# Theoretical Approaches to Business Intelligence and Knowledge Management Integration

**Fudhah AlSelami[†], Ibrahiem ELEmary[††], and Huda Alamoudi[†††]**

[†]Management Information system, University of Jeddah- Alkamel Branch , UJ, Jeddah ,Saudi Arabia .
[††]Information Science Department, King Abdul Aziz University ,KAAU , Jeddah ,Saudi Arabia.
[†††]Information Science Department, King Abdul Aziz University ,KAAU, Jeddah ,Saudi Arabia.

**Summary**
This paper provides an overview of academic literature on the issue of Business Intelligence and Knowledge Management integration in organizations. The main theoretical approaches to information integration are outlined; furthermore, contrasting perspectives on the co-dependency of BI and KM within the information integration framework are presented. The paper gives an overview of frameworks and models that address the issues of data transfer, BI and KM integration, and information integrity. Key processes applied to BI and KM for the purpose of extracting relevant business information are also described. The article compares and analyzes the key differences between the BI and KM perspectives, and outlines how organizations can leverage each perspective and the synergy effects between them to achieve superior efficiency. Lastly, it outlines the benefits that organizations receive from BI and KM integration, as well as the critical success factors required for its effective implementation.

***Key words:***
*Business Intelligence; Knowledge Management; Information integration; information systems; Data Governance*

## 1. Introduction

Business Intelligence and Knowledge Management have become critical factors in corporate technological strategies to provide fast and reliable access to vital business information. The time available to managers to make important business decisions has reduced significantly in the past three decades due to the overall trend of faster pace of technological integration and data transmission. Therefore, competitive pressures require that informed and efficient decisions based on available business data are to be taken quickly. Organizations are increasingly investing in business intelligence systems that enable them to take quick proactive, corrective and preventive measures to drive superior business performance. The integration of internal business intelligence systems and knowledge management practices plays a key role in improved analytics and decision management functions, so efforts to optimize information integration are required to further the capabilities and benefits of business intelligence practices.

## 2. Conceptual Approaches to Business Intelligence and Knowledge Management

### A. Business Intelligence

Business Intelligence (BI) is defined as a set of applications, technologies, and practices used for the collection, integration, analysis, and display of business information. The purpose of Business Intelligence is to organize, enhance, analyze and provide access to large amounts of data. This enables users to make the right strategic decisions that support their business or organizational goals. Business Intelligence is implemented in organizations through the means of Business Intelligence Systems, which can also sometimes be referred to as data-driven Decision Support Systems (DSS).
Business intelligence information is made available for internal use by the means of Business Intelligence reporting. BI reporting is the process of receiving and providing information or reports to end-users, organizations, and applications by the means of Business Intelligence software. BI reporting is integrated in BI software and is used for delivering summarized and structured reports for analysis or operations performed on one or multiple sets of data. Business Intelligence reports decentralize, collect and present available data; however, such data alone commonly does not undergo a previous process of enrichment by collected and systemized organizational knowledge.

### B. Knowledge Management

Knowledge Management (KM) is defined as a set of initiatives, processes, strategies, and systems that help organizations generate, store, organize, assess, use, disseminate and transform important information owned by the organization in order to support the creation of knowledge. Knowledge management relies on a systematic management of the organization's knowledge ecosystem and assets. The purpose of KM is to contribute to the

Manuscript received December 5, 2019
Manuscript revised December 20, 2019

creation of added value, as well as meeting tactical and strategic requirements necessary for various organizational activities, such as decision making, problem solving, learning and strategic planning.

Knowledge Management relies on established institutional processes of Knowledge Sharing. The latter is defined as a process of transferring or disseminating knowledge from one individual to another person or group in an organization with the goal of exchanging knowledge and experience. Knowledge sharing allows enriching individual learning and helps create, systemize and maintain a common repository of reusable knowledge that helps transform individual work experience into useful and applicable insights that support enhanced collective action and better decision-making.

