputs that the information system generates, which may take the form of reports or online displays (DeLone & McLean, 1992). Table 2 below summarizes information quality determinants used by the researcher in this study compared to determinants used in various studies.

The third quality factor "Service Quality" is regarded as an IS success dimension that assesses support quality level provided by the IS developer (DeLone & McLean, 2003). Pitt et al. (1995) assert that evaluating service quality is essential since the function of IS departments has changed from delivering goods to providing both products and services (DeLone & McLean, 2003).

Table 2: Subset of Determinants of Information Quality Used in the Study Compared to Various Studies (Source: The Researcher)

Determinant	Study									
	McKinney et al. (2002)	DeLone & McLean, 2003	Stvilia, et al., 2007	Petter et al., 2008	Gorla et al., 2010	Arazy & Kopak, 2011	Popovič et al., 2014	Wamba et al., 2018	Ji-fan Ren et al., 2016	Used in the Study
Accuracy		X	X	X		X	X	X	X	X
Completeness		X	X	X		X	X	X	X	X
Representation			X			X				
Objectivity			X			X				
Timeliness	X	X		X			X			X
Relevance	X	X		X			X			X
Consistency		X		X			X			
Content					X					
Format					X			X	X	
Currency								X	X	
Understandability	X									X
Usefulness	X									X
Adequacy	X									
Reliability	X									
Scope	X									

X: is the determinant used in the related study

Table 3 below summarizes service quality determinants used by the researcher in this study compared to determinants used in various studies.

Table 3: Subset of Determinants of Service Quality Used in the Study Compared to Various Studies (Source: The Researcher)

Determinant	Study			Used in the Study
	Pitt et al., 1995	Chang and King, 2005	Gorla et al., 2010	
Assurance	X		X	
Empathy	X		X	X
Responsiveness	X	X	X	X
Reliability	X		X	
Tangibles	X			
IS Training		X		
Flexibility		X		
Intrinsic Quality		X		
Interpersonal Quality		X		
Supportive				X
Interactive				X

X: is the determinant used in the related study

Based on illustrating the three quality factors discussed above namely as Information quality, System quality, and Service quality,

they represent quality factors of the IS resource. The researcher suggests that a firm having these three quality factors in a big data analytics environment can help driving BDAQ which in turn could have a considerable effect on improving Firm performance that will be measured by financial and non-financial performance indicators as shown in figure 2 below:

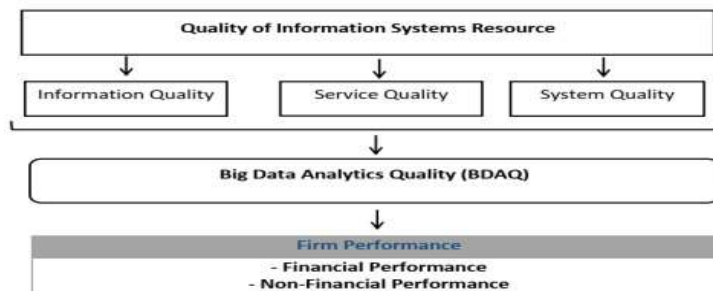


Figure 2: Improving Firm Performance Using Big Data Analytics Quality in View of Quality of Information Systems Resource

BDAQ will be measured by Accuracy, Reliability, Completeness, Relevance, and understandability of output of BDA tools and techniques implemented by the firm. Firm performance can be classified into financial and non-financial performance. Financial Performance will be measured by Return on Assets (ROA) and Return on Equity (ROE) based on firm financial statements. Non-Financial performance will be measured by response time, customer retention, and customer satisfaction.

11.2 BDAQ in View of RBV Approach

Starting with Barney (1991) who built RBV approach in which its origin relates to Wernerfelt's (1984) proposal that proposed analyzing firm via its resources. RBV's basic tenet is that a company's performance is based on its resources and capabilities, as well as other characteristics and traits (Barney 2014). The characteristics suggest that resources must be valuable, rare, inimitable, and non-substitutable (VRIN). That resources can help in reaching a Big Data Analytics Quality (BDAQ) in a firm that captures and generates big data. Ten years after VRIN framework, The Valuable, Rare, Inimitable,

and Organization (VRIO) concept was presented by Barney and Hesterly (2010). They focused the attention on having the element Organization (O) in the VRIO framework.

Using VIRO framework that relates to the RBV approach, firms can differentiate themselves based on their resources that are valuable, rare, inimitable, and organization. That resources in a big data environment could provide a competitive advantage and superior business value to the firm. Therefore, the researcher proposes that for a firm having valuable, rare, inimitable, and organization analytical resources can help driving BDAQ which in turn could have a considerable effect on improving Firm performance that will be measured by financial and non-financial performance measures as shown in figure 3 below.

Valuable resources were referred to as that resources that can exploit opportunities and eliminate threats. Rare resources were referred to as resources that is currently used and managed by a very limited number of rival companies or resources that competing firms did not possess. Inimitable resources were referred to as resources that cannot be easily copied by competitors or resources that are competitors find their expensive to copy. Organization was referred to that the firm resources that are organized as having a formal reporting structure, a management control system, and compensation policies.

