

Justifying Business Intelligence Systems Adoption: A Literature Review on Healthcare Supply Chain Perspective

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ABSTRACT

Business Intelligence (BI) systems have played an essential position in facilitating information sharing, strategic cost-cutting, and improvement in business process management through data-driven decision-making analytics. The technological enablers of Industry 4.0 have empowered the clinician to attain accurate information in formulating predictive and data-driven diagnoses based on artificial intelligence-enabled medical devices resulting in an efficient and quality clinical pathway for patients. However, there is a noticeable distinction between the hospital's technological aptitude between clinician and non-clinician. The current technological capability of the hospital information system is to digitize daily business processes that could not offer intelligence reports for predicting, forecasting, and data-driven decision-making support. The compilation of past works of literature is expected to justify the need for the healthcare supply chain to adopt BI solutions that produce near real-time data in making efficient inventory management and procurement to support the clinician in delivering efficient and quality clinical pathways for patients by bringing the supplies at the right moment. Hence, a study of BI solutions in healthcare supply chain operation is achieved through a narrative overview of existing literature from papers published online. The results show that appropriate technological tools, resource competencies, and supplier management platform as the essential dimensions to support the business intelligence adoption effort. The study, therefore, not only identified the critical dimensions in facilitating BI adoption but also offer practical awareness to the healthcare policymakers to better understand the strategic need for BI systems in managing the entire hospital operations to gain a competitive advantage.

Keywords: Business Intelligence, Healthcare, Supply Chain

INTRODUCTION

IR4.0 was first made public in the year 2011 as "Industrie 4.0" by the German government that focused on the manufacturing industry (Rojko, 2017). Technological innovation undoubtedly is the foreground of advancement in medical device innovation. Technological innovation encompasses numerous actions, decisions, individual and social behavior, and those indirectly aware of being part of the innovation process (Tornatzky & Fleischer, 1990). All through the industrial revolution, one, two, three,

and four, the Industry 4.0 technological advancement seems to be beneficial mainly toward the healthcare sector (Swabey, 2016). The two main healthcare supply chain main activities comprise procurement and inventory management. In the healthcare industry explicitly, data is generated daily through the use of medical devices and other Enterprise Resource Planning (ERP) software or also known as Hospital Information Systems (HIS). The ERP system originates from information systems for management in the 1990s (Almajali, Masa'deh, & Tarhini, 2016). Information is the crucial impetus in supply chain systems (Koupaei & Khamseh, 2017); nevertheless, not all data were able to convert into useful and timely information since ERP/HIS systems concentration was on the digitization of record-keeping instead of decision-support analytics (Koupaei & Khamseh, 2017; Pool, Jamkhaneh, Tabaeian, Tavakoli, & Shahin, 2018). Medical procedures and the accessibility of medical device consumables and operation supports come hand in hand. Both are critical elements to successfully provide quality patient treatment pathway (Pearson, Kleefeld, Soukop, Cook, & Lee, 2001) and reducing hospital stay duration. There is a noticeable distinction in the hospital's technical aptitude between clinical and non-clinical, which challenging to match the clinical intervention velocity. The current technological capability of the hospital information system is to digitize daily business operations. However, without BI systems, the accumulated data could not provide an accurate, real-time report for analyzing, predicting, forecasting, and data-driven decision-making support. Hence, data built-up was not well utilized, nor does it contribute to strategic decision-making processes.