### C. Information Integration

Effective use of information for the purpose of strategic decision making in organizations relies on the processes of information integration. This is the process of applying software, techniques, and practices that support the merging of information from varied sources with differing conceptual, contextual and typographical representations. Information integration allows consolidating data from unstructured or semi-structured sources through techniques such as data mining, text mining, and multimedia content processing. Information integration allows to collect, combine and organize enterprise data and information from a large group of heterogeneous data sources into a single data monitoring interface where data is displayed in a uniform format that helps users gain faster access to the right information and identify meaningful business insights.

## 3. Theory Overview on Business Intelligence and Knowledge Management Integration

Enterprise systems are key instruments in supporting the integration of information in organizations, which facilitates communication and use of organizational common knowledge. Information is defined as data that are organized, placed in context, and provided with meaning [1]. The effective use of IT information has long been linked to competitive advantages in organizations [2], but more recent research has shown that information use and management lead to improved organizational performance, management of internal processes, customer relationship management and strategic decision-making [3].

Laudon and Laudon [4] argue that integrated Business Intelligence and Knowledge Management systems can support the information integration in organizations and contribute to improved decision making. Kumar and Palvia [5] propose that at middle management level, the integration of BI and KM systems facilitates important operational and tactical decisions regarding budget management, sales and production planning, while at executive management level the reliable, consistent and complete information that is generated by the integration of BI and KM leads to better strategic decision making on the future of the company.

Khan and Quadri [6] write that BI and KM are the main tools providing the organization with an environment in which users are able to receive timely, adequate, reliable and complete information and knowledge. This results in more effective decision-making to achieve organizational goals. BI focuses on extracting valuable information in the form of explicit knowledge from various sources of data and leverages the advantage of large repositories of data that come from within or outside of the organization. According to Herschel and Jones [7], Business Intelligence solutions prove effective to strategic decision making when the information is easily accessible, accurate, complete, regularly updated and usable.

Knowledge Management complements Business Intelligence information by allowing the organization to retrieve and document both explicit and tacit knowledge, apart from promoting knowledge sharing within and outside of the institutional premises. Shehzad and Khan [8] define knowledge as explicit and tacit: explicit knowledge is present in the form of structured data and information, while tacit knowledge is often present in the organization in the form of know-how and undocumented practices. Moscoso-Zea et. Al. [9] argue that explicit knowledge "can be formulated, documented and reproduced", while tacit knowledge can hardly be documented and belongs to human knowledge. BI tends to focus almost entirely on explicit knowledge, so organizations need to integrate BI with KM to ensure that tacit knowledge is accessible throughout the organization and can be used to explain observable patterns. Rostami [10] writes that the role of KM is "to capture, acquire, organize and communicate tacit and explicit knowledge", which contributes to transforming information into actionable insights and practices, which can be reused at all levels of the organization.

Scholars have argued for some time about whether KM can be seen as a layer within the BI system [7], or whether BI instead should be considered a layer of KM [11]. More recent approaches focus on the process of knowledge discovery and suggest that both KM and BI can rely on text mining techniques for analysis of information that is either unstructured or semi-structured. Data mining techniques should be applied for analysis of structured information that is used for BI purposes [12]. The combination of both techniques contributes to discovery of knowledge, particularly when it adds a people-centric

layer that explores how humans interact and share knowledge in the organization.

## 4. A Framework for Business Intelligence and Knowledge Management Integration

Herschel and Jones [7], when examining the issue of KM and BI integration, propose that there is an interaction effect between them. This is supported by Rostami [10], who writes that the integration of KM and BI allows bringing the right information to all levels of the organization and improving productivity and decision-making. In light of the above, Khan and Quadri [6] have developed a framework for the integration of BI and KM that relies on data capturing and collection through ETL solutions and data storage in the internal data marts and data warehouses. ETL as an abbreviation stands for Extraction, Transformation, and Loading of data. ETL supports the process of transferring relevant data for analysis from original data sources to the organization's data warehouse. The key elements of ETL are:

### A. Extraction

Data is collected and extracted from multiple heterogeneous sources, including the internal operational systems (Intranet), as well as external sources. The data is subsequently consolidated, organized and separated from non-relevant data.

