

Prioritizing the Factors Influencing the Success of Business Intelligence Systems: A Delphi Study

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Abstract

Objective: To gain a better understanding of the factors influencing the success of business intelligence systems in South Africa. **Method:** This study addresses the above issue by conducting a two round Delphi survey among five experts in Business intelligence. For statistical analysis, descriptive statistics including frequency, percentage, mean and standard deviation were carried out on the survey instrument. **Results:** The results provide a framework that consists of six factors and thirty two sub factors for successful business intelligence system implementation. The six factors of success are information quality, system quality, service quality, individual impact and user quality. **Conclusion:** The findings in this study may allow the business intelligence community in South Africa to focus on those factors and sub factors identified as most likely to influence the implementation of BI systems. Focussing on the important factors and sub factors may assist to reduce or eliminate the likelihood of business intelligence system failure.

Keywords: Business Intelligence, Delphi, Information Systems Success

1. Introduction

Business Intelligence (BI) is the process of consolidating disparate amounts of data, analysing that data, and presenting a high-level set of reports that summarise the essence of that data enabling management to make important daily business decisions¹. According to² BI is among the most influential global technologies and was considered to be one of the most significant IT investments in 2010³. The BI market is growing; according to a Gartner report, The BI market grew from 6% in 2009 to 18% in 2010 for Middle East and Africa³. As the dependency on BI increases, so does the need to assess factors associated with BI success.

BI has many potential benefits such as: improving the decision-making process, faster and easier access to information, cost savings, and improved competitiveness⁴⁻⁶. Despite such potential benefits, the success rate of BI is reported to be very low⁷⁻⁹. Therefore it is essential for management and other stakeholders to have a full understanding of the success factors that may help

them to successfully implement BI systems. This study focuses on the success factors within the South African context. The purpose is to help reduce or eliminate the likelihood of BI system failure. The following research question guided this research:

What are the most important factors influencing the success of BI systems as perceived by BI experts in South Africa?

The remainder of the paper is organised as follows. First, we identify an initial set of success factors. The DeLone and McLean model is used as the foundation for the theoretical model of the study. Thereafter, the research method is discussed in detail, followed by the presentation and discussion of the results. The conclusion is presented in the final section of the article.

2. Theoretical Background

There are almost no studies that identify the important factors of BI systems success in South Africa that are based on the DeLone and McLean model. A key word

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and phrase search was used to check for previous research relating to the topic. The search engines used were Google Scholar, Proquest, Academic One File and Ebsco Host.

The DeLone and McLean (2003) model is one of the most widely used models of information systems (ISs) success and has been used for various ISs¹⁰⁻¹³. As BI systems are considered to be a type of IS¹⁴ their success can be analysed with the aid of existing ISs success models. The updated DeLone and McLean model²⁷ does not stipulate which sub factors each of the factors should contain. The researcher is free to fill the factors with respective sub factors, according to the IS. The only restriction is that the sub factors should correspond with the meaning of the factor¹⁵.

We designed the initial model based on the DeLone and McLean model²⁷ model. The suggested model consists of five factors: information quality, individual impact, system quality, service quality, and user satisfaction. The model also includes a sixth factor named user quality derived from the¹⁶ study. The study by¹⁶ found that the user quality factor has a positive relationship to the net benefits of a data warehousing system.

System quality is an essential factor in successful BI implementation¹⁷. The system quality factor from the DeLone and McLean (2003) model will be used to investigate the influence of system quality on BI systems success in South Africa. The sub factors used in this study are ease of use, user friendly, responsiveness, ease of learning, stability, security, and reliability and availability. This study uses the following seven sub factors of information quality: accuracy, usefulness, timeliness, completeness, relevance, understand ability [sic] and trustworthiness.

The service quality factor from the updated DeLone and McLean model²⁷ was used to explore the influence of service quality on BI systems success in South Africa. Service quality refers to the level of support that end users get from the service provider. Measures of service quality include responsiveness, accuracy, reliability, technical competence, and empathy of the personnel staff¹⁸.