The supply chain environment is shifting in line with the significant trend of big data and analytics, which is the subdivision of BI solutions (Langlois & Chauvel, 2017). BI solutions have gained extensive recognition in reinforcing an accurate and efficient decision-making activity due to the system's capability to provide comprehensive and complex information lacking in current ERP/HIS software and systems intelligence level (Koupaei & Khamseh, 2017). Business Intelligence (BI) was a phrase introduced by Richard Millar Devens in 1865 (Keith D. Foote, 2017). The first innovation of the BI technical approach is Decision support systems (DSS), followed by Online analytical processing (OLAP), Executive information systems (EIS), and Data warehouses (Keith D. Foote, 2017; Sangari & Razmi, 2015). The inefficiency of current healthcare supply chain arrangements are lacking in delivering real-time and useful information (Langlois & Chauvel, 2017) strategically in getting the right information (Sangari & Razmi, 2015; Banerjee & Mishra, 2017), right time (Langlois & Chauvel, 2017; Rane, Narvel, & Bhandarkar, 2019), the right user (Langlois & Chauvel, 2017), right quantity and to the correct location (Chen & Chiu, 2014) to support the clinician in delivering efficient and quality clinical pathway for patients.

The challenges faced in healthcare supply chain activities are managing inventories following patient conditions and requirements, slow-moving inventories but must-have for a lifesaving situation, uncertainties in inventory movement due to pandemic spread (such as Covid-19), natural disaster as to name a few. Not much attention has been paid to the importance of BI in the healthcare supply chain aspects to support the business to gain a competitive advantage (Langlois & Chauvel, 2017). Hence, this review is an attempt to clarify the intensity of the published study about BI systems in supply chain planning and management for healthcare policymakers to understand better the strategic need for BI systems in managing the entire hospital operations to gain a competitive advantage. This review is based on the technological, organizational, and environmental (T-O-E) framework. Accordingly, to recognize the potential dimensions in facilitating BI systems adoption for the healthcare supply chain.

METHODOLOGY

This study is based on a narrative literature review (NLR) guidelines suggested by Green, Johnson, & Adams (2006). The TOE framework (Depietro, Wiarda, & Fleischer, 1990) is an organizational-level theory that describes the adoption decisions and offers guidance to researchers and practitioners (Baker, 2012). The framework stated that the three elements influence the mechanism by which organizations embrace and initiate innovation developments. The context of technology, organization, and the

environment can offer both opportunities and constraints for adopting technological innovation (Depietro et al., 1990).

The rulebooks in performing a literature search include information sources, search terms and delimiting, and selection criteria. It is necessary to source literature works at least from a minimum of two reputable databases to gain an adequate depth of a study. The literature search initially performed using two primary sources of electronic databases, namely Elsevier's Scopus and Thomson Reuters' Web of Science (WoS). These databases remain as the primary data citation since indexing inclusive of all authors, institutions, and bibliographic references on all types of articles were warrant for efficient retrieval of data. Additionally, these databases' strength is in its comprehensive interdisciplinary field coverage (Mongeon & Paul-Hus, 2016). However, a further search of works of literature performed using the ProQuest database due to limited outcomes.

The search parameter covers the themes of the topic, which is also the keywords. The search parameters would help to narrow down and focus on the subject understudied. The search terms used to conduct the literature search from electronic databases are illustrated in Table 1. The search strings use simple Boolean operators 'AND' and 'OR.' Procurement, purchasing, and supply chain is used interchangeably since procurement or purchasing is a central part of the entire supply chain ecosystem (Langlois & Chauvel, 2017; Pool et al., 2018; Rane, Narvel, & Bhandarkar, 2019). The same with healthcare and hospital. However, the search result was limited, and therefore the searching keyword eliminates healthcare and hospital. Thus, the total initial result using the search string was 488 articles. Further delimitation is performed, thus reduces to 112 articles.

Table 1: Search procedure

Electronic Databases	Years	Search Strings	Field Tags/Codes	Hit
Scopus	1975 2019	("business intelligence" OR "BI") AND ("procurement" OR "purchasing" OR "supply chain" OR "SCM")	TITLE	200
Web of Science	1970 2020	("business intelligence" OR "BI") AND ("procurement" OR "purchasing" OR "supply chain" OR "SCM")	TI = Title	147
ProQuest	All dates	("business intelligence" OR "BI") AND ("procurement" OR "purchasing" OR "supply chain" OR "SCM")	Document Title - TI	141

In order to focus on the relevance of the literature search, the selection of inclusion and exclusion criteria were executed to emphasize further, as illuminated in Table 2. The subject area includes business, management and accounting, decision sciences, and social sciences. Only journal articles that are in the English language and published in the year 2011 and 2019 were shortlisted. The exclusion criteria comprise of non-scholarly work, highly technical books, reports, proceedings and reviews, duplications, and articles that are not in the English language.