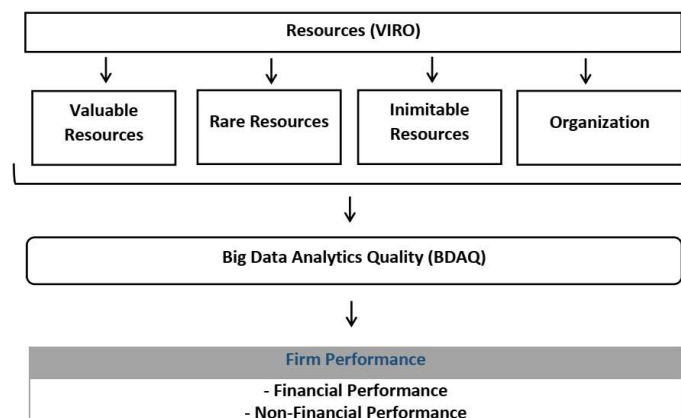


Figure 3: Improving Firm performance Using Big Data Analytics Quality in View of RBV Approach

11.3 Improving Firm Performance in View of BDAQ and a Firm Strategy Aligned with Analytics Quality

There is no doubt that organizations could get a competitive advantage if they used big data in a good way. Implementing efficient big data strategies is imperative and not optional since businesses compete in how they use big data (Senthilkumar et al., 2018). A big data strategy's goal is to employ big data technology to analyze enormous amounts of data and then provide valuable insights (Shokri & Osman, 2016). In this line, Shokri and Osman (2016) proposed certain methods for effectively applying big data and maximizing the potential advantages of embracing big data, including learning from experts' abilities and practices.

In terms of a company's approach to improving performance in the marketplaces in which it competes, such approach means implementing a strategy (Barney et al., 2001). The researcher will focus on developing the strategic fit or alignment, perceiving the company as a collection of resources connected by a specific governance structure, due to the unexpected nature of big data analytics.

When qualities of superior analytics are in line with the firm's strategy, performance is thought to be enhanced (Aslan et al., 2015). This is in line with the claim made by McAfee and Brynjolfsson (2012, p. 66) that "businesses prosperit

y in the big data age not merely because they have more or better data, but because their leadership teams establish specific objectives, define success, and ask the appropriate questions." Thus, choosing a strategy plays an important role in reaching superior firm performance.

According to Ross et al. (2013, p.93), "The greatest reason that investments in big data fail to pay off is because most firms don't do a good job with the information they already have,". They lack the knowledge necessary to control it, examine it in ways that deepen their comprehension, and adjust considering fresh information.



Figure 4: Improving Firm Performance in View of Big Data Analytics Quality and a Firm Strategy Aligned with Analytics Quality

Firm strategy that is aligned with analytics quality are the extent to which resources of the firms are used and the degree to which BDAQ is in line with the organization's overarching strategy. Although businesses make significant investments in enhancing analytics-driven insights, they frequently lack a connection to corporate strategy. Therefore the researcher suggests that for a firm to improve its performance it has to implement a strategy that is aligned with Analytics quality in order to reach firm performance translated into financial and nonfinancial performance as shown in figure 4 above.

11.4 BDAQ Model for Improving Firm Performance

As what have been discussed above, the researcher developed six hypotheses proposed that using the RBV approach and the IS quality measures in IS success Model along with a Firm strategy that is aligned with Analytics quality will affect the total BDAQ, which significantly affects the performance of the company translated into financial and nonfinancial performance.

1. **H1:** Quality of information system resource has a statistically significant positive influence on BDAQ.
2. **H2:** Other analytical firm resources that are Valuable, Rare, Inimitable, and Organized have a statistically significant positive influence on BDAQ.
3. **H3:** Quality of information system resource and other analytical firm resources together have a statistically significant positive influence on BDAQ.

4. **H4:** BDAQ has a statistically significant positive influence on firm non-financial performance.
5. **H5:** Alignment between analytics quality and firm strategy has a moderating influence on the relationship between BDAQ and firm non-financial performance.
6. **H6:** Quality of information system resource and other analytical firm resources together has a statistically significant positive influence on firm non-financial performance.

The BDAQ Model with research hypotheses is shown in figure 5 below:

