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A Business Intelligence Effectiveness Model:
Enhancing Organizational Decision-Making Capability

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ABSTRACT

Business intelligence (BI) is a technology-driven process that contributes toward revealing the position of an organisation in comparison to its competitors, market conditions, and future trends, and presents demographic and economic information. The objective of the research was to identify the elements that determine the effectiveness of BI for organisations. The research proposes a BI effectiveness model to enhance decision-making support by ensuring that decision-makers receive the right information at the right time in the most appropriate format. A quantitative research approach was followed, and purposive sampling was used for selecting research participants within an organisation in the telecommunications sector. The effectiveness of a BI department has a direct impact on the strength of an organization's decision-making capability. The components of the BI effectiveness model suggest focus areas for more effective information flow throughout the organisation, improved information accessibility, improved decision-making, and ultimately, improved productivity.

KEYWORDS

Availability, Business Intelligence, Business Performance, Data, Data-Driven, Decision-Making, Effectiveness, Framework, Information, Productivity, Strategy, Telecommunications, Usability, Utilization

INTRODUCTION AND BACKGROUND

Organisations utilize a technology-driven process for analysing data and presenting actionable information in support of informed business decision-making. This technology-driven process is referred to as business intelligence (BI) and contributes toward revealing the position of an organisation in comparison to its competitors, market conditions, and future trends, as well as present demographic and economic information. To deliver value that aligns with the business objectives and priorities, business intelligence should have a well-executed methodology, processes, governance, and technology. However, the focus areas of BI efficiency are mainly targeted at infrastructure development, information access, becoming more proactive in terms of meeting data needs and

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having a better understanding of needs (February 2017). Although the data is there, it is not readily available and other business units do not know that such data exists (Olszak 2016). This suggests that it is not only about the data, but also about putting systems and processes in place to ensure that data is always available and easily accessible for decision-making (Trieu 2017; Wieder & Ossimitz 2015). Therefore, there is a requirement to deliver more effective decision-making support through the effective deployment of BI structures, processes, and technologies.

Decision makers at all levels devote substantial efforts to making appropriate organisational decisions (Al-Tarawneh 2012). Many important theorists and practitioners consider decision-making to be the most critical, core managerial function. Business decisions must be motivated and the best way to motivate a business decision is by having reliable and consistent supporting data that shows historical trends that can be used to predict future business outcomes (Marin & Poulter 2004; Field 2009). The high volumes of available data in businesses necessitated efficient extraction, storage, transformation, sharing, and disposal processes so that the data could be used effectively to support decision-making (Delen & Demirkan 2013; Richards 2017). Hence the importance of this research, to establish models or frameworks that can be applied by organisations to ensure effective decision-making within organisations.

This research fulfils the gap in terms of providing an effectiveness model that is geared towards the enhancement of decision-making capabilities within organisations. One could describe a model as something which translates strategic intent into operational capabilities. It serves as the foundation to achieve strategic intent. To ensure BI efficiency, organisations must therefore employ a strong focus on the multifaceted technological, organisational, and process-related nature of their BI implementation (Yeoh & Popovic 2016; Surbakti et al., 2019). Hence the importance of this study, to test the effectiveness of current BI implementations to ensure good decision-making capabilities within organisations.

The BI implementation scope is a rather complex undertaking requiring appropriate infrastructure and resources over a lengthy period that, if not managed well, may result in large investments with little or no benefits to the organisation (Delen & Demirkan 2013; Yeoh & Popovic 2016). A business intelligence strategy should take into consideration the appropriate framework, methodology, processes, governance, systems, and technology to deliver value that aligns with the business objectives and priorities (February 2018). The success of a BI initiative should be measured in terms of value creation: whether the BI solution gives the business the tools to get as much value out of their data as possible, while at the same time providing valuable insight that can be applied to leverage enough revenue to cover the cost of implementing the BI solution and make a profit (February 2018). The uniqueness of this study is test whether BI solutions deliver the value that it is intended for, the study is strategic in nature, and not technical in nature which differentiates this study.

The research objectives of the study can be outlined as follows:

- To determine whether the effectiveness of a BI department is influenced by the availability of information to decision-makers.
- To determine whether the effectiveness of a BI department is influenced by the utilisation of the information by decision-makers.
- To determine whether the effectiveness of a BI department is influenced by the existence of a well-defined BI Strategy.
- To determine whether the utilisation of business information is influenced by the existence of a BI strategy.
- To determine whether the utilisation of business information is influenced by the existence of a BI strategy.

The contribution of the study was to recommend a model that would contribute towards more effective information flow throughout the organisation, improved information accessibility, improved decision making and productivity.

In this research study, I explored, through quantitative methods, the effective components of the BI department in terms of delivering decision-making support to decision-makers at all levels within the organisation. For this paper, effectiveness is defined as the level with which the BI department can support Decision-making within the organisation in terms of understanding Decision-making requirements through engagement with decision makers, providing the right information at the right time in the right format to the right person (February 2017).

LITERATURE REVIEW

BI is a capability that provides businesses with tools and methods that support organisations in making effective decisions (Brichni et al., 2015). BI describes a collection of applications, technologies, architectures, and processes for utilizing operational data to timeously provide organisations with the relevant insight to achieve improved operational and strategic decision-making (Gupta et al., 2015). The scope of implementing such a BI capability is more than the acquisition of a combination of software and hardware (Yeoh & Popovic 2016). The BI implementation scope is a rather complex undertaking requiring appropriate infrastructure and resources over a lengthy period that, if not managed well, may result in large investments with little or no benefits to the organisation (Delen & Demirkan 2013; Yeoh & Popovic 2016). To ensure BI efficiency, organisations must therefore employ a strong focus on the multifaceted technological, organisational, and process-related nature of their BI implementation (Yeoh & Popovic 2016; Surbakti et al., 2019).

However, the focus areas of BI efficiency are mainly targeted at infrastructure development, information access, becoming more proactive in terms of meeting data needs and having a better understanding of needs (February 2017). Although the data is there, it is not readily available and other business units do not know that such data exists (Olszak 2016). This suggests that it is not only about the data, but also about putting systems and processes in place to ensure that data is always available and easily accessible for decision-making (Trieu 2017; Wieder & Ossimitz 2015). Therefore, there is a requirement to deliver more effective decision-making support through the effective deployment of BI structures, processes, and technologies. The research question considered by this research study is "*what are the components of an effective BI model that will enable better decision-making capability in organisations*?".