Table 2: Study inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria	Hit
<ul style="list-style-type: none"> ▪ Subject area: business, management, and accounting; decision sciences; social sciences; operations research management science; information science library science ▪ Journal articles ▪ English language 	<ul style="list-style-type: none"> ▪ Non-scholarly work, proceedings, book chapters, reviews, reports, etc. ▪ Articles that are not in the English language ▪ Duplicate articles ▪ No access to electronic articles 	<ul style="list-style-type: none"> ▪ 63

Despite having the search strings and inclusion/exclusion criteria, which resulted in a narrow-down to 112 articles as per Figure 1 illustration. Further scanning on the title and abstracts, 2 articles do not have access, 63 articles are non-BI related study, and 40 articles were duplicate between all three databases. Therefore, only 7 articles were retained and proceed with the synthesizing process. Thus, consistent with the earlier statement of lack in the study perform for BI on the supply chain in healthcare.

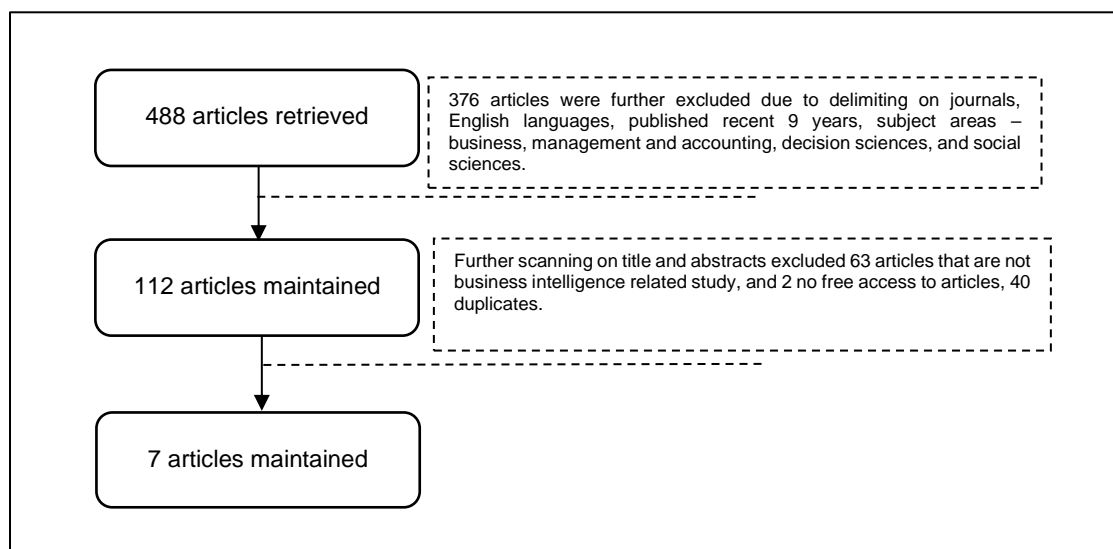


Figure 1: Articles retrieval, selection and retention process

RESULTS AND DISCUSSIONS

The narrative synthesis on the dimensions will go along with the core constructs of the Technological, Organizational, and Environmental (T-O-E) framework by Depietro, Wiarda, & Fleischer (1990). While the T-O-E framework is widely used on systems and software adoptions, only one shortlisted article was explicitly found on BI adoption. A review of all abstracts, discussions, findings, and conclusions was completed to well facilitate in diagnosing the dimensions to validate the urgent requirement for a healthcare supply chain to adopt business intelligence in helping their daily supply chain arrangements.