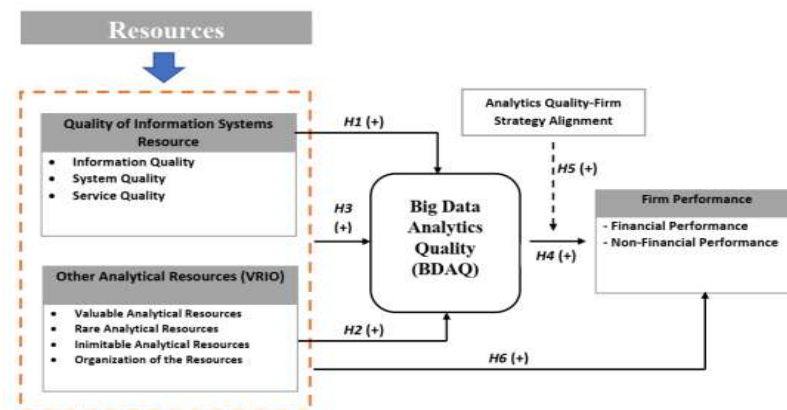


Figure 5: The Proposed BDAQ Model for Improving Firm performance

12. The Case Study

12.1 Sample Selection of the Study

The research is targeting the banking sector. The main field of the Case study is applied up on the Commercial International Bank (CIB) in Egypt. CIB has its own data science lab that contains its data lake. Inside the data science lab there are data scientists and mathematicians that could deal with big data. The targeted departments and bankers are not about anyone who worked for the bank, but specialized departments and bankers are needed. For applying the Case Study, a sample of CIB bankers working in the CIB head office buildings in the smart village in Cairo who are aware enough of analytics, IT, system development,

and design in the bank will be selected. Also, data scientists and mathematicians working in the bank data science lab departments are considered, especially Bank Analysts and IT managers with analytics experience.

12.2 Data Collection Methods

The researcher used interviews, survey questionnaires, and documentary analysis as techniques for gathering data. The researcher had used those various methods to get a comprehensive and more accurate state of the CIB regarding BDAQ and its impact on performance.

12.2.1 Interviews

Interviews are one of the methods used for gathering real data in which questions are asked to selected members to get what the interviewer really want and to detect their capabilities, intention, thinking, ambition, doing, or even feelings and satisfaction with their status. The questions asked in interviews may be described as open-ended or closed. The researcher in this study has used open questions to get more information about CIB itself and about CIB view of BDA, where the analytics is applied, ...etc. (See Appendix B)

12.2.2 A Survey using Questionnaire

Questionnaire is one of the methods of data gathering that are used in this research. The research questionnaire contains statements that are related to the IS quality measures of IS success model, statements related to other analytical resources that are valuable, rare, inimitable, and organized, statements about BDAQ, statements about Analytics quality and firm strategy alignment, and finally statements related to non-financial performance (See appendix A). The questionnaire doesn't include statements that measure financial performance of the bank, instead of that Bank Financial performance will be measured by ROA and ROE based on CIB financial statements after applying BDA.

The research questionnaire has been sent online via WhatsApp and Linked-In applications to members of CIB working as Chief data

officers, Data architect managers, Data Engineers, Chief communication officer, Information quality manager, Data scientists, and mathematicians. There are 65 questionnaires that were filled, 10 of them were disqualified since they don't relate to those specialized in dealing with data and data warehousing and for skipping and not answering some of the questions in the questionnaire. The following table summarizes the total number filled, and Valid copies of questionnaire of the Study.

Table 4: Sample of the Case Study

	Filled	Qualified	Disqualified
Number	65	55	10
Percent	100%	84.6%	15,4%

12.2.3 Documentary Analysis

The main documents used in this section is the Financial Reports of the Commercial International Bank and other banks existed in Egypt. These financial reports are written documents that are of great importance as it considered the most reliable source to get information about the banks and other institutions. CIB Financial reports for the year ended December 31, 2021, is used to measure Financial Performance of the bank. Bank Financial performance will be measured by ROA and ROE for the year ended December 31,2021 based on CIB financial statements after applying BDA. The CIB ROA and ROE calculated will be compared with the average ROA and Average ROE in the banking industry in Egypt as a benchmark for CIB financial performance. There are different sources for collecting data for computing ROA and ROE of CIB and other related banks. The required data are mainly collected from the annual reports and investor relations portion published throughout the following sites:

- The Egyptian Stock Exchange: <http://www.egx.com.eg/>
- Mubasher: <http://www.mubasher.info/countries/eg>
- The formal website of the bank itself

12.3 Study Variables:

Study dependent, independent, and moderator variables have been shown according to study hypotheses. The following table summarizes dependent, independent, and Moderating variables for the research.

Table 5: Summary of Dependent, Independent, and Moderating Variables for the Research.

Hypotheses	Relationship	Independent Variables	Dependent Variables	Moderating Variables
H1	Quality of information system resource has a statistically significant positive influence on BDAQ.	Quality of information system resource	BDAQ	-
H2	Other analytical firm resources that are Valuable, Rare, Inimitable, and Organized has a statistically significant positive influence on BDAQ.	Other analytical firm resources that are Valuable, Rare, Inimitable, and Organized	BDAQ	-
H3	Quality of information system resource and other analytical firm resources grouped together has a statistically significant positive influence on BDAQ.	Quality of information system resource and other analytical firm resources grouped together	BDAQ	-
H4	BDAQ has a statistically significant positive influence on Firm non-financial Performance.	BDAQ	Firm non-financial performance	-
H5	Alignment between analytics quality and firm strategy has a moderating influence on the relationship between BDAQ and Firm non-financial performance.	BDAQ	Firm non-financial performance)	Analytics quality and firm strategy Alignment
H6	Quality of information system resource and other analytical firm resources grouped together has a statistically significant positive influence on Firm non-financial performance.	Quality of information system resource and other analytical firm resources grouped together	Firm non-financial performance	-

12.4 Analysis of the Case Study

The responses to the questionnaire represent their point of view regarding the current state of the CIB. The responses are the data needed for doing Statistical Analysis and thus testing the hypotheses. It is necessary to note that the bank non-financial performance will be measured through the data gathered from responses to the research questionnaire as it can't be measured through financial statements. In

contrast the bank financial performance will be measured through financial statements of the bank on December 31, 2021, depending on ROA and ROE indicators.