Many organisations use BI to enhance their competitiveness in the market (Ranjan, 2009). The purpose of implementing BI as a competitive advantage is to enable the organisation to collect, store, transform, analyse, and convert data into information that supports decision-making (Marshall and Harpe, 2009, Dalrymple, 2011). Such decision-making capability is enabled through BI solutions that offer the means to transform data into information and derive knowledge through analytical tools to support decision-making (Martin et al., 2011). Analytical tools support decision makers to find the right information quickly and enable them to make well-informed decisions, both from an operational and historical point of view. BI systems bridge operational and historical data with analytical tools to present valuable and competitive information to business planners and decision-makers (Khan and Quadri, 2012). At a minimum, BI reveals the position of an organisation in comparison to its competitors, market conditions, and future trends, demographic and economic information (Khan and Quadri, 2012). Such positioning of an organisation is guided by the organisational strategy and as such, the BI strategy should take into consideration the appropriate framework, methodology, processes, governance, systems and technology to deliver value that aligns with the business objectives and priorities (Mohaghar, 2008).

BI uses methods, trends, and market future orientation, technologies and environment to understand the available capabilities of the organisation, and monitor competition, competitor activities, and the consequences of these activities (Chegini et al., 2013). BI covers functions and tasks of collecting, processing, and analysing a large volume of data from internal systems and external resources. These functions and tasks are possible, as BI uses advanced and agile tools of

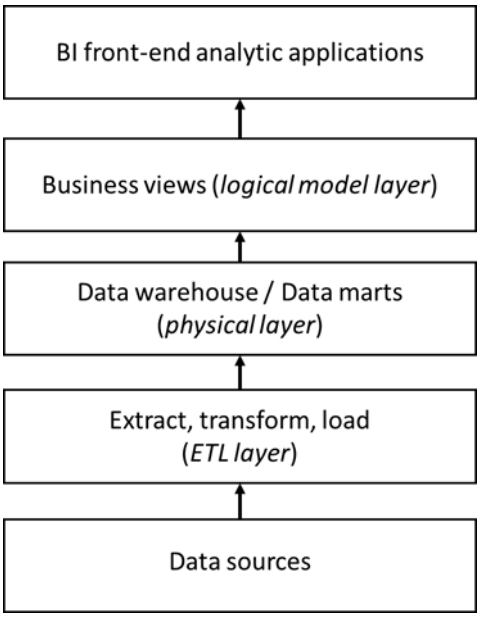
analysis, which help companies make timely and urgent decisions to achieve organizational objectives (Mohaghar, 2008). The concepts highlighted in this section, have a direct impact on the effectiveness of a BI department (Chegini et al., 2013, Khan and Quadri, 2012). These are contributing factors, and are largely dependent on how such concepts are addressed, applied and executed (Olszak, 2016). In the next sections, we consider BI architecture, the BI process, decision-making in the context of BI and measurement of BI.

BI Architecture

System architecture describes how the information technology components are organized into an overall system mostly based on the client-server computing paradigm (Lonnqvist and Pirttimäki, 2006). Client refers to any system component that requests a service from another component, while server points to any system component that receives, act on, and replies to client requests (Lonnqvist and Pirttimäki, 2006, Giachetti, 2010). BI architecture refers to these technology components, as well as to the framework for organising the data, and the management of information that is utilised to build BI systems for reporting and data analytics (Simon, 1998). Due to the focus on information in BI applications, the focal point of the supporting architecture for the BI capability has to consider the information view (Wu et al., 2007, Simon, 1998). From an information view perspective, different options are relevant such as the hub-and-spoke architecture with centralized data warehouse and dependent data marts, the data-mart bus architecture with linked conformed dimensional data marts and the independent non-integrated data marts. Figure 1 shows the components of a conceptual BI architecture (Wu et al., 2007).

The architecture represents the flow of data from the various data sources, into the storage area, through the transformation area, to the point of distribution until it reaches the users via the BI front-end. Data in this instance includes master- and meta-data and is processed by registering the data and identifying its source, where after it is collected and analysed. One of the most difficult challenges of the BI capability is the fact that disparate systems and domains hold different parts of the necessary data. A singular focus must therefore be on effective information delivery and technology integration (Wu

Figure 1. Conceptual BI Model (Wu et al., 2007)



et al., 2007, Wieder and Ossimitz, 2015). The effective delivery of information for decision-making is highly dependent on the efficiency of the BI processes which are presented in the next section.

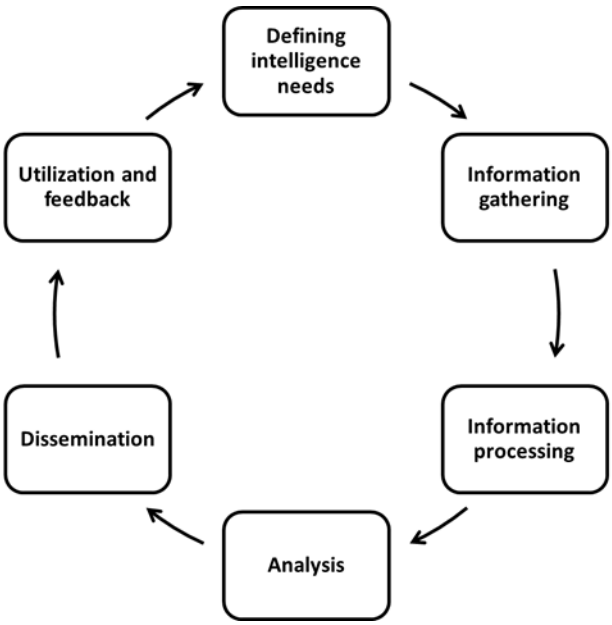
The BI Process

The BI process is the journey from understanding the decision-making requirement to the point where the actual decision is made (NOVINTEL INC., 1998, Pirttimäki and Hannula, 2003). Understanding the decision to be made is fundamental to designing the actual journey or steps to decision making. Conceptually, a BI process constitutes four specific activities: analysis, insight, action and measurement (NOVINTEL INC., 1998, Lonnqvist and Pirttimäki, 2006). The analysis highlights the need for BI and identifies the data required to improve or apply decision making, where insight is generated from the conclusions and knowledge drawn based on the analysed data. Action refers to the outcomes of the insight and decision-making activities and clearly states what will be affected. Measurement considers the outcomes of the actions as a result of insight and informs additional data required to be analysed and further improve the decision-making (Mohaghar, 2008, Sangar and Iahad, 2006). The ability of a business department to be effective in these activities contributes to its ability to support decision makers better within any organisation (NOVINTEL INC., 1998).

Many different models, mostly cyclical, representing the BI process have been suggested by researchers and organisations (Lonnqvist and Pirttimäki, 2006, Shariat and Hightower, 2007). The similar characteristics and phases of these BI processes are depicted in Figure 2.

