A Review of Literature on Critical Factors That Drive the Selection of Business Intelligence Tools

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Abstract— Business Intelligence Systems (BIS) has gained importance across many companies, from small-medium sized to well-established organizations. While there is extensive literature studying the adoption, implementation, and critical success factors (CSFs) of BIS, research focusing on factors influencing the selection of business intelligence (BI) software tools has been limited. The main objective of this paper is to discover and explore literature addressing the issue and concerns of software selection experienced by organizations. Furthermore, constructs and factors influencing business intelligence tools selection will be discovered and explored. The study also seeks to determine and examine important variables of interest relating to technical and non-technical factors in order to improve the selection of appropriate software tools that will assist in meeting the organization needs and objectives so as to successfully implement BIS. A narrative literature review was employed and a total of 32 studies was found significant; these studies are divided into three categories 1) selection methodology, 2) evaluation criteria, and 3) evaluation technique. Moreover, factors relating to a software tool, vendor and opinion emerged as influential in the BI tool's selection process. Lastly, the business intelligence conceptual model has emerged from the reviewed literature.

Keywords— *Business Intelligence (BI), Business Intelligence Tools, Business Intelligence Systems (BIS), Software Factors, Software Selection.*

I. INTRODUCTION

Given the observed development and upsurge use of business intelligence, software tools implementing and delivering successful BI solutions have become a crucial determinant that influence the success of BI systems [1]. The emphasis around important questions concerning project designers and decision-makers in previous studies has led to BI tools being classified as a top priority [2][3]. Some of the failures observed in business intelligence projects are a result of technological problems; particularly the inappropriate selection of the software employed [4].

Many successful organizations, from start-up to well-established, have invested many resources in decision support systems (DSS) as the basis and foundation for decision making [5]. The new era of business intelligence has stimulated many organizations to get rid of traditional methodologies of reporting and decision making, which depend on human intuition [6]. There are numerous benefits BI offers and the first and initial step in achieving the benefits' is the appropriate selection of software and technology capable to implement successful solutions [7]. Literature has significantly revealed that the selection of

suitable BI tools is difficult, time-consuming and problematic for many organizations [8][9].

The main aim and objective of this paper is to investigate and explore factors to consider when selecting business intelligence tools; methodologies; and the criteria required to be followed in order to provide guidance for organizations embarking on the BI software selection process. The paper also intends to provide insight for future research within the BI field.

The researcher found it critical to define the following important definitions useful from the onset:

- Business Intelligence (BI) is defined as the practice and process of using technology and application software tools to extract and transform raw data into useful information with the purpose to help organizations, executives and individuals to make sound and informed decisions [10].

- Business Intelligence Tools (BITs) are defined as the set of application software used to collect, transform and process data gathered from organizational data sources which enable the conduction of business reporting and improved organizational operation [11].

II. LITERATURE REVIEW

The issue of business intelligence software tools selection has been in the research domain for years and its literature dates back to more than two decades ago [12][13][14]. During the 2000's, many studies conducted over the years have shown that the appropriate selection of business intelligence tools is deemed complex and it is a taxing process to embark on as an organization [15]. By the early 2000s the nature of the software tool selection problem was a result of multiple product offerings in the market and the capability of vendors to produce more advanced products which complicated the selection procedure [16]. Shariat and Hightower Jr [15] posit that from a single Google search of "Business Intelligence Tools" presents thousands of responses and several vendor results.

Lately the focus has changed to the nature of the problem being attributed to the organization's failure to select and choose appropriate BI software tools that meet the organizations needs and objectives [17][18][19]. The consequences of inappropriate selection of software tools are: organizational economic loss, improper strategic decisions, abandoned projects and failure to implement sound BI systems[20]. The staggering percentage of business

intelligence systems failure, as a result of technological and managerial factors, is between 70% to 80% [18]. After years of attempts to significantly solve the problem of the rate at which BI projects fail, an intense and in depth analysis around the topic is required [20].

According to [21], failures of BI projects implementation are attributed to two universal viewpoints namely; technological and managerial obstacles. To curb some of the technological related issues, organizations must employ suitable software tools to meet the organizational needs. Critical success factors studies have shown that the success or failure of the BI systems implementation is also dependent on the choice of tool you employ as an organization [7] therefore it is necessary for organizations to put in place strong and correct data platforms [22]. Fig 1 below depicts a subset list of BI Tools providers and technology platforms in the market as per Gartner's 2019 mid-year magic quadrant. This helps organizations to ascertain how technology service providers are executing the stated vision and how they are performing against Gartner's market view [23].