Data analysis aims to analyze the data gathered from responses of the case study that is the CIB to test the hypotheses. To test the study hypotheses, regression analysis as a procedure will be used. SPSS, ver. 24.0 will be used to analyze the research sample data.

12.4.1. Descriptive Statistics of Total Sample

This section provides descriptive statistics for the variables that have been used to test the hypotheses. In the next table, descriptive statistics for variables are displayed. Descriptive statistics make it possible to summarize the central tendency of the data (the minimum and maximum values that each variable can take as well as the mean and the standard deviation) of the variables.

Table 6: Descriptive Statistics for Variables Used to Test the Hypotheses

	N	Minimum	Maximum	Mean	Std. Deviation
Quality of Information system Resource	55	1.00	5.00	4.0374	0.71151
Other analytical firm resources that are Valuable, Rare, Inimitable, and Organized	55	1.00	5.00	3.9414	0.71865
BDAQ	55	1.00	5.00	4.0454	0.5766
Analytics Quality and Firm Strategy Alignment	55	2.00	5.00	4.2242	0.6555
Non-financial performance	55	2.00	5.00	4.0671	0.6442

Number of Observation = 55

Table 6 Exhibits the descriptive findings of variables for the sample. It shows that; the average LIX score for Quality of Information system Resource is 4.0374, the standard deviation is 0.71151, the minimum amount is 1.00 and the maximum amount is 5.00. It also shows that the average LIX score for Other analytical firm resources is 3.9414, the standard deviation is 0.71865, the minimum amount is 1.00 and the maximum amount is 5.00. Also, the table shows that BDAQ ranges from 1.00 to 5.00 with a mean of 4.0454 and a standard deviation of 0.5766. With regards to the Analytics Quality and Firm Strategy

Alignment, it also shows that the mean is 4.2242, and the standard deviation is 0.6555. The minimum amount is 2.00 and the maximum amount is 5.00. Finally, the same will be regarding to non-financial performance.

12.4.2 Regression Analysis Used to Test the Hypothesis:

Regression analysis illustrates how independent variables affect the dependent variable.

12.4.2.1 Results for the Relationship between Quality of IS Resource and BDAQ

Table 7: Regression Results of Testing the First Hypothesis

Variable	Coefficient	t stat.	Sig.
Constant	0.726	2.113	0.039
Quality of IS Resource	0.822	9.717	0.000
F. stat.	94.411		
Sig.	0.000		
Adj. R ²	0.634		

Table 7 shows that the model is significant where $F = 94.411$ and significant at 0.000. The $\text{adj. } R^2 = 0.634$ which indicates that the independent variable explains 63.4% of the change in dependent variable. The table presents that the t stat. of the independent variable = 9.717 which is significant at 0.000. Regarding the significance level between independent and dependent variables it was found that Quality of Information System has a significant relationship with BDAQ with a significance level of 0.000. In addition, the coefficient is equal to .822 (positive), which shows a positive relationship between both variables, it means the higher the Quality of IS, the higher the BDAQ for the bank, which means that there is a statistically positive effect of Quality of IS on BDAQ for the bank, Therefore, the first hypothesis (**H1**) of the study is accepted.

12.4.2.2 Results for the Relationship between Other Analytical Resources and BDAQ

Table 8: Regression Results of Testing the Second Hypothesis

Variable	Coefficient	t stat.	Sig.
Constant	1.657	3.330	0.002
Other Analytical Resources	0.606	4.823	0.000
F. stat.	23.258		
Sig.	0.000		
Adj. R ²	0.292		

Table 8 shows that the model is significant where $F = 23.258$ and significant at 0.000. The $\text{adj. } R^2 = 0.292$ which indicates that the independent variable explains 29.2% of the change in dependent variable. The table presents that the t stat. of the independent variable = 4.823 which is significant at 0.000. Regarding the significance level between independent and the dependent variable it was found that Other analytical resources that are Valuable, Rare, Inimitable, and Organized have a significant relationship with BDAQ with a significance level of 0.000. In addition, the coefficient is equal to .606 (positive), which shows a positive relationship between both variables, it means the more the existence of Other analytical resources, the higher the BDAQ for the bank, which means that there is a statistically positive impact of Other analytical resources that are Valuable, Rare, Inimitable, and Organized on BDAQ for the bank. Therefore, the second hypothesis (H2) of the study is accepted.