### B. Transformation

The transformation process consists in the validation and correction of the extracted data with the goal of removing inconsistent, missing, or invalid values. The data transformation process converts the validated data into standard organizational formats and templates, and applies relevant rules that classify the data and prepare its allocation in the appropriate data mart or data warehouse.

### C. Loading

Once the transformation process is completed and the data has been successfully assigned to the relevant data mart or data warehouse, it is placed there through the Loading process.

Khan and Quadri argue that ETL processing is the first phase of information integration. In the second phase, BI tools such as Online Analytical Processing (OLAP) and Knowledge Discovery in Databases (KDD) are applied to the collected, transformed and stored data in order to extract valuable information or knowledge. OLAP consists in BI software solutions that enable analysts and end users to extract and view business data based on a set of multidimensional analytical queries. KDD consists in the extraction of implicit information from databases and implies that such information had not been identified previously but may be proven to be valuable for decision making. Extraction of tacit knowledge present in the organization in the form of insights, experience, understanding of the business and trade secrets is performed through the process of capturing, documenting, filtering, systemizing and storing by experts or knowledge management professionals.

In the third phase, the obtained information and knowledge must be stored and shared within the organization by the means of knowledge repositories. Information sharing can be performed through internal web portals, analysis reports, document management systems, automated dashboards, shared interfaces stored on cloud solutions, or other technological tools that facilitate the transfer of information and knowledge in a collaborative environment.

## 5. Evolution of Theoretical Approaches Towards The Integration of Business Intelligence and Knowledge Management

The first academic approaches to BI and KM regarded them as mutually supporting elements. Nonaka and Takeuchi [13] developed a knowledge creation model, which defended that tacit and undocumented knowledge can be transformed into explicit and structured knowledge, and that explicit knowledge could also become part of the tacit knowledge present in the organization as a result of its practical application. The co-dependency between the two elements received diverging interpretations: Herschel and Jones [7] defined BI as a subset of KM, while Sharma et al. [11] proposed that KM should be regarded as a subset of BI. Nonetheless, there was academic consensus that both elements participate and support each other in the process of information integration.

Subsequently, Cheng and Cheng [14] proposed a three-layer model that followed the hierarchical design approach to information system development:

I. In the first layer, data are collected and stored in data storage;
II. In the second layer, collected data are loaded via ETL (Extraction, Transformation, and Load) services and are processed and analyzed in the logical layer, where they are transformed into valuable information in a data warehouse;
III. In the third presentation layer, information is displayed as either reports or graphs with the help of OLAP services and is shared as actionable knowledge to support decision-making processes in the organization.

In order to support the process of information integration, Cheng and Cheng argue for the need to develop internal

information systems that make information available and reusable. As a second stage, Herschel and Jones [7] suggest that KM and BI must be integrated to ensure information accessibility and usability. Lastly, the collected information is analyzed, evaluated for accuracy and reliability, and shared within the organization.

Shehzad and Khan [8] present an integrated BI and KM model that demonstrates how the interaction of the two elements can support organizations in better resource management. The model is based on three layers: the Operational Layer, the BI and KM Layer, and the Output Layer (Figure 1). The Operational Layer includes operational systems that represent a mixture of manual and automated systems, and include Production, Inventory Control, CRM, Sales, Marketing, and others. These operational systems are used to process daily transactions and ensure integrity and accuracy of the transactional data. The data that is produced by this layer is uploaded to the BI and KM Layer, where sorting, filtering, advanced search and query generation on the data are performed. Information that results from this processing is extracted and treated according to user requirements. In the final output layer, processed information is presented as an output to the user in the form of summary reports and analytical graphs according to pre-defined user requirements and organization templates with the goal of supporting decision-making at the necessary level of the organization.

