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A Hybrid Framework for The Implementation of Business Intelligence Systems in Small Scale Enterprises

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Abstract

Small scale enterprises can improve their operations by implementing business intelligence systems. The business intelligence systems are complex and require expertise to ensure successful implementation, hence the need for small scale enterprises to determine their readiness before undertaking the project. To improve chances for successful implementation, this study proposed a framework to guide small scale enterprises on the requirements for business intelligence systems. The design steps defined by Edwards and Goodrich & Tamassia were followed to design the framework. The framework components were informed by the Diffusion of Innovation and Technology Organization and Environment theories, the Information Evaluation Model, and the critical success factors for BIS implementation. A small business may evaluate its resources against the framework components to determine whether to implement a business intelligence system. In future, the framework may be extended to include weights and other criteria to calculate a business's status.

Keywords: business intelligence, implementation framework, small scale enterprise, business intelligence system

1. INTRODUCTION

The harsh and complex economic environment has seen many Small-Scale Enterprises (SSEs) failing within a few months from inception. The business environments in which they operate in are growing rapidly, require good decision making and quick response to changes in the environment [12]. Implementing Information Technology (IT) solutions to support and manage a business's operations is one way of ensuring that the organization remains competitive. Business Intelligence Systems (BIS) are an example of an IT solution that can help to make relevant, accurate and informed decisions [7].

The authors in [6] defined a BIS as a tool that helps to gather, store and analyses data using analytical tools to improve an organization's decision making. Businesses can improve their productivity, operational performance by using the

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information from the BIS to inform decisions [1]. Organizations that implement BISs benefit from the systems' ability to provide analyzed data that can be in turn used to improve operational and strategic processes [8].

BISs are complex because of the highly complicated math functions involved in their features. The functions require appropriate infrastructure to function efficiently [14]. The infrastructure requires a high level of expertise, but the SSEs do not have the skills thus making it difficult for them to successfully implement the BISs [15]. SSEs require the knowledge if implementation is to be successful. An assessment of the BIS before buying and implementing them is a critical task for managers [3]. Evaluating the organizations against the requirements for BIS implementation may assist the SSE to know their status before an implementation attempt, which may prove expensive if it is unsuccessful or fails. The study therefore seeks to define a framework that will guide SSEs in evaluating their readiness to adopt BIS.

2. LITERATURE REVIEW

A review of literature was done to understand how frameworks can be designed.

2.1 Framework

A framework is a description of how to implement, create or manage a process [4]. An outline of interlinked ideas that support a specific objective and can be modified is a framework [5]. A framework is defined to communicate and understand problems and how they can be resolved. In this study, the framework is defined to assist SSEs to evaluate their resources to determine whether they are ready to adopt a BIS or not.

2.2. Framework design

The authors in [10] defined a step-by-step guideline that may be adopted when solving a design research problem. Identifying the problem is the first step, that is determining the need to develop the design. The objectives of the design must be specified to guide the process and ensure that the target product is achieved. Design and development of the solution defines the components of the solution which are then demonstrated to target users. The evaluation step is aimed at measuring the worthiness of the solution against its objectives. The resultant solution is communicated to the users when it has been successfully evaluated that is meet the objectives for its development. Figure 1 summarizes the design approach.

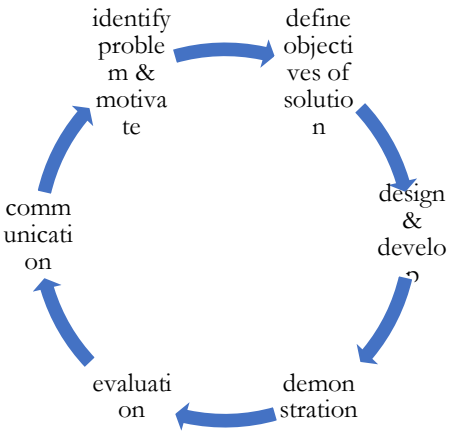

Figure 1 design research [10]

A framework may be designed by following the design steps defined by [2]. The authors defined steps which can be summarized into five steps as shown in Figure 2.