Fig 1: Magic Quadrant for Business Intelligence Tools [24].

III. METHODOLOGY

The research aims at determining the literature speaking to the selection of software tools or technology within the BI space. It also seeks to collate all the relevant literature about the selection of software to help organizations to make informed decisions during the software selection process. Furthermore, scholars will benefit from the paper, especially those conducting studies within the business intelligence field.

The researcher employed a narrative literature review. A narrative literature review is commonly known as the traditional way of conducting reviews, it includes a comprehensive, objective and critical analysis of knowledge around the topic. In order to ensure and provide a greater level of validity in the findings the following measure steps were followed:
- Search strategy and a search for relevant studies (determine corpus)

- Study selection process
- Quality assessment for the study
- Analysis of extracted information

The steps noted above are further described:

A. Search strategy and search

The search strategy includes a search of papers contributing new and valuable knowledge. A dry run to ascertain resources that need to be searched was conducted on IEEE explore library and other research databases. The researcher makes use of the following strings interchangeable:("Software selection" OR" Business intelligence tools selection" OR "selection of software tools" OR "selection of technology"). The information which was retrieved through the search strings for the dry run purpose was used in the main search study to develop and validate major searches.

The following terms were used in the final study: ("information systems selection" OR "Business Intelligence Tools Selection" OR "BI Tools Selection" OR "BI Software Selection" OR "Technology Selection") AND ("Selection Process" OR "Selection Methodology" OR "Choosing Business Intelligence Software" OR "Software Evaluation Process" OR "Business Intelligence Vendor Selection"). Multiple responses were returned after using the keywords and the researcher filtered the search as per the research requirements which is keen at looking for both new and old literature since the software selection problem has been in existence for more than two decades.

B. Publication Selection

The inclusion criteria of studied literature was based on studies that speak to business intelligence software tools selection. The relevance of articles reviewed was based on the number of citations the research paper has as well as the research papers building on the previous work, which has been done around the subject of tools selection e.g. software selection, a methodology for software tools selection, evaluation criteria for software tools, evaluation technique for software tools and software tools supporting decision making. Moreover, the inclusion criteria was based on an article contributing to new knowledge and information that was not previously identified in preceding articles.

Exclusion criteria were mainly based on all articles not related to the software selection literature, after reading the title and abstract of papers. All the papers which fall outside of the research scope, which is keen on discovering previous studies addressing the issue of software tool selection in business intelligence, were excluded.

C. Quality Assessment

To measure the quality of the final list of publications used in the literature review, the researcher answered the following questions by marking the list either true, false, and/ or not applicable thus resulting in the material presented in TABLE I:

- Is the software selection of business intelligence tools clear in the article?

- Is material selected speaking to the software selection?

D. Extracted Information

The literature review was performed by the first researcher whose responsibility entailed data extraction and the analysis of information. The secondary researcher was responsible for the guidance and validation of the information used in the study. The summary of contribution from the reviewed literature in the field of software selection/ BI tools selection is provided in TABLE I (as per references).

TABLE I: A Summary of Reviewed Literature

Literature Type	Software Type	Author(s)
Selection Methodology	Big Data	[8][34]
	Business Intelligence (BI)	[5][7][9][11][16][18][24] [26][29][35][36][38][42][43]
	Decision Support System (DSS)	[4][5][17][19][37]
	Enterprise Resource Planning (ERP)	[27][30][31][33][37]
	Extract, Transform, Load (ETL)	[1][3][14]
	Packaged Software	[12][13]
	Project Management (PM)	[44]
Evaluation Criteria	Business Intelligence (BI)	[9][16][26][32][42][43]
	Decision Support System (DSS)	[4][37]
	Enterprise Resource Planning (ERP)	[31][33]
	Extract, Transform, Load (ETL)	[2][3][14]
Evaluation Technique	Business Intelligence (BI)	[1][16][26][27][28][35]
	Enterprise Resource Planning (ERP)	[27]
	Extract, Transform, Load (ETL)	[2][3]

IV. SELECTION OF TOOLS (BUSINESS INTELLIGENCE)

Business intelligence has received more focus and has become a priority; for scholars, practitioners, and information systems(IS) organization executives; with many companies investing more resources in software services and BI cloud [25]. Despite the growth and evolution of the types of business intelligence solutions that can be adopted, a high risk of failure and inappropriate selection of tools still remains. Given both the developments and failures observed in the BI space this has resulted in a major focus and rise of academic studies and research in the selection of information systems which are categorized into four different groups viz: selection and evaluation of software tool, selection methodology, criteria for tool selection, selection and automated decision-making systems [26][27].