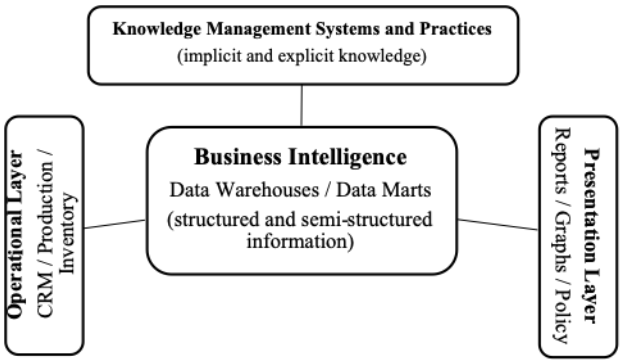


Fig. 1 Framework for BI and KM integration (adapted from Shehzad and Khan).

Based on the model above, a subset of academic literature was developed to propose a people-centric approach to the integration process of KM and BI. Theoreticians argued that since it is the people who use the information, share it and make decisions in an organization, any process of BI and KM integration must necessarily involve the transformation and use of knowledge concentrated in the human resources layer.

Alrumaih and Zemirli [15] argue that employees require training in Knowledge Management in order to understand how KM can support and bring value to BI. Rostami [10] suggests that the integration between the logical and presentation layers is carried out in a people-centric way; while Cheng and Cheng [14] defend that any process of BI and KM integration must be followed by evaluation and feedback that are fed back into the model to allow for its continuous improvement.

There are a number of factors that influence the process of BI and KM integration. Since information integration is a continuous process of improving decision-making in an organization [12], it relies on the concept of information integrity. Information integrity is the process of ensuring the availability, reliability, and reusability of collected data. Niesel [16] proposes a paradigm model that illustrates the relation between the steps of the data enrichment process and how each of them influences the process of information integrity from a Knowledge Management perspective:

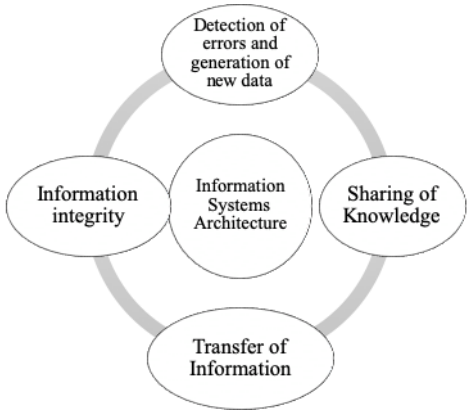


Fig. 2 Information Integrity process

IS architecture has a strong influence on the process of ensuring information integrity. It is commonly based on an ERP system, which represents a source database that is connected to a data storage warehouse through an ODBC (open database connectivity) connection. Figure 2 illustrates that the process of ensuring information integrity is circular with clockwise motion of the key steps, the first of which is the detection of errors and generation of new data and insights. Whenever the BI system's output differs from the expected output, a check is performed to establish whether deviations in the data output are due to technical errors or to data inconsistencies in the underlying source databases and systems. In the latter case, knowledge is shared with the functional process owner, the person responsible for the data input, or a master data management professional. Alternatively, in the absence of information deviations, newly generated data or insights may also be the trigger for the process of knowledge sharing.

Niesel argues that sharing of knowledge may occur in automated, semi-automated, or non-automated way. Automated error recognition tools, such as pre-programmed SQL queries, offer a simplified, efficient and reliable solution to ensure that information integrity is in place and maintained on a continuous basis. Semi-automated knowledge sharing occurs in the process of importing and uploading newly generated data into the ERP system, since it involves personal communication and requires that new source data is generated and loaded into the system via a manual update of the BI tool. Non-automated sharing of knowledge takes place in personal interactions between employees without the use of automated or semi-automated solutions.

Information transfer is initiated whenever users seek to identify the causes of detected errors, correct them, and – when necessary - upload new data files that provide reliable and accurate data to be integrated in the BI tools. Information transfer may be performed through EDI import or the update of source databases. Once the organization has gone through the phases of error detection and/or new data generation, knowledge sharing, and information transfer, it can be said that the information integrity has been achieved, since the updated data has been made to respond to the criteria of availability, reliability, and reusability. Due to the fact that information integrity is a continuous data quality assurance process, the abovementioned phases are repeated in an iterative cycle on a regular basis throughout the existence and functioning of the organization.