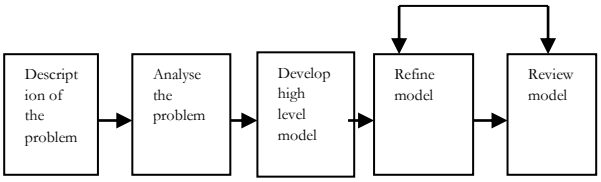

Figure 2 Framework design steps [2]

Literature identifies many approaches to framework design. The objective of the solution influences the choice of methodology to adopt. The approaches defined by [2] were combined to ensure that the limitations of one approach were complimented by the other approach. The step-by-step approach they defined is easy to follow as it involves common activities in software development.

3. METHODS

The methodology describes how the framework was designed, outlining the steps and methods followed to accomplish the target objective. The framework was designed following the design steps defined by [2]. A description of the activities carried out follows.

3.2. Description of the problem

The design starts with a description of the problem. Today's SSEs generate a lot of data through the various sources. This makes it difficult to extract meaning from the disintegrated data which could be useful for the success of the business

[9]. The complex BIS technology requires SSEs to have relevant skills for a successful implementation. The shortage of expert BIS skills in SSEs motivated the study, to design a framework that they may use to determine their readiness level, before embarking on a BIS implementation project.

3.3. Analyze the problem

A survey conducted to investigate the extent of BIS adoption by SSEs in Namibia indicated that most SSEs have not adopted these systems despite the benefits they may bring to their operations. The extent of adoption was measured against dimensions based on the DOI and TOE theories, the IEM and the critical success factors for BIS implementation to indicate that SSEs meet specified aspects for some dimensions yet they lack on others. These results further motivated this study to design a framework that will help SSEs to evaluate resources against the requirements for implementing a BIS and determine their readiness level.

3.4. Develop a high-level framework

The framework was informed by a review of the critical success factors (CSFs) for BIS implementation, the DOI and TOE theories as well as IEM. The readiness dimensions were derived from these theories, and they include Relative Advantage, Compatibility, Observability, Tradability, Complexity from DOI, technological, organizational, and environmental dimensions from TOE namely Technology, Organization and Environment.

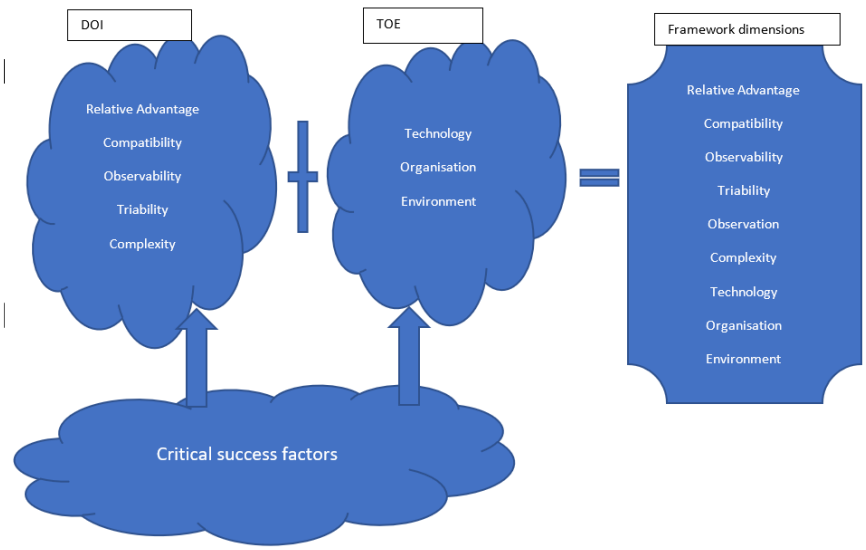

Figure 3 high level framework

Figure 3 shows the high-level framework dimensions derived from the combination of the CSFs for BIS implementation, DOI and TOE theories. For SSEs to successfully implement a BIS, they must consider the aspects defined in each of the framework dimensions.

3.5. Refine specifications of the framework

The specification of the framework was refined at each iteration of steps four and five. More dimensions and aspects were reviewed to ensure that the framework addresses all the critical success factors for BIS implementation by SSEs. The step involved consolidating similar aspects from both theories thereby eliminating duplication of aspects. For instance, both DOI and TOE had aspects relating to organization, these aspects were integrated into the organizational dimension instead of evaluating them under each theory. The objectives of the framework design were thus finalized and are shown in Figure 4.