The user satisfaction factor from the updated DeLone and McLean model²⁷ model was used to examine the influence of user satisfaction on BI systems success in South Africa. Numerous researchers¹⁹⁻²² have identified user satisfaction as one of the most extensively used single measure of IS success. User satisfaction refers to the perception of the end user towards the system in relation to what the end user expected upon first use of

the system¹⁷. Measures of user satisfaction used in this study are: efficiency, effectiveness and overall satisfaction.

The user quality factor identified in the study¹⁶ will be used to explore the influence of user quality on BI systems success in South Africa. Most of the available literature on BI indicates that skilled users are crucial to the success of a BI system²³⁻²⁶. Low levels of user quality increases the cost of both learning and using the BI system²⁶.

The individual impact construct from the DeLone and McLean model²⁷ will be used to examine the influence of individual impact on BI systems success in South Africa. Individual impact refers to the effect of the system on the behaviour of the end user¹⁷. This can be contrasted with organisational impact which refers to the influence on the organisational performance such as operating cost reduction, overall productivity gains, increased sales, increased market share, increased profit, return on investment, return on assets, net income to operating expense ratio, increased work volume and product quality¹⁹. The individual impact of an IS is context specific^{17, 27}. In other words, in this study, the individual impact that can be realised needs to be based on BI, at the individual level of analysis. Job performance, individual productivity, job effectiveness, extent of analysis in decision making, decision making quality, problem identification speed, and decision making speed are the sub factors for Individual Impact used in this study.

3. Research Method

This study used a modified two rounds Delphi Study to find out experts' opinion towards the most relevant and important factors and sub factors for BI system success. The main aim of using the Delphi Method is to reach consensus²⁸. One advantage of the Delphi Method is anonymity in answering questions which often sets the participant at ease and provides opinions that are free from peer pressure^{29,30}. Participants of the Delphi study were five experts based in South Africa. The size of the panel of a Delphi Method unlike conventional surveys does not require a statistically large number of participants to be valid^{31,32}. The participant group consisted of two academics and three industry practitioners. Table 1 shows the characteristics of participants of the Delphi Study.

In choosing expert participants for this study, each expert was required to meet at least five of the following minimum criteria³³: (1) Knowledge and experience in IS/

BI, (2) Academic Qualification: has an earned a degree (National Diploma/B-Degree/M-Degree/PhD), (3) Experience: Industry experience of at least 8 years, (4) Published articles in peer reviewed journals, books and or conferences in IS/BI, (5) Teaching: Has served as an instructor in the teaching of courses focusing on IS/BI or recognised related field, (6) Professional registration with a recognised IS or ICT registration body (7) Capacity, willingness, and time to participate.

Table 1. Delphi Participant Profile

Current Position	Industry Sector	Years Experience	Highest Qualification
BI Consultant	Mining	11	Honours
BI Architect	Financial Services	9	Honours
BI Architect	Mining	8	MBA
Academic	Higher Education	7	Ph.D.
Academic	Higher Education	8	Ph.D.

In this study, participants indicated their level of agreement with pre-formulated statements provided on a questionnaire. To reduce the risk of bias of the limited options the participants are given an option to suggest other factors and sub factors at the end of the questionnaire^{34,35}. The questionnaire was divided into two sections. The first section contains 57 statements measuring the six success factors: user quality, service quality, system quality, information quality, user satisfaction and individual impact. A 4-point Likert-type scale was used for rating the factors. The scale levels were; very important (4), important (3), slightly important (2) and unimportant (1). The second section gathered general demographic information about the respondents such as Title, highest qualification, gender, industry and BI experience. Table 2 lists the factors of BI system success.

Table 2. Factors of BI System Success

Factor	Number of Items	Source
System Quality	8	19,25
Information Quality	7	19,25
User Quality	3	25
User Satisfaction	3	27
Service Quality	4	39
Individual Impact	4	5

The instruction to the participants was to rate the sub factors according to how important each sub factor is towards the success of a BI system. To initiate the second

round, an email was sent to the first round participants with the questionnaire attached. In the second round, each participant received a personalised questionnaire showing their response from the first round and a summary of the other participants' responses. The second round gave the participants an opportunity to change their ratings of the level of importance in light of the new information received. All 5 (100%) experts returned the second round Delphi questionnaire.