The literature review shows that decision making in the field of software technology selection becomes more complex and difficult as the number of product offerings and multiple tools flood the market [7][16]. Apart from the vast amount of product offerings to choose from, there are thousands of vendors offering BI solution services [28][29]. The problem of the choice of tool to use, is regarded as an organizational strategic decision, that impacts organizational performance [1]. If the selection of the software tool is not guided by a concrete plan, the acquisition of the software tool to employ then becomes a major distraction to the organization's objectives [18][30].

According to [26] the selection and acquisition of software are complex due to the following: 1) Difficulty in finding application of software to meet organizational needs, 2) Incongruities between numerous hardware and software systems 3) Lack of essential technical knowledge and technical experience from final decision-makers and 4) Innovation and advancements observed in technology. It is ubiquitous that during the process of software selection organizations often allocate minimal time for the process; this coupled with the enormous amount of pressure decision-makers are under, this not only has a negative effect on decision-makers but it also effects the outcome e.g. lack of time and experience to plan the selection procedure [27].

A. The Methodology For Selection of Software Packages

Methodology for software tool selection encompasses procedures and steps which final decision-makers follow during the software selection process [31]. The methodology is used and projected as an adaptable guideline based on the organization's requirements and needs. According to [26][31] the methodology consists of six sequential steps that need to be followed:1) Definition of requirements; 2) Preliminary investigation of the availability of software tools and packages; 3) Shortlisting of software packages; 4) Evaluation criteria establishment; 5) Evaluating software packages and 6) Selecting appropriate software package.

The previous studies conducted by [8][17] highlight the severity of problems operational managers continue to endure and experience while choosing software's that are suitable for the business requirements given the various methodologies researchers have proposed over the years, hence [8][17] posit that decision-makers need to clarify their needs and state what the software packages must entail and offer, thus the critical factors influencing software tool selection are vital.

B. Software Evaluation Criteria

The Literature concerning selection and evaluation of software provides a criterion which aids organizations to evaluate software packages e.g. data mining, CRM, DSS, and ERP [4][32][33]. The literatures studied lack a generic criteria that can be employed and followed for the evaluation of any software package. With the current state of the criterions the meaning of each evaluation can be interpreted by the evaluator in whichever manner. Some of the observed literature solely focus and emphasize on the quality and functionality attributes of the technology software and disregard crucial factors associated with a vendor, opinion, and cost and benefits [25]. Fig 2 depicts the evaluation criterion which includes several characteristics that need to be consider for the selection of technology software tool [26].
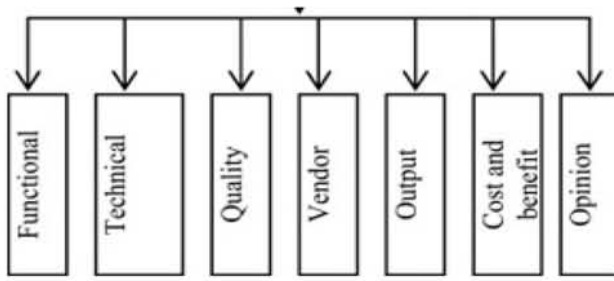
Fig 2: Technology Software Evaluation Criteria [25].

The components depicted in Fig 2 are defined and interpreted as follows: Functional criteria denotes the practicality and ability of the technology software tool, the functional capabilities for a software package are said to vary e.g. ERP, CRM, BI, and data mining [7].The Technical criteria component denotes technical requirements concerning the software and hardware characteristics [32]. Quality criteria are responsible for assessing the eminence of the software; *ISO/IEC 9126* stipulates the quality model and features that need to be considered for evaluation of the software tool [33]. Vendor criteria are concerned with the valuation of the vendor ability and capability regarding the software tool they offer[29]. Output component measures the ability of the software tool to support other systems outputs e.g. output to other packages [34]. Cost and benefits component measures the affordability and aids of the software tool. Opinion component measure the advice, perception and views surrounding the software tool by different stakeholders [26].

C. Software Selection Factors

Plethora of literature [14][17][32] has revealed that software tools selection depends on both technical and non-technical factors, these factors are interrelated and need to be considered equally thus neither of them weigh more than the other [32]. For the aims and objectives of this paper, the researcher will focus on technical factors(functional) and non-technical factors(non-functional).