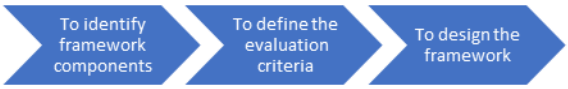

Figure 4 objectives of the framework design

3.6. Design a framework

The design of the framework involved identifying its components from the DOI, TOE theories and IEM. The theories define dimensions which can be evaluated by considering several aspects against which an organization's readiness to adopt BIS can be measured. Table 1 shows the identified components.

Table 1 Framework components

	Dimension	Aspects
DOI DIMENSIONS	Relative Advantage	• Improve operational efficiency • Reduce operational costs • Improve organizational performance • Increase Competitive advantage • Improve decision making • Availability of data storage platforms
	Compatibility	Availability of hardware and software resources for BIS use Data storage and accessibility Use of data in decision making process Impact of new technologies on data management

		Change process in organization
	Observability	• Prior BIS knowledge • BIS usage by competitors
	Tradability	• Participate in BI related issues
	Complexity	• BIS expertise in organization • Data analysis expertise in organization
TOE DIMENSIONS	Technology	• Currently used systems and hardware • Ease of use of current software, security • Software license issues • Availability of data analysis software • Defined data handling procedures and adherence • Review of data handling procedures
	Organization	• Factors hindering BIS adoption • Knowledge in BIS • Capital requirements • Readiness to migrate • Availability of BIS that support the processes • Change and reception of change by organizational stakeholders
	Environment	• Availability of data analysis service in house • Competitors using BISs • Funding capital requirements • Availability of BIS support • Availability of BIS relevant to operations

3.7. Review and evaluation of framework

Walkthroughs were conducted by other researchers to check the framework logic and test whether the framework addresses the goals and objectives for which it was designed. The tests were conducted at each step of the framework design, with refinements implemented at each iteration. The framework was tested at all stages of its development to ensure that anomalies and errors are dealt with early. Walkthroughs were conducted by a peer researcher to test whether the framework supports the objectives set for its development. The tests conducted are summarized in Table 2.

Table 2 test results of walkthrough

Test aspect	Result
Aspects inform the dimensions	Aspects identified measure the stated dimension for an SSE. The aspects are also part of the critical success factors identified in literature review.
Aspects included in the DOI and TOE theories	Some dimensions had aspects that are related to one or more dimensions in the framework. This was more of duplicated aspects. Tradability, Observability and Complexity dimensions had one aspect defined for each of the dimensions. The aspects matched with those in Relative Advantage. The relating aspects were thus extended to incorporate the details specified in the other dimensions.
Aspect's description clear to understand	The phrases are brief and clear with a few that require rephrasing
Aspects are logically arranged	The aspects are grouped by dimension and the dimensions laid out in the order of the weights assigned to the dimension
Logical relationship of dimensions	The dimensions were mixed up, not allowing a proper consideration of each dimension.
Are dimension weights assigned reasonable	Weights assigned to each dimension are justified.

The walkthrough process revealed that some aspects appeared in more than one dimension causing redundancy in the evaluation process. The duplicate aspects in dimensions were eliminated and the dimensions that evaluated similar aspects were combined. For example, the aspects defined for the Tradability, Observability and Complexity dimensions adopted from DOI were incorporated into the Relative Advantage and Compatibility dimensions to ensure that an aspect appears only once in the framework.

4. RESULTS AND DISCUSSION

The result of the study is a framework with dimensions and aspects defined to evaluate an SSE's status to BIS adoption. An organization's resources must be measured against these dimensions and aspects to determine whether they are ready to adopt a BIS or not. Figure 5 shows the defined framework.