12.4.2.3 Results for the Relationship between Quality of IS Resource and Other Analytical Resources Grouped together and BDAQ

Table 9: Regression Results of Testing the Third Hypothesis

Variable	Coefficient	t stat.	Sig.
Constant	0.455	1.161	0.251
Quality of IS Resource	0.740	7.231	0.168
Other Analytical Resources	0.153	1.397	0.000
F. stat.		49.028	
Sig.		0.000	
Adj. R ²		0.640	

Table 9 shows that the model is significant where $F = 49.028$ and significant at 0.000. The $\text{adj. } R^2 = 0.640$ which indicates that the independent variables explain 64% of the change in dependent variable. The table presents that the t stat. of the independent variables = 7.231 for Quality of IS Resource which is significant at 0.168 and = 1.397 for Other Analytical Resources which is significant at 0.000. It was found that Quality of information system resource has a strong significant relationship with BDAQ with a significance level of 0.000 which is less than 0.05, while Other analytical resources have a weak significant relationship with BDAQ with a significance level of 0.168 which is larger than 0.05. In addition, the coefficient for Other analytical resources = 0.153 (positive), and for Quality of IS resource is equal to .740 (positive), which shows a positive relationship between the independent and the dependent variables, it means higher the Quality of information system and the more the existence of Other analytical resources that are Valuable, Rare, Inimitable, and Organized, the higher the BDAQ for the bank it will be, which means that there is a statistically positive impact of Quality of Information Systems resource and Other Analytical Firm Resources Grouped together on BDAQ for the bank, leading to the third hypothesis (**H3**) of the study to be accepted.

12.4.2.4 Results for the Relationship between BDAQ and Non-Financial Performance

Table 10: Regression Results of Testing the Fourth Hypothesis

Variable	Coefficient	t stat.	Sig.
Constant	.652	1.523	0.134
BDAQ	0.844	8.027	0.000
F. stat.	64.432		
Sig.	0.000		
Adj. R ²	0.540		

Table 10 shows that the model is significant where $F = 54.285$ and significant at 0.000. The $\text{adj. } R^2 = 0.540$ which indicates that the independent variable explains 54% of the change in dependent variable. The table presents that the t stat. of the independent variable = 8.027 which is significant at 0.000. Regarding the significance level between independent and the dependent variable it was found that BDAQ has a significant relationship with Non-Financial Performance with a significance level of 0.000. In addition, the coefficient is equal to .844 (positive), which illustrates a positive relationship between both variables, it means the higher the BDAQ, the higher the Non-Financial Performance for the bank, which means that there is a statistically positive impact of BDAQ on bank Non-Financial Performance, leading to the fourth hypothesis (H4) of the study to be accepted.

12.4.2.5 Results for the Alignment between Analytics Quality and Firm Strategy as a Moderator on the Relationship between BDAQ and Firm Non-Financial Performance.

Table 11 below shows that the model is significant where $F = 54.285$ and significant at 0.000. The $\text{adj. } R^2 = 0.664$ which indicates that the independent variable and the moderating variables explains 66.4% of the change in dependent variable. The table presents that the t stat. of the independent variable = 2.969 which is significant at 0.005 and t stat. for the moderating variable = 4.524 which is significant at 0.000. Regarding the significance level between independent variable,

Moderating variable, and the dependent variable it was found that BDAQ has a significant relationship with Non-Financial Performance with a significance level of 0.005 which is less than 0.05, and the Analytics quality-Firm strategy alignment has a strong significant impact on the relationship between BDAQ and Non-Financial Performance with a significance level of 0.000 which is less than 0.05. In addition, the coefficient for BDAQ is equal to 0.397 (positive), and for Analytics quality-Firm strategy alignment is equal to 0.459 (positive), which shows a positive impact of the moderating variable on the relationship between independent variable and the dependent variable, it means better Analytics quality-Firm strategy alignment, the higher the Non-Financial Performance for the bank, leading to the fifth hypothesis (H5) of the study to be accepted.

Table 11: Regression Results of Testing the Fifth Hypothesis

Variable	Coefficient	t stat.	Sig.
Constant	0.521	1.421	0.161
BDAQ	0.397	2.969	0.005
Analytics Quality-Firm Strategy Alignment	0.459	4.524	0.000
F. stat.	54.285		
Sig.	0.000		
Adj. R ²	0.664		

12.4.2.6 Results for the Relationship between Quality of IS Resource and Other Analytical Resources Grouped together and Firm Non-Financial Performance

Table 12 below shows that the model is significant where $F = 39.250$ and significant at 0.000. The $\text{adj. } R^2 = 0.586$ which indicates that the independent variables explain 58.6% of the change in dependent variable. The table presents that the t stat. of the independent variables = 6.249 for Quality of IS Resource which is significant at 0.000 and = 1.663 for Other Analytical Resources which is significant at 0.124. Regarding the significance level between independent and dependent variables it was found that Quality of information system resource has

a strong significant relationship with BDAQ with a significance level of 0.000 which is less than 0.05, while Other analytical resources have a weak significant relationship with BDAQ with a significance level of 0.124 which is greater than 0.05. In addition, the coefficient for Other analytical resources is equal to .209 (positive), and for Quality of information system resource is equal to .782 (positive), which shows a positive relationship between the independent and the dependent variables, Which means that the higher the Quality of information system and the more the existence of Other analytical resources, the higher the Non-Financial performance for the bank it will be, which means that there is a statistically positive impact of Quality of Information Systems resource and Other Analytical Firm Resources Grouped together on Non-Financial Performance for the bank, leading to the hypothesis number six (H6) of the research to be accepted.