1) Technical Factors

Technical factors are the type of factors which focus on the practical aspect and the capability of the software tool to deliver the desired results and outcome without experiencing technical issues and problems [7]. According to [35] software tools must conform to a certain number of characteristics in order to be considered suitable and capable to deliver their intended competences and subsequently deliver the intended value and objectives, namely: reliability, functionality, efficiency, usability, and maintainability. TABLE II depicts a list of some of the technical factors gathered from previous literature along with the variables of interest (constructs) which previous research deems crucial for consideration during the selection of software tools.

TABLE II: The Technical Factors Influencing Selection of Packaged Software [12][18].

Technical Construct	Technical Factor's
Software Tool	>Availability of an integrated hardware/software package >Compatibility with existing hardware/software >Ease of use/user-friendly >Functionality >Availability of source code
Vendor	>Availability of technical support >Availability of user manual for important information, tutorial for learning and troubleshooting guide >Technical skills >Experience in using product developed by same vendor >Quality of product
Opinion	>Potential vendors/sales representatives >In house "Experts" >External Consultants >Computer/IS trade magazine, software product leaflets

2) Non-Technical Factors

Non-Technical factors are the types of factors that do not involve the technical ability of the technology software and focus on the non-practical aspect of the software tool [36]. Literature has shown that these types of factors play an important role in the acquisition of the software and in most cases are overlooked [37]. Although non-technological factors are influential and dominant during BI initiatives, in most cases they are disregarded as their significance and importance are questioned by many. This is because they are considered as being time-consuming during an already taxing process of acquiring a suitable technology to employ [38]. TABLE III depicts the list of non-technical factors and variables of interest that are important to consider when selecting the software technology to employ, as per literature.

TABLE III: The Non-Technical Factors Influencing Selection of Packaged Software [12][18].

Non-Technical Construct	Non-Technical Factor's
Software Tool	>Price >Popularity >Lifespan >Version currently in the market
Vendor	> Reputation > Business Skills > References > Past business experience with vendor > Ethics and Integrity > Professionalism
Opinion	> Subordinates > End-users >Outside acquaintances >Improvement in customer service

D. Variables of Interest

There are two types of variables that emerged from studied literature, namely independent and dependent variables. The independent variable is referred to as a variable with a strong and contingency effect on the studied phenomenon [39]. Independent variables consist of the vendor, software tool and opinion variables as they are said to have a strong contingency effect in the software selection

process. The dependent variable is referred to as the variable being analysed and studied [39]. Dependent variables play a vital role during the software tool selection process. They are measured by software tool, vendor, and opinion related characteristics. These characteristics serve as determinants and have an influence on the choice of software to select (outcome). Furthermore, it can be measured quantitatively or qualitatively based on the extent to which each character is significant e.g. software tool level of functionality can either have a minimal/ major extent during the selection process and/or the software tool performance can either be very good/poor. Dependent variables include critical factors (significant factors per construct).

1) Software Tool Construct

The Software tool construct refers to a set of technologies, practices, and applications used for the extraction, transformation, analysis, and presentation of organizational information in order to achieve sound planning, reporting, and insights [34]. The Software tool construct consists of both technical and non-technical factors. The technical factors for software tool construct are listed in TABLE II (not limited to the list). The most prominent technical factors of software tool construct that appeared in most articles include functionality, efficiency, ease of use, reliability, and maintainability of the software tool. Apart from the aforementioned technical factors of software tool construct; underlying code set, and availability of source code are also some of the technical aspects that were highlighted in some of literature reviewed. Contrarily, non-technical factors focus more on the cost and price of the software tools which are said to be expensive and exorbitant nevertheless the return on the investment is often valuable [40][41]. Lifespan, popularity, and version of the software currently in the market also emerged as significant non-technical factors.

2) Vendor Construct

The vendor construct component refers to the custodian, external companies, and consultant personnel responsible for providing support for business intelligence services [41]. The market is flooded with vendors providing and offering BI products and platforms designed to solve organizational and data embedded problems [42]. BI vendors play an important role in the selection of software since they are viewed as experts and specialists of BI products [43]. Technical factors for the vendor include technical support, technical skills, user training and experience [32], thus vendors are required to possess a high level of technical expertise and problem-solving skills. The non-technological factor characteristics are measured by business skills, reputation, references and past business experience with the vendor, just to name a few from TABLE III.