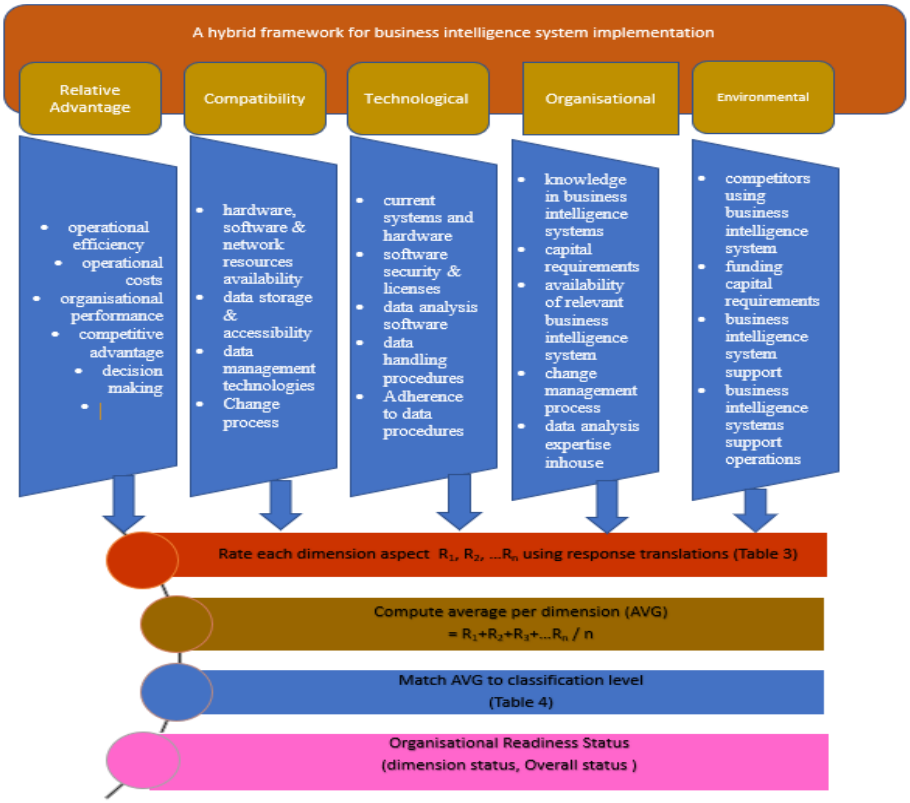

Figure 5 Hybrid framework for Business Intelligence Systems Implementation

4.1 The framework components

The framework was defined from considering the DOI and TOE technology adoption theories, the IEM as well as the critical success factors for BIS implementation. Relative advantage, compatibility, observability, Tradability and complexity dimensions were defined from the DOI theory. Technology, Organization and Environment dimensions are defined in the TOE theory. A high score on the aspects defined in these dimensions can be interpreted as a need for the SSE to adopt BIS. Relative advantage aspects seek to evaluate the impact of BIS on the SSE's operations. Operational efficiency indicates whether a business's core processes can be improved by adopting a BIS. The authors in [11] mentioned that organizations that have adopted BIS have managed to reduce their operational costs and make informed decisions. Measuring the impact of BIS adoption on costs and quality of decision making would help an SSE evaluate the need for adopting a BIS. The framework suggests that an

organization that wishes to improve on the defined aspects may adopt BIS to benefit from its features and improve organizational performance.

The compatibility dimension evaluates whether an SSE's current resources are adequate for the adoption of a BIS. The aspects measure the current resources compatibility with standard BISs by comparing the minimum requirements for successful implementation with what the SSE has. Infrastructure, data accessibility, management, and application as well as the change management process are the key aspects for this dimension. An organization with defined data handling and management resources and procedures may be considered ready to adopt a BIS. In other words, the available resources must enable a smooth transition from current infrastructure and procedures to the adopted BIS. BIS technology is complex and requires expert skills to implement [8]. The organizational dimension emphasizes on this aspect as well, showing that it is a critical indicator of an SSE's readiness to adopt BISs. A successful implementation require skilled personnel to manage and support it. The dimension focuses on the data analysis expertise within and organization. The aspects help to evaluate whether an SSE will be able to extract meaning from the data patterns. If they lack knowledge, then the organization would not benefit from the BIS implementation. The availability of skills within the organization is more ideal as it reduces the costs of outsourcing, which could otherwise be too high for small businesses.

The Technology dimension focuses on evaluating the hardware, software and network resources of an SSE. The evaluation considers the information systems currently used by the SSE. Successful implementation of BIS involves migrating data from current systems onto the new BIS hence the need to evaluate whether the information can be migrated. The technology dimension also considers the network resources of an SSE. Network resources help to ensure that the BIS is accessible to the authorized users and data sharing may be made easy. The developed framework evaluates the network resources to inform the choice of BIS that will support the SSE's organizational structure and data sharing needs
Organization dimension focuses on aspects that deal with human capital, organizational culture, and policies. In [13], the author stated that a BIS must match the organizational culture, maintain, and improve it. The introduction of a BIS is not expected to alter organizational culture but improve the process yet maintaining the integrity and vision of its operations. In the framework, human resources are a critical success factor for BIS implementation. An SSE requires employees with knowledge in BIS to lead the implementation of the chosen BIS. Employees will interact with the BIS as they carry out their duties. Lack of knowledge in BIS may result in a failed implementation, with BIS available but employees unable to perform their task on the system. It is thus important to

assess the level of expertise in deciding whether to adopt a BIS as well as selecting the BIS that employees can easily understand after training.