Table 12: Regression Results of Testing the Third Hypothesis

Variable	Coefficient	t stat.	Sig.
Constant	0.087	0.182	0.856
Quality of IS Resource	0.782	6.249	0.000
Other Analytical Resources	0.209	1.563	0.124
F. stat.	39.250		
Sig.	0.000		
Adj. R ²	0.586		

12.4.3 Financial Statement Analysis to Measure Bank Financial Performance

The Financial Reports of the Commercial International Bank is used to measure bank financial performance as Financial Reports are considered the most reliable source to get information about the banks and other institutions. CIB Financial reports for the year ended December 31, 2021, is used to measure Financial Performance of the bank. Bank Financial performance will be measured by ROA and ROE for the year ended December 31,2021 based on CIB financial statements after applying BDA. The CIB ROA and ROE calculated will

be compared with the average ROA and Average ROE in the banking industry in Egypt as benchmark for CIB financial performance.

- **Formula used for ROA Calculation**

$$\text{ROA (\%)} = \frac{\text{Net Income}}{\text{Total Assets}} \times 100$$

- **Formula used for ROE Calculation**

$$\text{ROE (\%)} = \frac{\text{Net Income}}{\text{Total Stockholder's Equity}} \times 100$$

It's crucial to note that Egyptian banks with a very low ROA and ROE are considered as outliers and excluded from calculation of average ROA and Average ROE in the banking industry in Egypt. The following table illustrates Net income (In thousands), Total Assets (In thousands), Total Stockholder's Equity (In thousands), ROA percentage calculation, and ROE percentage calculation Information for every bank of the 12 Egyptian banks selected. The average ROA and Average ROE for the 12 Egyptian banks selected is shown also in the table.

Table 13: Summary of Net income, Total Assets, Total Stockholder's Equity, ROA, and ROE Information for 12 Egyptian banks.

Name of Bank	Net Income (In thousands)	Total Assets (In thousands)	Total Stockholder's Equity (In thousands)	ROA (%)	ROE (%)
Commercial International Bank (CIB)	13,420,385.00	496,651,124.00	68,928,168.00	2.702175501	19.47010256
BANQUE MISR	23,546,885.00	1,583,055,122.00	131,612,042.00	1.487433045	17.89113264
ALEX BANK	2,750,030.00	114,899,515.00	13,721,686.00	2.393421765	20.04148761
QNB BANK	7,452,037.64	354,195,091.32	45,051,714.87	2.103935889	16.54107433
CREDIT AGRICOLE EGYPT	1,592,489.00	60,235,359.00	8,668,933.00	2.643777719	18.3700693
FAISAL ISLAMIC BANK OF EGYPT	2,682,904.00	130,982,482.00	17,043,047.00	2.048292229	15.7419269
BANQUE DU CAIRE	3,630,825	255,353,077	19,413,842	1.421884178	18.70224863
ADIB	1,379,922	89,450,255	6,463,354	1.542669722	21.34993689
SUEZ CANAL BANK	604,675	57,431,259	4,400,124	1.052867394	13.74222636
Housing & Development Bank	1,830,084.729	76278337.35	9,229,439.66	2.39921948	19.82877396
alBaraKa Bank	1,132,367.236	82,321,778.55	6,004,171.58	1.375537866	18.85967482
ACDB	710,245.85	48,356,161.62	6,413,435.345	1.468780447	11.07434329
Total	60,732,850.46	3,349,209,561.84	336,949,957.46	22.63999524	211.6129973
Average ROA in the banking industry in Egypt = $22.63999524 \div 12 = 1.88666627$ %					
Average ROE in the banking industry in Egypt = $211.6129973 \div 12 = 17.63441644$ %					

12.4.4 Comparing Results of Financial and Non-Financial Performance

As shown above CIB Non-Financial Performance can't be measured through financial statements, therefore it was measured through a survey questionnaire distributed to the bank. Non-Financial performance indicators chosen in the questionnaire are Customer Retention, Response Time, and Customer Satisfaction. The data collected from the Qualified responses about these indicators will be used to calculate the average scale for all responses about Non-Financial Performance.

	Average Scale for a 5-Licart Scale	Average scale for all responses related to non-financial performance indicators
Number	3	4.06
Representation	60%	81.2%

As shown above also the CIB financial performance was measured by CIB Financial reports for the year ended December 31, 2021. The Bank Financial performance was measured by ROA and ROE for the year ended December 31,2021 based on CIB financial statements after applying BDA. Also, an average of ROA and Average of ROE in the banking industry in Egypt is calculated and will be used as a benchmark for determining how CIB financial performance looks like. The following table represents the average ROA in the banking industry as a Benchmark compared to ROA for the CIB.