The nature of a BI process in an organisation may be systematic or ad hoc in nature. Through a systematic process, an organisation may discover new business opportunities or identify trends by constantly collecting competitor-related information or business environment-related data (Premkumar, 2005, Sangar and Iahad, 2006). The execution of an ad hoc BI process enables an organisation to obtain information required for a particular, and often one-time, intelligence need (Lonnqvist and Pirttimäki, 2006, Ritchie et al., 2001). The first step in the BI process is to identify the intelligence requirements of decision makers by identifying the key topics based on qualitative or quantitative data gathered from sources. During the next step, information processing, the collected information is

Figure 2. BI Process (Lonnqvist and Pirttimäki, 2006)



refined and after the refined information is enriched, analysed, and transformed into usable intelligence. In the dissemination phase, the intelligence is delivered to the decision-maker after the intelligence generated during the other steps, is considered and used (Ritchie et al., 2001).

From an organisational perspective, Novintel (NOVINTEL INC., 1998) supports the continuous and systematic process of BI that produces knowledge, insights, and forecasts on an organization's operating environment. The BI cycle is the center of any intelligence system in an organization and it especially focuses on external information and knowledge (Pirttimäki and Hannula, 2003). Therefore, some phases may be in a different order, or missing altogether, depending on the organization and the specific intelligence efforts in question (Pirttimäki and Hannula, 2003).

In the next section, we consider decision-making in the context of BI as enabled by the BI process.

Decision-Making in the Context of BI

Outcomes of the BI process, are to provide a single version of the truth across an entire organisation, to provide simplified system implementation, deployment and administration, and to deliver strategic, tactical and operational knowledge, as well as actionable insight (Premkumar, 2005). When considering these outcomes, then it is suggested that an organisation should design its structure or business processes to facilitate information processing and enable an information processing capability (G. et al., 2015, Wieder and Ossimitz, 2015). An information processing capability will enable decision makers to process a large amount of data that will inform decision-making, reduce cost and improve organisational performance (G. et al., 2015, Valesky, 2007).

Once an organisation has developed a strong information processing capability that matches its data processing requirements, then decision-makers will also be in a position of access to sufficient information and data-driven insights to enable it to make informed decisions (G. et al., 2015, Premkumar, 2005). Such informed decisions not only improve internal business efficiencies but also support business practice evaluation, and the design of new products and services and enable greater flexibility (G. et al., 2015). When an organisation accesses complete and accurate information about the interrelationship between choices and outcomes, then the organisation will be empowered to make successful decisions, generate viable organisational strategies and improve organisational performance (G. et al., 2015, Wieder and Ossimitz, 2015). It is therefore in the interest of the organisation to establish an effective BI capability in support of better decision-making. In the next section, we discuss the measurement of BI in the context of expected benefits.

The Measurement of Business Intelligence

The measurement of business performance has a long tradition in organisations (Pirttimäki et al., 2006). It is a practical managerial tool that can be applied in various situations and for different purposes. In the context of BI, too, some authors have identified its measurement as an important task (Solomon, 1996). Several scholars believe that the measurement of BI is difficult to carry out and only a few organisations have mechanisms in place to measure the value of BI (Gartz, 2004, Hannula and Pirttimäki, 2003, Marin and Poulter, 2004, Simon, 1998). Thus, measurement is considered an important aspect of BI, but at the same time, it is considered difficult to carry out in practice. Pirttimäki et. al. (Pirttimäki et al., 2006) suggest two main goals for measuring BI. Firstly, the valuation of BI should be conducted to prove that it is worth the effort (does it offer the end users the expected value it promises?). Secondly, the measurement of BI activities should follow to help manage the BI processes more effectively.

Table 1 presents the main reasons for measuring BI, the valuation of the effects of BI and the management of the BI process (Pirttimäki et al., 2006). When evaluating BI, it comes down to proving the worth of BI to the organisation. Continuous improvement managers need measures to be able to justify their department's existence (Davidson, 2001). Similarly, executives need to know whether it is rational for them to invest in BI. Thus, valid, and reliable BI process measures may increase the BI discipline's credibility among companies. Moreover, measurement results showing the actual

Table 1. Measuring BI (Lönnqvist and Pirttimäki, 2006)

Purpose for measurement	Main users of measurement information	Expected benefits
Valuation of the effects of BI	• Organisations applying BI • BI service providers • BI professionals • Researchers	• The ability to prove that BI services are worth the effort and demonstrate the actual effects of BI • Increased credibility of BI as a managerial tool • Improved rigour in BI research
Management of BI process	• BI service providers • BI professionals	• Continuous improvement of BI products and services

effects of the BI processes applied in organisations would also be useful for researchers (Davidson, 2001, Pirttimäki et al., 2006).

Another reason for the measurement of BI activities is to assist in managing the BI process. This ensures that the BI products suit the users' needs and that the process is well organised as a BI process can be a high-priced waste if the information gathered is not exact or it does not match the information needs (Herring, 1996, Pirttimäki and Hannula, 2003). The users of this operative measurement information regarding the BI process are likely to be BI professionals in organisations. In this view, the typical measurement purposes, e.g. guiding activities and learning can be applied to continually improve BI products and services (Pirttimäki and Hannula, 2003, Pirttimäki et al., 2006).

In the next section, we address the research approach applied to design a BI effectiveness model for enhancing organizations' decision-making capability.

RESEARCH METHODOLOGY

The research design refers to the overall strategy chosen to integrate the different components of a study coherently and logically, thereby, ensuring that the researcher will effectively address the research problem (Oates 2006). It constitutes the blueprint for the collection, measurement, and analysis of data (Creswell 2012). This section discusses the research approach and provides a view of the methods and techniques used to gather and analyse the research data. To achieve the outcomes of the study and to consider the question "what are the components of an effective BI model that will enable better decision-making capability in organisations?", a quantitative research approach was employed.

Research Procedure and Sample

The design of this research was descriptive and cross-sectional. The research was descriptive because the aim of the research was to explain and describe factors that affect the degree to which business intelligence is used by the decision makers within an organisation. Descriptive research can be either quantitative, or qualitative or both. describes qualitative research as that which focuses on meanings and the way people understand things. It studies the activities of social groups and looks for patterns of behaviour. Quantitative research is an approach for testing objective theories by examining the relationship amongst variables Denscombe (2003:267). The research was cross-sectional because data was collected from the 121 participants who had a one chance opportunity to take part. According to Babbie and Mouton (2002:72), a descriptive research design is suitable for exploratory research of this nature.