The majority of the technology adoption literature utilizes the T-O-E framework that assesses both the internal and external firms' factors influencing the adoption process. Similarly, policymakers need to consider the three key determinants of technological, organizational, and environmental context in facilitating the adoption of BI systems in the healthcare supply chain.

The first context of the framework is on the technological aspect, and the focus is on technology availability and the influence of technological characteristics during the adoption process (Arpaci, 2012). Many authors agree that it is fitting to have the appropriate technologies and tools on top of established yet distinct procedures in supply chain management. However, the lack of acquiring the latest technology and tools led to the barrier of BI implementation (Sangari & Razmi, 2015; Banerjee & Mishra, 2017; Koupaei & Khamseh, 2017; Langlois & Chauvel, 2017; Pool et al., 2018; Rane et al., 2019). ERP/HIS systems have contributed to the improvement of supply chain management, namely the green supply chain, internal information sharing, and cost optimization (Koupaei & Khamseh, 2017). Innovation adoption should be made easy to operate so that stakeholders can access mutual and

real-time databases (Banerjee & Mishra, 2017). BI systems that are supposed to enhance the decision-making tools of ERP software are significant missing. Thus, signifying the urgency of a collaborative effort between clinical and non-clinical software due to the data integration from multiple clinical devices.

Next, the organizational context describes an organization characteristic that includes the firm size, structure, complexity, human resources quality, and the volume of internal slack resources (Arpaci, 2012). The barriers at the organizational level are relatively more significant, such as lacking technology competencies, lack of training and information, lack of alignment and commitment from the top management, lack of financial support, and lack of effective strategy (Rane et al., 2019). In the business intelligence strategy of supply chain management, it is entirely possible to mitigate organizational barriers when an organization devises its plan not only in terms of technological innovations but along in the three primary BI competencies: managerial competence, technically competent, and cultural competence. Recent research suggested that managerial competence is the ability to provide the correct information to the intended person at the appropriate time. Technical competence is the capability of utilizing the BI tools in generating useful information in support of supply chain decision making. Conclusively, the ultimate BI competency is on the cultural aspect, which refers to the ability to develop quality information and interaction in achieving robust BI culture (Langlois & Chauvel, 2017). Development of appropriate strategies by identifying the main barriers that will hamper supply chain agility, able to overcome obstacles, and promotes agility (Rane et al., 2019). However, healthcare institutions appear to be distinctive in their organizational characteristics as clinicians enjoy considerable autonomy as individuals and as a group (Robert, Greenhalgh, MacFarlane, & Peacock, 2009). Hence, the entire healthcare ecosystem competencies must have a balance in innovation adoption and avoid perceiving any individuals and groups as a passive user.

Finally, the environmental context includes the industry pressure, competitors, regulations, and government intervention in which business is operated (Arpaci, 2012). The uncontrollable barriers in the supply chain would be the lack of supplier effectiveness, lack of transportation effectiveness, and lack of awareness in legislation (Rane et al., 2019). The uncontrollable external business arena leads to uncertainty, such as manufacturing and delivery lead time. In light of these uncertainties, supply chain management is facing challenges in matching the demand with supply in which the healthcare industry is experiencing the like of it. While BI in the supply chain acts as a value-added service through direct procuring of materials via the internet (Chen & Chiu, 2014), it is not suited for the healthcare industry since medical supplies and devices are warranted to accord to Medical Device Act 2012 for patient safety (Medical Device Authority, 2019). Thus, the BI approach in the healthcare supplier management platform is essential in overcoming the struggle in recognizing the authorized representative (AR) of the given supplies and timeliness in procuring processes. In summary, the discussion asserted that that organizational context poses a more significant influence (Khazaei Pool et al., 2018) on the performance of the current supply chain systems, adopting BI systems.