It is common to choose the level of consensus after the first round³⁶. According to³⁷, achieving a certain level of agreement is regarded as the most common measure of consensus. For this Delphi study, the attainment of a certain level of agreement among the panellists is used as a measure to confirm which of the factors and sub factors are important towards the success of BI systems.

A sub factor which received two-thirds level of consensus and a polarity of less than 1.2 among the responses was chosen for this study. The percentage of agreement in this study was calculated by summing the number of responses for the very important and important categories and dividing by the number of respondents and multiplying it by 100. The polarity is stated as either strong if the polarity is greater than or equal to 1.5; weak if it is greater than or equal to 1.2 but less than 1.5; or none if it is less than 1.2³⁸.

The details of the results are discussed in the next section.

4. Results and Discussion

Table 3 summarises the final results of the Delphi study. As can be seen in Table 3 there are a number of factors with a 100% level of agreement. There are also a number of sub factors with a 0 % level of agreement. The results show that consensus was gained on 30 of the 57 items in the first round, 8 items for systems quality; 4 items for service quality; 5 items for individual impact; 3 items for user quality; 3 items for user satisfaction; 7 items for information quality.

According to the Delphi method, the factors, which gain consensus, can either be removed from the next round questionnaire or included, with the advantage of an opportunity to gain a higher level of consensus³⁷. The advantage of removing the factors is that the next questionnaire is shorter, reducing the risk of attrition³⁷. For this research, the consensus factors were removed.

Table 3. Results of the Delphi Study (First and Second Round)

Factor	Sub Factor	Round one consensus (%)	Round two consensus (%)
System Quality	Availability	100	
	Ease of Use	100	
	Ease of Learning	100	
	Responsiveness	100	
	User Friendly	100	
	Reliability	100	
	Stability	100	
	Secure	100	
	Data Accuracy	0	0
	Data Currency	0	0
	Database Contents	0	0
	Access	0	0
	User Requirements	0	0
	System Features	0	0
	System Accuracy	0	0
	Flexibility	0	0
	Efficiency	0	0
	Sophistication	0	0
	Integration	0	0
	Customisation	0	0
Information Quality	Accuracy	100	
	Usefulness	100	
	Timeliness	100	
	Completeness	100	
	Relevance	100	
	Understandability	100	
	Trustworthy	100	
	Importance	0	0
	Availability	0	0
	Usability	0	0
	Conciseness	0	0
	Uniqueness	0	0
User Satisfaction	Efficiency	100	
	Effectiveness	100	
	Overall Satisfaction	100	
	Enjoyment	0	0
	Information	0	0
	Systems	0	0
User Quality	Business Skills	100	
	Technical Skills	100	
	Analysis Skills	100	
Individual Impact	Job Performance	100	
	Individual Productivity	100	
	Job Effectiveness	100	
	Extent of Analysis in Decision Making	80	
	Decision Making Quality	60	100
	Problem Identification Speed	80	
	Decision Making Speed	60	100
	Learning	0	0

	Awareness/Recall	0	0
	Decision Effectiveness	0	0
Service Quality	Assurance	100	
	Empathy	100	
	Responsiveness	100	
	Knowledgeable	100	
	Reliability	20	0
	Tangible	40	0

So 27 sub factors that did not reach consensus were the only ones used in the second round questionnaire. Only 2 items for individual impact gained consensus in the second round. The Delphi study is concluded after two rounds with a total 32 items out of 57 gaining consensus.

The panel of experts confirmed the importance of information quality in determining BI system success. This finding is not surprising because BI is largely used for decision making; so information quality will affect the quality of management reports, which in turn influence the decision outcomes. The Delphi findings also indicate that the quality of the user is crucial if a BI system is to be implemented successfully.