RESEARCH INSTRUMENT

Data was collected in a telecommunication organisation in South Africa operating in a market with fierce competition, high demand for customer experience, stringent regulation, and a strong vision to

achieve excellence as a data-driven organisation. Data was collected through an online questionnaire consisting of 26 questions using a 5-point ordinal scale where 1 represented strong agreement, and 5 represented strong disagreement. The online questionnaire consisted of 26 questions using a 5-point ordinal scale. For the online questionnaire, 182 possible respondents were asked to participate, and 121 responses were received. The purpose of the questionnaire was to assess and evaluate the degree to which BI systems were used for making efficient business-related decisions in telecommunications. The online questionnaire consisted of 5 sections:

- **Demographics:** This section of the questionnaire established the profile of the research participants.
- **Assessment on utilisation of business information:** Utilisation in this section of the questionnaire refers to the usage of business information by decision makers across all levels within the organisation.
- **Effectiveness of the BI department:** Effectiveness refers to the level to which the BI department can support Decision-making within the organisation in terms of understanding Decision-making requirements through engagement with decision makers, providing the right information at the right time in the right format to the right person.
- **Availability of information:** Availability refers to the ability to distribute information into the organisation making it available to support decision-making.
- **BI Strategy:** This section refers to a BI strategy used for the enhancement of decision-making capabilities within the organisation.

The four dimensions identified for the research are (1) utilisation, (2) effectiveness, (3) availability, and (4) BI strategy, these were derived from previous qualitative research conducted namely A Best Practise Business Intelligence Framework for the Telecommunications Industry: An Empirical Study.

RESULT

Demographic Profile of Participants

A link to the online questionnaire was emailed to 182 possible research participants and 121 responses were received, yielding a response rate of 67%. Table 1 presents an overview of the profile of the research participants.

In terms of respondent roles, executive and senior management (Director, Executive and General Manager) contributed to just over 15% of the respondent's middle-management (Senior Manager, Manager and Supervisor) contributed just over 16% of the respondent profile with specialists adding 14.88%. Consultants and business partners contributed 4.13% and 3.31% respectively. *Consultants* in this instance refer to contractors appointed on a fixed-term contract in the organisation and the *business partner* denotes an internal representation of the BI department that is allocated to a specific department. The representation of departments in Table 2 indicates that the Sales and Marketing Department contributed 25.62%, the Customer Services department 23.97%, and the Customer Experience Department 12.4% in terms of the research participant profile. The Digital and Online Department was the lowest contributor at 1.65%.

Data Analysis and Findings

This section presents the results of the frequency tables on each of the questionnaire sections where data was collected namely (1) utilisation, (2) effectiveness, (3) availability and usability, (4) BI strategy and framework, as well as reliability and validity tests and Spearman's correlations.

For each table, the variable refers to the statement that required a response from the research participant and for each variable, the count and percentage across the ordinal scale are presented. For each of the 4 questionnaire sections, we present a detailed overview, as well as a summary.

Table 2. Demographic Profile of participants

Respondents role	Count	Percent
Business Partner	4	3.31
Consultant	5	4.13
Director	6	4.96
Executive	9	7.44
General Manager	4	3.31
Manager	38	31.4
Senior Manager	18	14.88
Specialist	18	14.88
Supervisor	19	15.7
Total	**121**	**100**

Department	Count	Percent
Business Intelligence	4	3.31
Customer Experience	15	12.4
Customer Service	29	23.97
Data Warehouse	3	2.48
Digital and Online	2	1.65
Information Technology	10	8.26
Networks	11	9.09
Procurement	3	2.48
Project management	12	9.92
Sales and marketing	31	25.62
Total	**121**	**100**

Reliability

Reliability is measured by the repetition of results (Kaboub, 2008:786). This is achieved by scientific and experimental methods that aim to measure the influence of a specific variable in a situation (Krauss, 2005:759). The researcher seeks to discover, describe, explain facts, and replicate the results given the same set of parameters within the unchanged environment (Yeasmin & Rahman, 2012:155). Reliability tests conducted during this research include Cronbach's Alpha, the normal distribution and spearman's correlation.

Cronbach's Alpha Test

According to Bryman & Bell (2014) reliability is tested using Cronbach's Alpha which is designed to calculate the "average of all possible split-half reliability coefficients. The items in each dimension were recomputed into four thematic areas as per the four dimensions, utilisation, BI strategy and framework, effectiveness, and availability & usability of BI technology.

Table 3 indicates that the Cronbach's Alpha coefficient for all dimensions is greater than 0.7 and overall greater than 0.89. This is an indication of the high levels of consistency and reliability of the data in this research. This means that the questions asked measured what the study set out to measure, a specific focus on consistency.

Normal Distribution Test

Normal distribution tests compare the shape of your sample distribution to the shape of a normal curve. The test assumes that if your sample is normal shaped, the population from which it came is

Table 3. Test scale = mean (standardized items)

Item	Obs	Sign	Item-Test	Item-Rest	Interterm	Alpha
			Corr.	Corr.	Cov.	
Utilisation	121	+	0.872	0.7764	0.503573	**0.8647**
Effectiveness	121	+	0.8662	0.7628	0.500968	**0.8688**
Availability	121	+	0.8847	0.7747	0.454591	**0.8666**
BI Strategy	121	+	0.8746	0.7732	0.487975	**0.8648**
Test scale					0.486777	**0.8962**

normally distributed. Non-normal data can occur because of the scaling of variables (e.g., ordinal rather than interval) or the limited sampling of subjects. Having Likert scale results that *do not* follow a normal distribution does not allow for a parametric test when testing a hypothesis.

Shapiro – Wilk Test for Normal Data

The Wilk's Shapiro test (Table 4) of normality indicates that two out of the four dimensions (Availability and usability) follow a normal distribution, and the p-value is greater than 0.05. Having Likert scale results that do not follow a normal distribution allows for a parametric test when testing a hypothesis, in this case, the paired t-test is applied. The normal distribution graphs below indicate an almost symmetric (bell shape) pattern of data distribution for only two dimensions: effectiveness of the BI department and Availability of BI technology. Refer to figure 3.

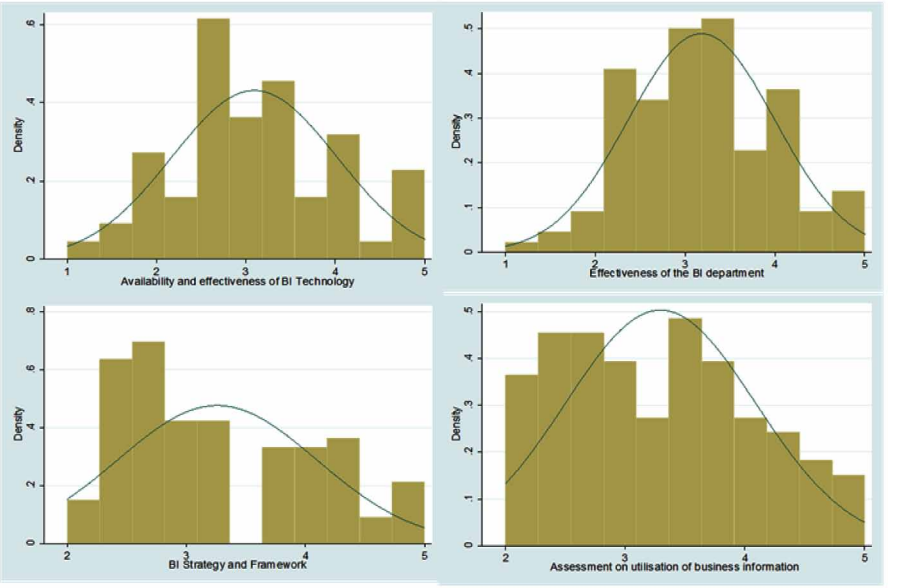
Spearman's Correlation

The Spearman rank-order correlation is a nonparametric measure of the strength and direction of association that exists between two variables measured on at least an ordinal scale. These numbers measure the strength and direction of the linear relationship between the two variables. The correlation coefficient can range from -1 to +1, with -1 indicating a perfect negative correlation, +1 indicating a perfect positive correlation, and 0 indicating no correlation at all. A negative correlation also means