	Average ROA in the banking industry as a Benchmark	ROA for the CIB
ROA	1.9%	2.7%
Representation	60%	85%

The following table represents the average ROE in the banking industry as a Benchmark compared to ROE for the CIB.

	ROE Benchmark	ROE for the CIB
ROE	17.6%	19.5%
Representation	60%	67%

13. Research Results

The results of the case study conclude that all research hypotheses proposed are accepted by the researcher as there is a positive relationship between each of the following.

- Quality of IS resource and BDAQ for the bank.
- Other analytical resources (measured by Valuable, Rare, Inimitable, and Organized) and BDAQ for the bank.
- Quality of IS resource and Other analytical resources grouped together and BDAQ for the bank.
- BDAQ and Non-Financial Performance for the bank
- Analytics quality and firm strategy alignment as a moderator and the relationship between BDAQ and bank non-financial performance.
- Quality of information system and Other analytical resources grouped together and non-financial performance for the bank.

In relation to bank financial performance measured by ROA and ROE. The CIB has the highest ROA (2.7%) compared to other banks in Egypt, While CIB has a high ROE % (19.5%) compared to other banks in Egypt. It is crucial to note that bank non-financial and financial performance are parrel with each other as the nonfinancial performance is achieved by 81.2% while financial performance in terms of ROA is 85% and in terms of ROE is 67%. That is indeed, both bank nonfinancial and financial performance are above average banks performance.

14. Research Recommendations:

The researcher recommends the following for the commercial International Bank in Egypt.

- The bank must develop a long-term strategy to deal with BD and BDA as it plays a very crucial role to help achieve quality of analytics and to get the maximum benefit from it to improve bank performance
- The bank should take into consideration the importance of existence of Other analytical resources that are valuable, rare, inimitable, and Organized for reaching a higher level of BDAQ that integrating BDAQ with Analytics quality-Firm strategy alignment for the relationship between BDAQ and Nonfinancial performance, the bank performance will better and better.
- The bank should continue investing in having a high big data quality system due to its significant role in reaching BDAQ that will improve bank financial and nonfinancial performance.
- Investing in having a BDAQ is the solution to keep pace with the pace of change and shift in consumer behaviors due to digitalization.

15. Suggestions for Future Research:

The researcher recommends the following issues for further research:

- Demonstrating the concept of BDAQ and how it can be defined, illustrated, and modeled is still needs to be further researched with other Variables and how established firms can reach BDAQ in a better way.
- Applying the proposed BDAQ Model in two different firms in the same industry with getting similarities and differences between them.
- Researching and Investigating the Model Stability Across Time or Settings.
- Using BDAQ Model for Improving Decision Making Process.
- Using BSC to Determine the effect of BDAQ on Firm Performance.
- Using BDAQ Model for Equalizing Top Industry Performers in the Market.

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Appendix A: Survey Questionnaire

Tanta University
Faculty of Commerce
Accounting Department



The academic research was of great importance to our community. As researchers there are a duty falling about us to help address our industry's problems and provide appropriate solutions. First, the researcher proposes a research model to explore the impact of Big Data Analytics Quality (BDAQ) on firm performance in view of Resource-based view approach and IS quality measures in IS Success Model along with using a firm strategy that is aligned with analytics quality.

The study is targeting the banking sector and aims to test the effect of having a Big Data Analytics Quality on banks' performance. The study is applied on the Commercial International Bank (CIB).

Yet, this framework needs to be evaluated for relevancy of application, that is why a multiple of questions have been asked, the answers of which would give an indication of the framework relevancy. The researcher wishes that you could help him in this research through filling this questionnaire. The secrecy of answers is assured as they will only be used for research purpose and the results will be sent to you if you wish so.

Personal Information:

1. Name
(optional):.....
2. Age
(optional):.....
3. Job
Title:.....
4. E-
mail:.....

5. CIB Branch

Name:.....

6. CIB Branch

Address:.....

The following statements are related to the Blocks that could constitute the BDAQ and its relationship with CIB Bank financial and non-financial Performance. *BDAQ will be measured by Accuracy, Reliability, Completeness, Relevance, and understandability of output of Big Data Analytics tools and techniques used by bank. Financial performance will be measured by ROA and ROE based on CIB financial statements before and after applying BDA. Non-financial performance will be measured by customer retention, bank response time, and customer satisfaction.* Please carefully read each statement and give your objective opinion on the following questions by marking (✓) against only one of the corresponding 5 choices (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) that you consider appropriate according to your point of view. Scales ranging from 1 to 5 will into taken into consideration in a way that (1=" Strongly Disagree") and (5=" Strongly Agree").