This study not only identified the factors in BI system implementations in South Africa, but also determined which sub factors are the most important in the implementation process. The finding of this study can be used to identify and allocate resources to those factors that require to be considered for monitoring the BI system project effectively. Attending these factors improve the likelihood of a successful BI system implementation.

5. Conclusion

The study focussed on identifying the most important factors and sub factors for BI systems success for organisations in South Africa. The study identified the following factors as important for BI systems success; information quality, individual impact, system quality, service quality, user quality and user satisfaction. This study concludes that 32 sub factors should be considered during the BI implementation as the most important factors from the 57 factors identified by the literature. The analysis identified seven sub factors for information quality, seven for individual impact, eight for system quality, four for service quality; three for user quality and three for user satisfaction. This study carries significance in that it raises awareness of the factors and sub factors that may be taken into consideration

when planning the implementation of BI systems in South Africa. These factors and sub factors may reduce the failure rate in BI implementation and encourage companies to implement BI systems in their organization in South Africa. Furthermore, this study contributes to the literature on BI system success.

The primary limitation of this study was that we acquired our initial list of success factors from reviewing related work from the field of IS. Alternatively our first round could have been open ended allowing for the researcher to ask the expert panel for success factors directly. Second, our expert panel consisted only of practitioners and academics. There is a need to include other BI stakeholders. By including the views of other stakeholders it is possible that a more objective and comprehensive view of the important factors will be compiled. Future studies need to address some of these limitations.

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7. References

1. Stackowiak R, Rayman J, Greenwald R. Oracle Data Warehousing and Business Intelligence Solutions. 1st edn. Wiley Publishing, Inc, Indianapolis. 2007.
2. Arnott D, Pervan G. A Critical Analysis of Decision Support Systems Research Revisited. The Rise of Design Science. Journal of Information Technology. 2014; 29(4):269-93. Crossref
3. Gartner Says Worldwide Business Intelligence, CPM and Analytic Applications/Performance Management Software Market Grew Seven Percent in 2012. Date Accessed: 01/01/2013; Available from: Crossref
4. Isik O, Jones MC, Sidorova A. Business Intelligence Success and the role of BI capabilities. Intelligent Systems in Accounting, Finance and Management. 2011; 18(4):161-76. Crossref