Table 4. Shapiro – Wilk testing normal distribution

Variable	Obs	W	V	z	Prob>z
Utilisation	121	0.971	2.777	2.289	0.011
Effectiveness	121	0.992	0.735	-0.689	0.754
Availability	121	0.990	0.942	-0.135	0.554
BI Strategy	121	0.967	3.232	2.629	0.004

Figure 3. Distribution of data



that low scores on the first are associated with high scores on the second (Ritchie, et al, 2001). In other words, the variables move in the same direction when there is a positive correlation. The variables move in opposite directions when there is a negative correlation. In a sample, it is denoted by p and r. The following table provides results for the association between entrepreneurial intentions and the independent variables. The statistical significance was set at the 5% level.

Table 5 indicates that there is a strong positive correlation between the effectiveness of the BI department and utilisation of business information ($r=0.7$; $p<0.05$), Availability and usability of BI technology ($r=0.71$; $p<0.05$), and BI strategy and framework ($r=0.62$; $p<0.05$). The results are highly statistically significant at a 1% level. These results suggest that a unit increase in each of the three dimensions: utilisation of business information, Availability and usability of BI technology, and BI strategy and framework is likely to increase organizational commitment by a magnitude of between 6 and 7 times. Further, statistically significant results indicate some very weak negative associations between the respondent's role in the organisation and utilisation of business information ($r=-0.23$; $p<0.05$), the effectiveness of the BI department ($r=-0.18$; $p<0.05$), and 4.BI strategy and framework ($r=-2.5$; $p<0.05$).

Factor Analysis

Principal component analysis (PCA) is a statistical technique used for data reduction (STATA, 2014). Principal Component Analysis is a data reduction method; it picks out which factors are critical in each dimension affecting another dimension.

Utilisation

The Kaiser-Meyer-Olkin (KMO) test is a measure of how suited your data is for Factor Analysis. The test measures sampling adequacy for each variable in the model and the complete model. The statistic is a measure of the proportion of variance among variables that might be common. Kaiser-Meyer-Olkin measure of sampling adequacy= 0.8648.

Table 6 indicates that there were two highly influential factors (eigenvalues>1) out of eight in this dimension. They account for a cumulative 63.8% of the total variation in the dimension. These results suggest that the first factor (I am generally dependent on the BI department for my business decisions) could have as much as 4 times as much influence on the utilisation of business information,

Table 5. Spearman's rank correlation

Variable	1	2	3	4	5	6
1. Utilisation	1					
2. Effectiveness	**0.700**	1				
Two tailed-sig	0					
3. Availability	**0.646**	**0.7109**	1			
Two tailed-sig	0	0				
4. BI strategy	**0.727**	**0.6278**	0.7061	1		
Two tailed-sig	0	0	0			
5. Department	0.0592	-0.0948	-0.0188	-0.059	1	
Two tailed-sig	0.5188	0.3011	0.838	0.5206		
6. Role in organisation	-0.233	-0.1798	-0.1019	-0.2458	0.0238	1
Two tailed-sig	0.0101	0.0485	0.2662	0.0066	0.7956	

1 = Utilisation, 2 = Effectiveness, 3 = Availability, 4 = BI strategy and framework, 5 = department and 6 = Role

Table 6. Factor rotation matrix with principal components

Component	Eigen-value	Diff	Proportion	Cum	Principal components (eigenvectors)
I am generally dependent on the BI department for my business decisions.	**4.0174**	2.927	0.5022	0.5022	**0.4642**
I am confident that I can make business decisions in the shortest possible time all the time	**1.0897**	0.228	0.1362	0.6384	**0.4155**
I can provide updated information to my superiors within an hour of the request	0.8617	0.212	0.1077	0.7461	0.2006
I can extract the required information from a central reporting / BI tool	0.6489	0.212	0.0811	0.8272	0.4039
I generally spent less than4 hours compiling reports for monthly EXCO or STEERCO	0.4366	0.082	0.0546	0.8818	0.4077
I use multiple sources for information to support my decision making	0.3545	0.045	0.0443	0.9261	0.4132
My organisation uses automated dashboards and reports to deliver information directly to mobile devices and/or to my e-mail.	0.3088	0.026	0.0386	0.9647	0.3729
My organisation ensures that decision-makers have access to all relevant information to be efficient in their decision-making process.	0.2824	.	0.0353	1.0000	0.3813

and accounts for 50.2% of the total variation in the scale. The second factor (I am confident that I can make business decisions in the shortest possible time all the time) has an almost 1-time influence on this scale and accounts for 13.6% of the total variance.

PCA: Effectiveness

Table 7 indicates that there was only one highly influential factor (eigenvalue>1) out of eight in this dimension. It accounts for a cumulative 62.8% of the total variation in the dimension. The results suggest that the first factor (I receive relevant and accurate information to support my decision-making from the Business Intelligence (BI) department) has 5.0 times as much influence on the effectiveness of the BI department. The factor loadings (0.4) indicate that this factor may not be highly correlated to this scale. The rest of the factors, although they account for the remaining 38% of the total variance in the subscale, have an eigenvalue of less than 1, hence considered not critical or influential in this dimension.