Taken together all context, the only paper shortlisted in this review and was using the T-O-E approach has concluded that the organizational context having the most significant effect towards BI acceptance, followed by technological context and environmental context was the least in effecting BI acceptance (Khazaei Pool et al., 2018). Nonetheless, this review proceeds to conclude all three elements of the T-O-E framework to enhance the robustness and success rate of BI adoptions.

Based on the limited amount of literature obtained on BI in the supply chain, the three central aspects are finalized as (T) acquiring the appropriate tools and technologies, (O) possess resource competencies, and (E) availability of supplier management platform (refer to Figure 2), to facilitate in the adoption efforts. This review offers a brief check on BI adoption in supply chain management, and none was focused on the healthcare industry. Despite the limitations, the fact is that BI systems enable the enrichment of the decision-making tools for the present supply chain software (ERP/HIS), indeed

gaining magnitude in different industries. It is justifiable that healthcare management is known for having a complex ecosystem and warrant for BI adoption to convert clinician databases into analytics information for non-clinician to collaborate with the patients' clinical pathway.

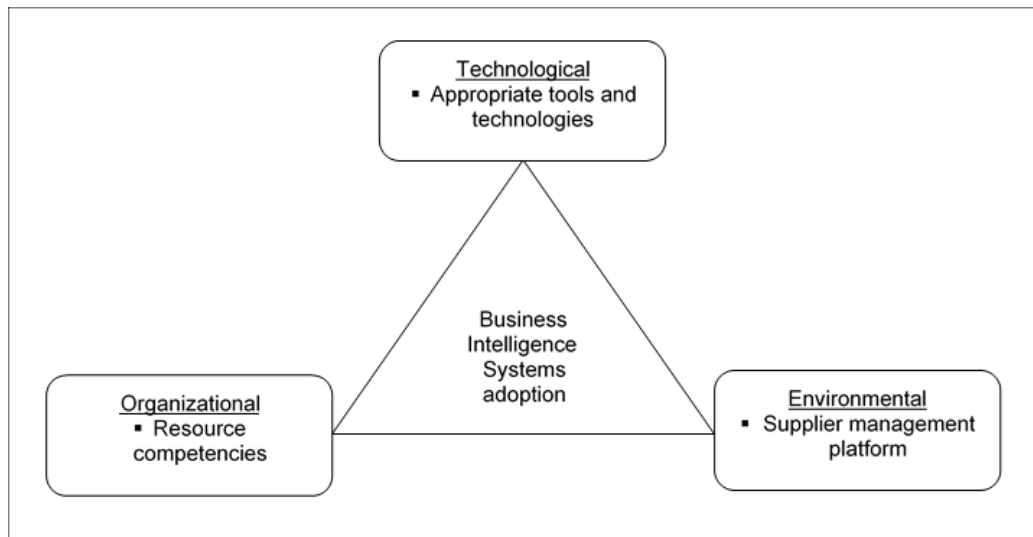


Figure 2: Summary by Technological, Environmental and Environmental (TOE) Context

CONCLUSION

In a nutshell, it will be a risk to the healthcare supply chain if policymakers continuously lacked the awareness to adopt BI systems. The growing imbalance in the healthcare device innovations increased the swiftness in clinical diagnoses, which at some point, the healthcare supply chain will no longer be able to synchronize with the clinicians in delivering quality care to patients. While the selected literature was confined to the searched string, it is worth noting that the implementation of BI to enhance the connectedness of the entire hospital operations requires attention.