5. Hou C. Examining the effect of user satisfaction on system usage and individual performance with business intelligence systems. An empirical study of Taiwan's electronics industry. *International Journal of Information Management*. 2012; 32(6):560-73. Crossref
6. Hocevar B, Jaklic J. Assessing benefits of business intelligence systems. *Journal of Management*. 2010; 151:87-119.
7. Half of data warehouse projects to fail. Accessed Date:22/05/2013; Available from: Crossref
8. Gartner BI Summit. Business intelligence benefits lie in orchestration. Accessed Date:05/06/2013; Available from: Crossref
9. Legodi I, Barry M. The current challenges and status of risk management in enterprise data warehouse projects in South Africa. *Technology Management for Global Economic Growth*. 2010; p. 1-5.
10. Lai JY, Yang CC. Effects of employees' perceived dependability on success of enterprise applications in e-business. *Industrial Marketing Management*. 2009; 38(3):263-74. Crossref
11. Brown I, Jayakody R. B2C e-Commerce Success, a Test and Validation of a Revised Conceptual Model. *The Electronic Journal Information Systems Evaluation*. 2008; 11(3):167-84.
12. Bernroider EWN. IT governance for enterprise resource planning supported by the DeLone-McLean model of information systems success. *Information and Management*. 2008; 45(5):257-69. Crossref
13. Hwang M, Xu H. A Structural Model of Data Warehousing Success. *Journal of Computer Information Systems*. 2008; 49(1):48-56.
14. Yeoh W, Koronios A. Critical Success Factors for Business Intelligence Systems. *Journal of Computer Information Systems*. 2010; 50(3):23-32.
15. Němec R, Zapletal F. Proposal of Decision-making Model using the DeLone and McLean's Information Success Model together with the AHP. *Acta Informatica Pragensia*. 2015; 4(2):122-39 Crossref
16. Almabhouh A, Saleh AR, Ahmad AA. Framework of Data Warehouse Systems Success. An Empirical Study. *International Journal of Electronics Communication and Computer Engineering*. 2012; 3(3):596-09.
17. Seddon PBA. Respecification and Extension of the DeLone and McLean Model of IS Success. *Information Systems Research*. 1997; 8(3):240-53. Crossref
18. Petter S, DeLone W, McLean E. Measuring information systems success, models, dimensions, measures, and interrelationships. *European Journal of Information Systems*. 2008; 17(3):236-63. Crossref
19. DeLone WH, McLean ER. Information Systems Success. The Quest for the Dependent Variable. *Information Systems Research*. 1992; 3(1):60-95. Crossref
20. Doll WJ, Torkzadeh G. The measurement of end-user computing satisfaction. *MIS Quarterly*. 1988; 12:259-74. Crossref
21. Gatian AW. Is User Satisfaction a Valid Measure of System Effectiveness? *Information and Management*. 1994; 26:119-31. Crossref
22. Igbaria M, Nachman SA. Correlates of user satisfaction with end user computing. An exploratory study. *Information and Management*. 1990; 19(2):73-82. Crossref
23. Sakaguchi T, Frolick M. A review of the data warehousing literature. *Journal of Data Warehousing*. 1997; 2(1):35-54.
24. Cooper BL, Watson HJ, Wixom BH, Goodhue DL. Data warehousing supports corporate strategy at First American Corporation. *MIS Quarterly*. 2001; 24(4):547-67. Crossref
25. Wixom BH, Watson HJ. An Empirical Investigation of the Factors Affecting Data Warehousing Success. *MIS Quarterly*. 2001; 25(1):17-41. Crossref
26. Hwang H, Ku C, Yen DC, Cheng C. Critical factors influencing the adoption of data warehouse technology: a study of the banking industry in Taiwan. *Decision Support Systems*. 2004; 37(1):1-21. Crossref
27. DeLone WH, McLean ER. The DeLone and McLean Model of Information Systems Success : A Ten-Year Update. *Journal of Management Information Systems*. 2003; 19(4):9-30. Crossref
28. Thompson RL. Task-technology fit and individual performance. *MIS Quarterly*. 1995; p. 213-36.
29. Goodman C. A Delphi survey of clinical nursing research priorities within a Regional Health Authority. University of London. 1986; 35(6): 857-63.
30. Halpern SR. Indicators of organizational readiness for clinical information technology/systems innovation: a Delphi study. *International Journal of Medical Informatics*. 2002; 63(1):179-204.
31. Loo R. The Delphi Method. A Powerful Tool for Strategic Management. Policing. *International Journal of Police Strategies and Management*. 2002; 25(4): 762-69. Crossref
32. Mullen P. Delphi. Myths and Reality. *Journal of Health Organization and Management*. 2003; 17(1):37-52. Crossref PMID:12800279
33. Skulmoski G, Hartman F, Krahn J. The Delphi method for graduate research. *Journal of Information Technology Education*. 2007; 6:1-21.
34. Hasson F, Keeney S, McKenna H. Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*. 2000; 32(4):1008-15. Crossref PMID:11095242
35. Keeney S, Hasson F, McKenna H. A critical Review of the Delphi technique as a research methodology for nursing. *International Journal of Nursing Studies*. 2001; 38(1):195-200. Crossref
36. Jooste J. A Critical Success Factor Model for Asset Management Services. Stellenbosch University. 2014; p. 1-17.
37. Keeney S, Hasson F, McKenna H. The Delphi technique in nursing and health research. 1st edn. Chichester, England: John Wiley and Sons. 2011. Crossref
38. Loe DR. Exploring Complex Policy Questions Using the Policy Delphi. *Applied Geography*. 1995; 15(1):53 - 68. Crossref
39. Yoon S, Suh, H. Ensuring IT Consulting SERVQUAL and User Satisfaction: A Modified Measurement Tool. *Information Systems Frontiers*. 2004; 6(4), 341-51. Crossref