PCA: Effectiveness Versus Availability

Table 8 indicates that there are highly influential factors (eigenvalue>1) out of seven between the two dimensions. These are that a clearly defined BI Framework will enhance decision-making capability within the organisation and my organisation does have an enterprise BI portal/tool which I can extract my information from. They account for a cumulative 73.1% of the total variation in the dimension. The results suggest that the first factor (I believe that a clearly defined BI Framework will enhance decision-making capability within the organisation), has 3.99 times as much influence between the two scales. The second factor (My organisation does have an enterprise BI portal/tool which I can extract my information from) has a 1.1 magnitude of influence in this dimension. The rest of the factors, although they account for 40.7% of the total variance in the subscale, have an eigenvalue of less than 1, hence considered not critical or influential in this dimension. The factor loadings (0.8)

Table 7. Factor rotation matrix with principal components

Component	Eigenvalue	Proportion	Cum	Principal components (eigenvectors)
I receive relevant and accurate information to support my decision-making from the Business Intelligence (BI) department	**5.02**	0.6279	0.6279	**0.3917**
I engage with someone from the BI department regularly, at least once a month	0.86	0.1081	0.736	**0.3312**
I would recommend the service and information offered by the BI department to other colleagues	0.63	0.0792	0.8152	**0.3041**
I am comfortable making decisions based on information provided by the BI department	0.43	0.0544	0.8696	**0.3731**
The BI department notifies me when there are problems with specific dashboards or reports	0.35	0.0437	0.9133	**0.3847**
I trust the integrity of the information I receive from the BI Department	0.29	0.0366	0.9499	**0.327**
The Business Intelligence (BI) department understands all my decision-making requirements	0.24	0.0302	0.9802	**0.333**
During engagements with the BI department, they truly empathize with me to understand my information needs	0.16	0.0198	1	**0.3735**

Kaiser-Meyer-Olkin measure of sampling adequacy=0.8856

Table 8. Factor rotation matrix with principal components

Variable	Eigenvalue	Proportion	Cumulative	Principal components (eigenvectors)
I believe that a clearly defined BI Framework will enhance decision-making capability within the organisation	**3.99**	0.5698	0.5698	0.8469
My organisation does have an enterprise BI portal/tool where I can extract my information from	**1.13**	0.1616	0.7314	0.4883
The enterprise BI portal/tool is easy to use; I find it user friendly	0.73	0.1047	0.8361	0.4369
The enterprise BI portal/tool is fast, it can provide answers to my questions quickly	0.58	0.0834	0.9195	0.4545
I would recommend the use of the enterprise BI portal/tool to my colleagues	0.27	0.0381	0.9577	0.4236
My organisation has a clearly defined and communicated BI strategy in place	0.17	0.0244	0.9821	0.4295
My organisation has a BI Framework in place that ensures the delivers relevant, consistent, and timeous information to all decision makers within the organisation	0.13	0.0179	1	0.4207

for the first factor indicate that this factor is highly correlated to this scale, while the second factor has a moderate correlation to the dimension.

Paired t-Test

A paired sample t-test performs t-tests on the equality of means. The t-test command performs t- tests for one sample, two samples and paired observations. The independent samples t-test compares the difference in the means from the two groups to a given value, STATA calculates the t-statistic and its p-value under the assumption that the sample comes from an approximately normal distribution.

Utilisation Versus Effectiveness

The results from Table 9 indicate that the difference between the means of Utilisation of business information and the Effectiveness of the BI department is positive (0.11) and higher than the hypothesized mean (Ho: mean (diff) >0). The p-value associated with the t-test is statistically significant at a 5% level ($p < 0.05$). A conclusion can be made that there is a 1.98 times effect of the Utilisation of business information on the effectiveness of the BI department.

The Paired t-Test between Availability and Usability Versus Effectiveness

The independent samples t-test compares the difference in the means from the two groups to a given value, STATA calculates the t-statistic and its p-value under the assumption that the sample comes from an approximately normal distribution. The results indicate that the difference between the means of availability and usability of BI technology and the effectiveness of the BI department is slightly positive (0.09) and higher than the hypothesized mean (Ho: mean (diff) >0). The p-value associated with the t-test is statistically significant at a 5% level ($p < 0.05$). A conclusion can be made that there is a weak (1.4 times) effect on Availability and usability on the effectiveness of the BI department.

Table 9. Utilisation of business information and effectiveness of the BI department

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
The utilisation of business information	121	**3.29**	0.07	0.79	3.152	3.437
Effectiveness of the BI department	121	**3.18**	0.07	0.82	3.035	3.329
Diff	121	**0.11**	0.06	0.62	0.000	0.225

Mean (diff) = mean (UTILISATION - EFFECTIVENESS) t = 1.98
Pr (|T| > |t|) = 0.0492

Table 10. Paired t-test between Availability versus effectiveness

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Effectiveness of the BI department	121	**3.18**	0.07	0.82	3.035	3.329
Availability of BI Technology	121	**3.10**	0.08	0.92	2.929	3.262
Diff	121	**0.09**	0.06	0.67	-0.034	0.207

Mean (diff) = mean (EFFECTIVENESS - AVAILABILITY)
t = 1.42 Pr (|T| > |t|) = 0.057

The Paired t-Test Between BI Strategy and Framework Versus Effectiveness

The results indicate that although there is a negative (-0.08) difference between the means of BI Strategy and framework and the effectiveness of the BI, the p-value associated with the t-test is not statistically significant at a 5% level (p <>0.05). A conclusion can be made that there is no relationship between BI Strategy and framework and the effectiveness of the BI department.

Ordinal Regression Analysis

The research aims to assess and evaluate the current level of efficiency in decision-making and propose a suitable framework that could be used by the local telecommunications industry for intelligent and efficient decision-making. To establish this relationship, an ordinal regression analysis is suitable is conducted (Lunt, 2001; Long, J. S, & Freese J. 2014).

Model Specification

Ordered logit models are used to estimate relationships between an ordinal dependent variable (effectiveness of the BI department) and a set of independent variables (utilisation of business information, availability and usability of BI technology, and BI strategy and framework).

Ordered Logistic Regression - Effectiveness

LR chi is the Likelihood Ratio (LR) Chi-Square test that at least one of the predictors' regression coefficients is not equal to zero in the model. Prob > chi2 is the probability of getting an LR test statistic as extreme as, or more so, than the observed under the null hypothesis; the null hypothesis is that all the regression coefficients in the model are equal to zero. Log Likelihood is used in the Likelihood Ratio Chi-Square test of whether all predictors' regression coefficients in the model are simultaneously zero and in tests of nested models. Pseudo R2 is McFadden's pseudo-R-squared (UCLA, 2017).

Table 12 indicates that there is statistically a positive relationship between the effectiveness of the BI department and factors of (i) utilisation of business information (β=0.85; $p<0.05$) and (ii) Availability and usability of BI technology (β=0.75; $p<0.05$). These results suggest that a unit improvement/increase in the utilisation of business information will more likely lead to an improvement in the effectiveness of the BI department by 85%. Similarly, a unit improvement/increased availability and usability of BI technology will more likely lead to an improvement in the effectiveness of the BI department by 85%. Hence a conclusion can be made that improving these factors in these sub-dimensions is likely to increase efficiency in decision- making in this company. Although results for the relationship between factors of BI strategy and framework and effectiveness of the BI department are not statistically significant (p-value>0.05), they indicate a very negligible effect (4%) of the former to the latter. A conclusion can be made that there is no relationship between these two factors.