REFERENCES

- Almajali, D. A., Masa'deh, R., & Tarhini, A. (2016). Antecedents of ERP systems implementation success: a study on Jordanian healthcare sector. *Journal of Enterprise Information Management*, 29(4), 549–565. <https://doi.org/10.1108/JEIM-03-2015-0024>
- Arpaci, I. (2012). Organizational Adoption of Information Technologies: a Literature Review. *International Journal of EBusiness and EGovernment Studies*, 4(2), 37–50.
- Baker, J. (2012). The technology–organization–environment framework. In *Information systems theory* (pp. 231–245). Springer.
- Banerjee, M., & Mishra, M. (2017). Retail supply chain management practices in India: A business intelligence perspective. *Journal of Retailing and Consumer Services*, 34, 248–259. <https://doi.org/10.1016/j.jretconser.2015.09.009>
- Chen, Y. M., & Chiu, Y. P. (2014). Enhancing business intelligence for supply chain operations through effective classification of supplier management. *Uncertain Supply Chain Management*, 2(4), 229–236. <https://doi.org/10.5267/j.uscm.2014.7.006>
- Depietro, R., Wiarda, E., & Fleischer, M. (1990). The context for change: Organization, technology and environment. *The Processes of Technological Innovation*, 199(0), 151–175.

- Green, B. N., Johnson, C. D., & Adams, A. (2006). Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. *Journal of Chiropractic Medicine*, 5(3), 101–117.
- Keith D. Foote. (2017, September). A Brief History of Business Intelligence. DATAVERSITY. Retrieved December 24, 2019, from <https://www.dataversity.net/brief-history-business-intelligence/#>
- Khazaei Pool, J., Balouei Jamkhaneh, H., Tabaeian, R. A., Tavakoli, H., & Shahin, A. (2018). The effect of business intelligence adoption on agile supply chain performance. *International Journal of Productivity and Quality Management*, 23(3), 289–306. <https://doi.org/10.1504/IJPQM.2018.089802>
- Koupaei, M. N., & Khamseh, A. A. (2017). An integrated enterprise resources planning framework for supply chain management using business intelligence tools. *International Journal of Business Performance and Supply Chain Modelling*, 9(3), 202. <https://doi.org/10.1504/ijbpscm.2017.10010001>
- Langlois, A., & Chauvel, B. (2017). The impact of supply chain management on business intelligence. *Journal of Intelligence Studies in Business*, 7(2), 51–61. Retrieved from <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021962438&partnerID=40&md5=ead1194>
- Medical Device Authority. (2019). Medical Device Authority: Background. Retrieved February 1, 2020, from <https://portal.mda.gov.my/introduction/background.html>
- Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics*, 106(1), 213–228.
- Rane, S. B., Narvel, Y. A. M., & Bhandarkar, B. M. (2019). Developing strategies to improve agility in the project procurement management (PPM) process: Perspective of business intelligence (BI). *Business Process Management Journal*. <https://doi.org/10.1108/BPMJ-07-2017-0196>
- Robert, G., Greenhalgh, T., MacFarlane, F., & Peacock, R. (2009). Organisational factors influencing technology adoption and assimilation in the NHS: a systematic literature review. Report for the National Institute for Health Research Service Delivery and Organisation Programme.
- Rojko, A. (2017). Industry 4.0 concept: Background and overview. *International Journal of Interactive Mobile Technologies*, 11(5), 77–90. <https://doi.org/10.3991/ijim.v11i5.7072>
- Sangari, M. S., & Razmi, J. (2015). Business intelligence competence, agile capabilities, and agile performance in supply chain An empirical study. *International Journal of Logistics Management*, 26(2), 356–380. <https://doi.org/10.1108/IJLM-01-2013-0012>
- Swabey, P. (2016). Healthcare to benefit most from the Fourth Industrial Revolution, executives predict. The Economist Intelligence Unit (EIU). Retrieved September 14, 2019, from <https://eiuperspectives.economist.com/technology-innovation/healthcare-benefit-most-fourth-industrial-revolution-executives-predict>
- Tornatzky, L. G., & Fleischer, M. (1990). Technological Innovation as a Process. In Lexington, MA: Lexington Books (pp. 28–49). Retrieved from <https://www.researchgate.net/publication/291824703>