The framework includes the Environment dimension with competitors, availability of BIS support, availability of relevant BISs and sources of funds as key aspects. It is important to note that an SSE requires a forecast of its activities / operations to go through an informative evaluation. The SSE's performance and competitors' way of doing business often influence its decision. For instance, if competitors have implemented BISs, an SSE may decide to implement a BIS also to gain competitive advantage. The aspects defined must be holistically considered by an SSE that intends to implement or adopt a BIS.

4.2 Decide on readiness Status

To define the organization's status, the scores for each of the dimensions is calculated. An organization may be considered ready to adopt BIS only when all dimensions are rated as ready. In case of a dimension not ready, a recommendation may be given to the SSE to improve their resources defined by the aspects in the failing dimension. Each dimension has several aspects defined to inform the SSE on its status for that dimension. The SSE's score may be calculated as follows:

1. The aspect, for each dimension may be rated by providing one response on a Likert scale of Strongly Disagree to Strongly Agree.
2. The Likert Scale responses for each of the aspect are translated to values as shown in Table 3.

Table 3 Likert Scale responses translation

Likert Scale	Value
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

3. An average for a dimension, Avg is calculated as Avg = Sum of responses/ number of aspects
4. The average is calculated for each of the dimensions defined in the framework.
5. Match the resultant dimension average to the classification level as defined in Table 4 to determine the status of the SSE resources to adopt BIS.

6. Decide on the overall status for the concerned SSE by considering the averages for each of the dimensions and advise on whether the organization is ready to adopt BIS or not.

An organizational score for a dimension is calculated as the average score for all aspects defined in that dimension. The average dimension score determines the maturity level of that dimension for the SSE under consideration. The IEM model was used to establish an organization readiness level, dimension by dimension. Table 4 shows the readiness levels and their description.

Table 4 Readiness levels and their descriptions

Dimension and description	**Level**	**Explanation**
Relative Advantage		
Benefits of using BIS Availability of skills, hardware, and software resources	1	Lack of skills, resources required for decision making
	2	Some skills available, used across the organization. Lack of infrastructure
	3	Lack of expert skills and in Infrastructure available but not sufficient for BIS implementation. Improvement is required
	4	Expert skills for decision making available in the organization. Resources may be extended as required by most BISs.
	5	Expert skills available, required hardware and software available
Compatibility		
Current systems compatibility to BISs Data storage, access, sharing and usage Availability of decision-making software and its security	1	The way data is stored and accessed is not centralized. No decision-making software is available. Data sharing difficult within organization
	2	Data regularly collected but dispersed, no central storage making access difficult. Security to data compromised. No decision-making software is used.
	3	Data stored centrally in departments, departmental data sharing possible and analysed for decision making.
	4	There are software programs to store,

		manage and share data across organisation. Data accessed for decision making
	5	Organisation has software to manage and handle data across the whole organisation ensuring ease of access and security. Data informs decision making.
Technology		
Available computer technologies	1	No computer technologies are in use in organisations. Individual employees have their own data handling processes.
	2	Employees in departments follow some data handling processes and systems
	3	Data handling process and computer technology used across the whole organisation are the same
	4	Computer technologies, data handling processes match those used by competing organisations
	5	Computer technologies, data handling processes can be easily extended and modified to support new business processes
Organisation		
Expertise and human resource skills Change management Teamwork Management support	1	Employees fear change, lack of knowledge of BI, shortage of capital to invest in BIS
	2	Employees accept change if the benefit, are computer literate but no capital to invest in BIS
	3	Employees embrace change, have basic BI and computer skills. Lack of management support for BIS initiatives
	4	Employees embrace change, have BI knowledge and computer skills. Capital available but little management support is available.
	5	Expertise in BI among employees who regard change as a growth opportunity which succeeds through teamwork. Capital

		available.
Environment		
Organisations' fears about BISs	1	Majority of organisations fear the cost of implementing BIS, lack knowledge and skills, feel that BISs do not match their business operations
	2	Majority of organisations fear the high cost of BISs and do not have the knowledge and skills to effectively use BIS
	3	Costs deter organisations from implementing BIS though basic knowledge and skills of BIS are available amongst employees
	4	Capital is available, skills and knowledge can be acquired but fears losing valuable organisational information
	5	Capital is available, acceptable level of knowledge and skills with high push to adopt BISs