The department to which one belongs seems to have a very low negative effect (7%) on efficiency in decision making as measured by the effectiveness of the BI department (β=0-0.07; $p<0.05$). The

Table 11. Paired t-test between BI strategy and framework versus effectiveness

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Effectiveness of the BI department	121	3.18	0.07	0.82	3.035	3.329
BI Strategy and Framework	121	3.26	0.08	0.84	3.108	3.409
Diff	121	- 0.08	0.06	0.71	- 0.205	0.051

Mean (diff) = mean (EFFECTIVENESS – BI STRATEGY)
t = -1.19 Pr (|T| > |t|) = 0.2363

Table 12. Ordered logistic regression - Effectiveness

Effectiveness	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
Utilisation	**0.85**	*0.19*	4.51	0	0.479	1.215
Availability	**0.75**	*0.16*	4.83	0	0.448	1.062
Bi Strategy	**0.04**	*0.18*	0.19	0.847	-0.325	0.397
Department	-0.07	*0.04*	-1.87	0.062	-0.135	0.003
Role in the organisation	-0.02	*0.05*	-0.48	0.633	-0.113	0.069
/cut1	1.15	0.77			-0.356	2.666
/cut2	1.55	0.70			0.168	2.922
/cut3	1.79	0.68			0.457	3.123
/cut4	1.97	0.67			0.663	3.285

Number of Obs =118, LR chi2 (7) = 43.6, Prob > chi2 = 0.000, Log likelihood = -117.44, Pseudo R2 =0.156

employees' role is not related to the effectiveness of the BI department; the results are statistically insignificant (p-value>0.05).

Ordered Logistic Regression - Utilisation

Table 13 indicates that there are statistically strong positive relationships between the utilisation of business information and the factors of (i) effectiveness of the BI department (β=0.85; $p<0.05$) and factors of (ii) BI strategy and framework (β=0.87; $p<0.05$). These results suggest that a unit improvement/increase in these two factors will likely lead to an improvement in the utilisation of business information by over 80%. Hence a conclusion can be made that the effectiveness of the BI department and BI strategy and framework have a positive effect on the utilisation of business information.

Ordered Logistic Regression - Availability and Usability

Table 14 indicates that there are statistically strong positive relationships between Availability and usability and the factors of 1. Effectiveness of the BI department (β=0.86; $p<0.05$) and factors of 2. BI strategy and framework (β=0.85; $p<0.05$). These results suggest that a unit improvement/increase in these two factors will likely lead to improvement in the Availability and usability of BI technology

Table 13. Ordered logistic regression - Utilisation

UTILISATION	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
EFFECTIVENESS	**0.85**	0.18	4.79	0	0.502	1.199
AVAILABILITY	**0.08**	0.16	0.47	0.64	-0.245	0.399
BISTRATEGY	**0.87**	0.17	4.98	0	0.528	1.214
Department	0.07	0.04	2.12	0.034	0.005	0.143
Role in the organisation	-0.03	0.05	-0.71	0.478	-0.124	0.058
/cut5	2.12	0.66			0.821	3.422
/cut6	2.36	0.66			1.074	3.645
/cut7	2.76	0.65			1.489	4.026
/cut8	3.08	0.65			1.816	4.346

Table 14. Ordered logistic regression - Availability and usability

AVAILABILITY	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
UTILISATION	0.19	0.1986	0.93	0.35	-0.204	0.575
EFFECTIVENESS	0.86	0.1778	4.82	0	0.508	1.205
BISTRATEGY	0.85	0.1795	4.76	0	0.503	1.207
Department	0.03	0.0358	0.86	0.388	-0.039	0.101
Role in the organisation	0.08	0.0469	1.61	0.107	-0.016	0.168
/cut16	4.924	0.684			3.584	6.264
/cut17	5.283	0.694			3.923	6.643
/cut18	5.482	0.701			4.108	6.856
/cut19	5.622	0.707			4.236	7.007
/cut17	5.283	0.694			3.923	6.643
/cut18	5.482	0.701			4.108	6.856
/cut19	5.622	0.707			4.236	7.007

by over 80%. Hence a conclusion can be made that effectiveness of the BI department and BI strategy and framework have a positive effect on Availability and usability of BI technology.

Resultant Business Intelligence Framework

Resulting from the pathway analysis is a proposed BI framework based on the four dimensions under study.

Figure 4 is a pathway analysis that shows a business intelligence framework that could be used for enhancing efficiency and productivity. The structural equation model depicts the relationships between the four dimensions under study, with a focus on effectiveness of the BI department as an outcome. The pathway analysis is also explained by Table 15.

Table 15 indicates that there are statistically positive relationships between effectiveness of the BI department and factors of 1. Utilisation of business information (β=0.43; $p<0.05$) and 2. Availability and usability of BI technology (β=0.38; $p<0.05$). These results confirm the regression results. They suggest that a unit improvement/increase in utilisation of business information will more likely lead

Figure 4. Pathway analysis

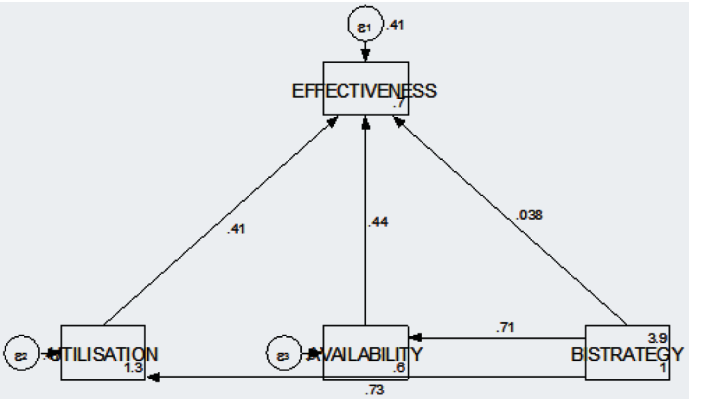


Table 15. Structural equation model

Structural	Coef	StfErr.	z	P>z	[95% Conf. Int]	
EFFECTIVENESS	<-					
UTILISATION	**0.43**	0.089106	4.78	0	0.252	0.601
AVAILABILITY	**0.38**	0.073381	5.22	0	0.239	0.527
BISTRATEGY	**0.00**	0.091357	0.05	0.96	-0.174	0.184
Department	**-0.03**	0.017186	-1.93	0.053	-0.067	0.000
Role in the organisation	**-0.01**	0.022837	-0.6	0.549	-0.058	0.031
_cons	**0.84**	0.295061	2.86	0.004	0.266	1.423

to improvement of the effectiveness of the BI department by 43%. A unit improvement/increase Availability and usability of BI technology will likely lead into improvement in the effectiveness of the BI department by 38%. Hence a conclusion can be made that improving these factors in these sub dimensions is likely to increase efficiency in decision making. Although results for the relationship between factors of BI strategy and framework and effectiveness of the BI department are not statistically significant (p-value>0.05), they indicate very negative effect (-3%) of the former to the later. A conclusion can be made that there is no relationship between these two factors. The department in which the respondent belongs is a significant factor affecting effectiveness of the BI department, consistent with cross tabulations.