3) Opinion Construct

Opinion construct refers to the perception and views of business intelligence fraternity and IS management regarding the BI tool to employ. What BI professionals and decision-makers deem of the tool along with what the feedback they receive from peers and competitors of the tool, often has an influence on the choice of tool they select to employ [26]. In the literature reviewed, opinion appeared as one of the vital constructs consisting of a multitude of factors to be considered during the software selection process. As a software tool and vendor construct, opinion consists of technical and non-technical factors. The technical factors of

opinion construct comprise of in-house experts, potential vendors/salesperson, software product leaflets and representatives of external consultants, whereas non-technical factors focus on outside acquaintances, subordinates, and end-users.

E. Conceptual Model

Based on the theoretical framework and literature for software selection in data mining (in fig 3), packaged software and project management [12][26][44]; the conceptual model has emerged which the researcher's view may help to guide an in-depth analysis of the software and BI tools selection studies.
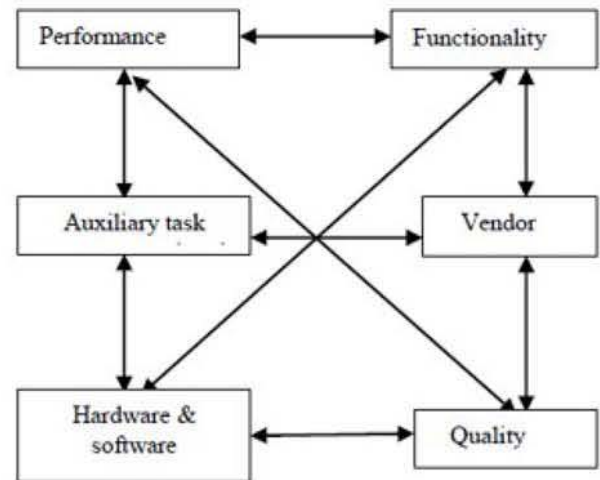

Fig 3: Big Data Software Selection Framework [26]

The researcher proposes the conceptual model depicted in Fig 4 as very few frameworks are found in literature speaking to the selection of business intelligence tools or software. The model may be used as a guide and lens for studies within the business intelligence field. Important concepts from theories in packaged software, project management, and data mining which are closely related to the BI tool's selection phenomenon are employed and used to develop the conceptual model.
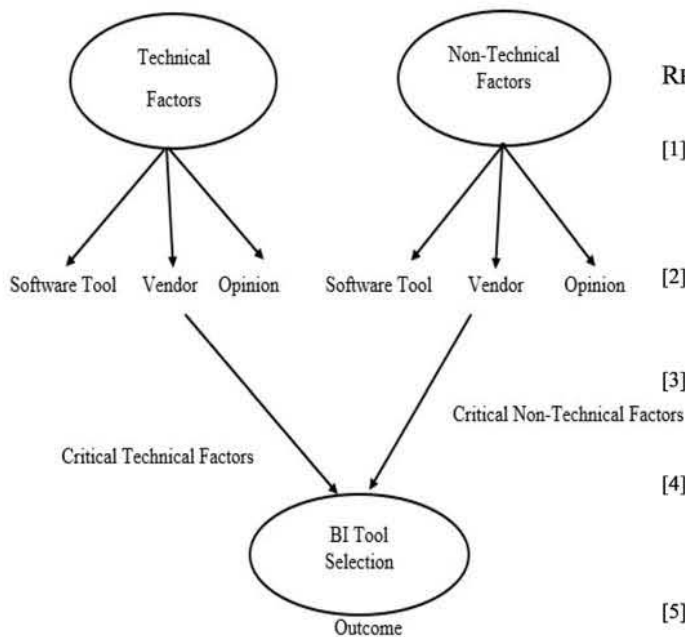
Fig 4: Conceptual Model for Business Intelligence Tools Selection

V. CONCLUSION

The process of selecting an appropriate business intelligence tool plays a vital role in the successful implementation of business intelligence systems in order to meet the organization needs and objectives. Our study was aimed at identifying and discovering factors influencing the selection of business intelligence tools. A narrative literature review was utilised to identify and focus on selection methodology, selection criteria and evaluation criteria. The results showed that a variety of technical and non-technical factors linked to a software tool, vendor, and opinion constructs are critical. Furthermore, the results revealed that technical and non-technical factors are interrelated therefore they need to be equally considered. The paper also provided business intelligence linked definitions. Moreover, a conceptual model emerged from the reviewed literature which can be adopted and used as a lens for future studies seeking to discover critical factors for the selection of software, as a minimal number of frameworks relating to the selection of tools are available. The literature review leads to the conclusion that a study is necessary to investigate which focused factors are crucial for business intelligence from the discovered list, as no previous studies have solely focused on the BI space, this will assist in reliably and accurately testing the factors that are critical for BI tools selection.

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