5. CONCLUSION AND FUTURE WORK

Implementing BISs can benefit SSEs in several ways including improved operational efficiency and decision making. However, implementation efforts by SSEs have not been successful. The designed framework is a guideline of dimensions and aspects that SSEs must consider determining their readiness to adopt BIS. The framework design was informed by the DOI and TOE theories, IEM and the CSFs for BIS implementation. The consolidation of the theories was to define a comprehensive framework that evaluated that SSE on all the aspects necessary for technology adoption. In this study, the framework defines a novel framework where shortcomings of one adoption theory are addressed by the other theory. Its use would ensure informed evaluation of the SSE on its readiness to adopt BIS.

We recommend that the framework be used to assist SSEs in making a decision of whether or not to implement a BIS. The framework may be modified to add more dimensions and features to ensure an easier evaluation for SSEs. In future, the framework will be implemented to produce an evaluation software for SSEs to use.

6. ACKNOWLEDGEMENT

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REFERENCES

[1] Davenport, T. Business intelligence and organizational decisions, International Journal of Business Intelligence Research, Vol. 1, No. 1, pp.1–12, 2010.

[2] Edwards, S., Dorn, B. & Sanders, D., Problem Solving and Algorithms. 2012 [Online] Available at: http://sofia.cs.vt.edu/cs1114-ebooklet/chapter4.html [Accessed 18 July 2020].

[3] Elbashir, M. Davern and P. A. Collier, "Measuring the effects of business intelligence systems:the relationship between business process and organisational performance," International Journal of Accounting Information Systems, vol. 9, no. 3, pp. 135-53, 2008.

[4] Roessing, R.M. The Business Model for Information Security. ISACA Journal, 1-27, 2010 [online] available at https://www.isaca.org/Knowledge-Center/BMIS/Documents/IntrotoBMIS.pdf.

[5] Turban, E. R. Sharda, D. Delen and D. King, Business Intelligence, A Managerial Approach, 2nd ed., Boston: Prentice Hall, 2011.

[6] Turban, E., Sharda, R., Dursun, D. and King, D. Business Intelligence: A Managerial Approach, 2nd ed., Prentice Hall, Upper Saddle River, NJ, ISBN-13: 978-0136100669, 2008.

[7] Watson, H. "Real time: the next generation of decision-support data management', Business Intelligence Journal, Vol. 10, No. 3, pp.4–6, 2005.

[8] Williams, S. and Williams, N. The Profit Impact of Business Intelligence, Morgan Kaufmann, San Francisco, CA, ISBN: 978-0-12-372, 2007.

[9] Yeoh, W. A. Koronios and J. Gao, "Managing the implementation of business intelligence systems: A critical Success Factors Framework," International Journal of Enterprise Information Systems, 2008.

[10] Hevner, A., vom Brocke, J. & Maedche, A. Roles of Digital Innovation in Design Science Research. Bus Inf Syst Eng 61, 3–8, 2007.

[11] Raj, R., Wong, S. and Beaumont, A. Business Intelligence Solution for an SME: A Case Study. DOI: 10.5220/0006049500410050 In Proceedings of

the 8th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2016) - Volume 3: KMIS, pages 41-50 ISBN: 978-989-758-203-5

[12] Jahantigh, F. F., Habibi, A., & Sarafrazi, A. A conceptual framework for business intelligence critical success factors. International Journal of Business Information Systems, 30(1), 109–123, 2019.

[13] P. C. Lai, "The Literature Review of Technology Adoption Models and Theories for Novelty Technology," JISTEM- Journal of Information Systems and Technology Management, vol. 14, no. 1, pp.21-38,2017.

[14] S. I. Chang, S. Y. Hung, D. C. Yen and P. J. Lee, "Critical factors of ERP adoption for small and medium-sized enterprises: An empirical study," Journal of Global Information Management (JGIM), vol. 18, no. 3, pp. 82-106, 2010.

[15] A. M. Khan, N. Amin and N. Lambrou, "Drivers and barriers to business intelligence adoption: a case of Pakistan," in 14th European and Mediterranean Conference on Information Systems (EMCIS), Abu Dhabi, UAE, 2010.