Key to the entire process of ensuring information integrity is the people-centric knowledge management perspective. People in organizations tend to have a large number of personal interactions through which they share knowledge, experience, insights, and best practices. To ensure that the information integrity process is coherent and suffers no interruptions, organizations make sure to establish key contact points and roles so that users who detect data errors or other irregularities within the source data know whom to contact. This guarantees that the processes of knowledge sharing and information transfer are not interrupted, that the accumulated knowledge is guaranteed and present at all times, and that users assume responsibility for maintaining the accuracy and reliability of source data on a continuous basis.

Table 1: Key differences between Business Intelligence and Knowledge Management

| | **Business Intelligence** | **Knowledge Management** |
|---|---|---|
| **Form of knowledge** | Explicit, often formalized or documented in internal repositories of knowledge, available for consumption and use outside of human interaction. | Frequently implicit or tacit, rarely documented or made available outside of human interaction. |
| **Information sources** | Databases, structured or semi-structured data sources, integrated information systems. Often present in the form of documents, reports, tables and other documented data sources. | Unstructured, often undocumented information in the form of expertise, specialist knowledge, best practices, lessons learned, industry know-how, and others. |
| **Type of data** | Quantitative data and metrics, codified qualitative data. | Unstructured or semi-structured qualitative data. |
| **Information transfer processes** | Automated or semi-automated via machine systems, do not require human interaction. Information can be supplied and used in a variety of formats and outputs. | Non-automated communication processes that typically require human interaction for the transfer of unstructured knowledge. |
| **Validation of information** | Information validity can be verified, tested and confirmed (or rejected) through automated or semi-automated processes aimed at preserving data quality. | The validity of information cannot be attested via automated processes. Input from other sources of knowledge needs to be collected, organized and compared with the original information in order to validate or reject its accuracy. |
| **IT tools** | ETL, KDD, OLAP, SQL, BI systems, data mining, statistical analysis tools, among others. | Knowledge sharing, internal e-learning tools, communication platforms, knowledge repositories, expertise hubs and communities. |
| **Use cases** | Used to extract insights, trends and patterns from large amounts of data. Provides objective information that can be used for strategic business decisions or future modelling / predictive analytics. | Used to contextualize the data within the larger industry know-how and employee expertise. Builds upon the quantitative information provided by BI and enriches it with best practices and lessons learned. |

As illustrated in Table 1, Business Intelligence and Knowledge Management rely on distinct approaches, tools, data sources, information transfer and processing techniques. Organizations must leverage both BI and KM

to pursue a successful competitive strategy, but the approach to each of these elements needs to take into account their specificities. The BI perspective needs to be applied when the organization deals with large amounts of structured or semi-structured quantitative data that can be loaded, transformed and stored via ETL and OLAP tools. It is critical in situations where identification of patterns, trends and predictive models is required to provide competitive business advantage but cannot be accessible through mere human observation. Furthermore, the BI perspective provides increased data accuracy due to the possibility of integrating data validation tools such as systems checks, automated SQL verification queries, and others. On the other hand, the KM perspective is based on a human-centric model and as such deals with unstructured or semi-structured, mostly qualitative data sources that require text mining, knowledge mining, knowledge sharing and other techniques in order to be transformed into structured and formalized knowledge. These techniques are commonly applied in settings that rely at least partially on human interaction and thus do not allow for fully automated data mining processes. The validity of the generated knowledge can be attested only via juxtaposition with other sources of the same expertise or know-how and cannot rely on automated solutions. Despite the unstructured nature of the source data, the KM perspective is crucial in validating the outputs of BI against industry understanding, technical expertise and business know-how in order to contribute to informed business strategy.