DISCUSSION

According to Gartner (2009), every company needs a clear set of goals and objectives to achieve maximum benefits from its business intelligence planning and projects. Articulating such goals are essential, but an organisation must do more to state its goals to achieve its BI and planning objectives. It needs a working framework that provides a blueprint for success. This research conducted confirms that a definite need exists for a Business Intelligence framework that will ensure the delivery of relevant, consistent, accurate and timeous information to decision makers at all levels and departments within the organisation. Coupled with this is the need for a well communicated and maintained Business Intelligence strategy. The researcher concludes that such a framework and strategy drive the effort required to reach all the decision makers within the organisation with the support and information required for their decision making. The business intelligence efforts fail largely within organisation because of ineffective engagement models and the failure to understand what the actual business questions is be answered and which decisions is to be supported with the available information.

The major contribution of the research is that it established a relationship between the four dimensions: Effectiveness, Utilisation, Availability and BI strategy. The relationship becomes known as the BI effectiveness model. The effectiveness model contributes toward establishing a more effective BI department that leads to more efficient decision-making. It contributes towards evolving from the concept of reporting requirements to decision-making requirements. Furthermore, it highlights the importance of having a clearly defined and well-communicated BI strategy and framework. The framework will contribute towards the delivery of relevant, consistent, accurate and timeous information to decision-makers at all levels and departments within the organisation.

The BI Effectiveness Model

The effectiveness of a BI department has a direct impact on the strength of an organisation's decision-making capability. Effectiveness in this context is defined as the level with which the BI department

can support Decision-making within the organisation in terms of understanding Decision-making requirements through engagement with decision makers, providing the right information at the right time in the right format to the right decision maker. It also has a specific focus on the ability to provide an always available, easy-to-use BI technology that can answer specific business questions and support specific decisions in the shortest possible time.

Based on the findings of the quantitative analysis, the proposed model has three specific elements that have a direct impact on the effectiveness of a BI department: utilisation, availability and usability, and BI framework and strategy. The BI effectiveness model is shown in Figure 5 where the circled number represents the relationship established in the quantitative analysis.

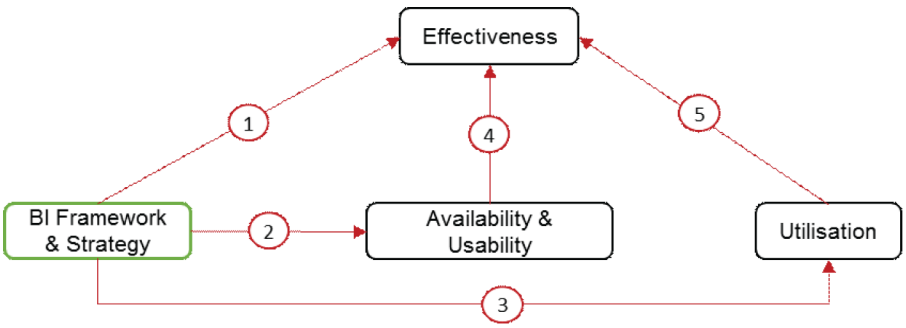
The outcome of the research study established the following relationships between the components of the BI effectiveness model:

1. A defined BI framework and strategy would lead to a more effective BI department.
2. A defined BI framework and strategy would ensure the availability of the information through BI technology.
3. A defined BI framework and strategy would increase the utilisation of business information.
4. Greater availability and usability of the BI technology leads to a more effective BI department.
5. Greater utilisation of business information leads to a more effective BI department.

BI strategy refers to the enhancement of decision-making capabilities within the organisation coupled with a well-communicated BI Strategy. This BI framework and strategy drive the *availability* of technology used for the distribution of information into the organisation which may include an information portal or a BI tool. The BI framework and strategy also have an impact on the *utilisation* of available organisational information by decision makers across all levels within the organisation.

Effectiveness denotes the level with which the BI department can support decision-making within the organisation in terms of understanding decision-making requirements through engagement with decision-makers and providing the right information at the right time in the right format to the right person. Greater *availability and usability* of BI technology and tools lead, to greater *utilisation* of business information, and the BI strategy leads to a more effective BI department in terms of BI department's support of enhanced decision-making in the organisation. To achieve more effective decision-making within the organisation, more efficient support, data architectures and BI processes are required. The proposed BI effectiveness model will ensure the effective delivery of BI, and more so, decision-making support across the organisation.

Figure 5. The BI Effectiveness model



IMPLICATIONS

Traditionally business intelligence has been a very technical subject, a subject driven by available technology and the ability to process more records per second. The actual value of what was produced within the BI department was never questioned or examined. Furthermore, the effectiveness of a BI department has never been researched. This model would contribute towards more effective Business Intelligence delivery within any organisation which will have four specific major implications:

- An effort to understand decision making requirements better.
- Questioning the usability of the information produced by the BI Department.
- Ensuring the design and implementation of a BI strategy and Framework.
- Measuring the actual utilisation of the information produced by the BI Department.

LIMITATIONS AND FUTURE RESEARCH

The views and responses presented in this research is only from one Telecommunications Company. The researcher assumed that all participants would answer the survey questions truthfully. Researching the real impact of having a decision information support management programme within an organisation of which the purpose is to profile decision makers according to their business questions and decisions. Subsequently providing information support to support each question and each decision identified. The impact on the effectiveness of business intelligence departments if they could truly understand the needs and requirements of each decision maker is identified as an area of further study.

CONCLUSION

Organisations invest in BI systems as such a system supports decision-making in the organisation, improves efficiency within the organisation and ultimately, increases productivity. BI is utilised to share information across an organisation through rich visualization capabilities that enable the organisation to improve business performance, solve business problems and design new or improved products and services. However, due to multiple reasons, BI departments often do not understand such decision-making requirements, resulting in a lack of decision-maker support. Therefore, the purpose of this paper was to propose a BI effectiveness model for better decision-making support ensuring that decision maker receive the right information at the right time in the best possible format. The outcome of the quantitative study proposed a BI effectiveness model consisting of multiple components namely utilisation, effectiveness, BI strategy, availability, and usability. A defined BI strategy would lead to a more effective BI department, ensure availability and usability of the BI technology, and would increase the utilisation of business information. Greater availability and usability and greater utilisation of business information of the BI technology led to a more effective BI department. By taking cognisance of these relationships and by ensuring that the key components are in place, organisations may ultimately increase the effectiveness of decision-making. As data were collected in a telecommunication organisation in South Africa, it is acknowledged that further research is required to generalise the findings of this study.

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