Statements	The degree of agreement					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1) <u>Information System Success as the most important resource</u>						
A. <u>Systems Quality</u>						
1	Bank Big Data Analytics System is Easy to use.					
2	Bank Big Data Analytics System has no unexpected hang downs.					
3	Bank Big Data Analytics System is Reliable.					
4	Bank Big Data Analytics System is Flexible.					

5	Bank Big Data Analytics System response time is low.					
6	Bank Big Data Analytics System Integrates Big Data from different areas.					
B. Information Quality						
1	Bank Big Data Analytics System produce Complete information.					
2	Bank Big Data Analytics System produce Accurate information.					
3	Bank Big Data Analytics System produce Timeliness information.					
4	Bank Big Data Analytics System produce Understandable information.					
5	Bank Big Data Analytics System produce Relevant information.					
6	Bank Big Data Analytics System produce Useful information.					
C. Service Quality						
1	Bank Big Data Analytics System is Responsive.					
2	Bank Big Data Analytics System Communicates with its users.					
3	Bank Big Data Analytics System is Interactive with its users.					
4	Bank Big Data Analytics System is Supportive to its users					
5	Bank Big Data Analytics System is Responding well to its user's needs.					
2) Other analytical resources (Valuable, Rare, Inimitable, Organization)						
A. Other Valuable Analytical Resources						
1	The Bank Other Analytical Resources used can exploit opportunities.					
2	The Bank Other Analytical Resources used can eliminate threats.					

B. Other Rare Analytical Resources					
1	The Bank Other Analytical Resources used is currently controlled by only a small number of competing banks.				
2	The Bank is Developing and Installing a technology that other banks did not possess.				
C. Other Inimitable Analytical Resources					
1	The Bank Other Analytical Resources used cannot be easily copied by competitors.				
2	The Bank Other Analytical Resources used are Costly to be imitated by competitors.				
D. Organization of Other Analytical Resources					
1	The Bank has a formal reporting structure.				
2	The Bank has a management control system.				
3	The Bank has Compensation policies.				
3) Big Data Analytics Quality (BDAQ)					
1	The output of Big Data Analytics tools and techniques used by bank is complete.				
2	The output of Big Data Analytics tools and techniques used by bank is Accurate.				
3	The output of Big Data Analytics tools and techniques used by bank is Understandable.				
4	The output of Big Data Analytics tools and techniques used by bank is Relevant.				

5	The output of Big Data Analytics tools and techniques used by bank is Reliable.					
6	The output of Big Data Analytics tools and techniques used by bank is Formatted.					
4) Analytics quality-firm strategy alignment						
1	The big data analytics plan aligns with the Bank mission, goals, objectives, and strategies.					
2	The big data analytics plan contains quantified goals and objectives.					
3	The big data analytics plan contains detailed action plans/strategies that support company direction.					
5) Firm performance (Non-Financial Performance)						
A. Customer Retention						
1	Using big data analytics improved Number of customers relative to competitors.					
2	Using big data analytics improved Number of active customers relative to competitors.					
3	Using big data analytics improved Number of customers making contract loans relative to competitors.					
4	Using big data analytics improved Number of customers giving the bank more time relative to competitors.					
5	Using big data analytics improved Frequency of customers entering the bank relative to competitors.					

B. Response Time					
1	Using big data analytics improved Number of Requests per second processed relative to competitors.				
2	Using big data analytics improved Average Requests per second processed relative to competitors.				
3	Using big data analytics improved Quick response relative to competitors.				
4	Using big data analytics improved Average Response time relative to competitors.				
C. Customer satisfaction					
1	Using big data analytics reduced customer Waiting time relative to competitors.				
2	Using big data analytics improved Quality of bank services relative to competitors.				
3	Using big data analytics improved the usage of the offered banking products relative to competitors.				
4	Using big data analytics improved response to customer complaints and inquiries.				
5	Using big data analytics provides Innovative Banking services relative to competitors.				

Appendix B: Interview Questions

Questions for the Chief Data Officer and the General manager of Data and Data Warehousing Departments

The interview with the Chief Data Officer and the General manager of Data and Data Warehousing departments was conducted in two days, in the first day the researcher meets the Chief Data Officer and the General manager in his office and in a latter day the researcher continued the interview through a phone call that lasts about an hour. The interview was conducted to gather information about the Following questions related to the Big Data Analytics in the Commercial International Bank (CIB). The following Questions are asked:

- 1- Is what called big data analytics are used inside the Commercial International Bank?
- 2- What is the level of knowledge of the employees in the bank about big data?
- 3- What departments in the bank have knowledge about big data analytics?
- 4- Is big data analytics applied in all CIB branches across Egypt?
- 5- What are the steps taken by the bank to deal with big data?
- 6- Is there an explicit way for CIB to have a big data analytics quality?
- 7- Is the big data analytics quality being measured?
- 8- What are the procedures followed by the bank to obtain the big data analytics quality?
- 9- What branches of CIB actually deal with big data analytics?
- 10- What is the average number of specialists working on big data analytics within CIB?
- 11- Are there financial statements for each branch of the Commercial International Bank separately that can be viewed, or there are only financial statements for the CIB of Egypt as a whole?