The shortcomings of BI and KM lie in the fact that neither of these perspectives can be applied as a standalone solution to inform an organization's decision-making. Furthermore, overreliance on any of these perspectives against the other can lead to distorted or biased information that contributes to misguided business decisions. Lack of sufficient integration of both perspectives in the organization's internal and external processes may lead to functional units "moving at different speeds" or taking tactical decisions that are not aligned with the overall macro strategy. Finally, lack of optimal integration between BI and KM results in information that has not been validated by the contrasting perspective, and thus leads to subpar decision-making that can ultimately hinder the organization's competitive standing. Therefore, it is critical that organizations develop, implement and maintain comprehensive information integration strategies that allow them to optimally combine BI and KM, and to leverage their synergy effects.

## 6. Benefits and Critical Success Factors of Business Intelligence and Knowledge Management Integration

KM, strategic orientation, and organizational innovation have a strong impact on organizational performance in modern business [17]. Organizations that undertake the integration of Business Intelligence and Knowledge Management systems tend to be in the middle of rapid internal or industry changes, such as the emergence of large volumes of data, strong industry push for innovation, information revolution or environmental challenges [16]. The fast-growing technological capabilities for data collection and generation require the use of software solutions and tools that can transform processed data into valuable information and knowledge. Shehzad and Khan [8] argue that BI and KM integration helps organizations "arrive to the right information at the right time". The main goal of information integration is to ensure that the organization is able to rapidly respond to market changes. Therefore, Chang et al. [18] suggest that information from internal and external sources, as well as market intelligence and knowledge, needs to be collected, integrated and regularly updated for the purpose of being used by all levels of the organization to respond to various market situations.

Shehzad and Khan [8] argue that, in order to ensure successful BI and KM system integration, organizations need to rely on a number of critical success factors. These include committed management support and sponsorship of the integration process, clear business vision and a well-established case to defend the need for KM and BI integration. Other factors are business-driven methodology and project management, as well as sustainable data quality and governance framework. Committed management support, the presence of a clear business vision and case for the integration of KM and BI enables the adoption and internal endorsement of BI and KM systems. Business-driven methodology and project management allow for appropriate project scoping, planning and adoption of a continuous improvement and data quality / data governance framework. This results in increasing productivity and efficiency of operations, ability to predict organizational challenges and to plan optimal strategies on how to address them.

## 7. CONCLUSION

Rapid advancement of the Big Data landscape and the growth of massive amounts of data faced by modern organizations have driven the need for effective tools and techniques that can allow processing and extracting of business insights from that data, as well as transforming the collected data in useful knowledge. Furthermore, the

exponential speed at which organizations are now able to share data and information with their stakeholders, as well as collect such data from their counterparts, has also led to rapid transformation of the marketplace and competitive business setting. In this fast-changing world, organizations are increasingly required to take swift crucial decisions that affect their overall business strategy, and thus need to rely on technological and knowledge management solutions that support and validate those decisions.

In this article, we have discussed the benefits that two such solutions – Business Intelligence and Knowledge Management – can provide to organizations in this complex and dynamic environment. Business Intelligence allows to systemize, process and analyze large amounts of data available to the organization, and thus contributes to transforming quantitative data into information that can be used for accurate, data-based decision making. Knowledge Management also contributes to informed decision-making by providing qualitative insights and validating the information resulting from Business Intelligence against the accumulated business knowledge and industry know-how. Effective information integration can only be achieved when BI and KM are combined and sufficiently integrated to generate and transfer knowledge within the organization. In this article, we have discussed several models and frameworks that approach the issue of BI and KM integration, as well as the stages of that integration process. Organizations that achieve optimal information integration benefit from improved knowledge generation and knowledge sharing processes, higher organizational efficiency and performance, as well as faster and more intelligent decision-making in competitive business setting.

Finally, we have discussed that optimal integration between BI and KM relies on a number of critical success factors, such as executive sponsorship, company culture, internal and external knowledge sharing processes, the presence of a business case that justifies the need for BI and KM integration, as well as sustainable data quality and governance framework. With clear business vision and successful integration between BI and KM, organizations can achieve superior efficiency and business performance that lead to competitive advantage on the market and excelling against the competition.

## References


[1] R. Glazer, "Marketing in an Information-Intensive Environment: Strategic Implications of Knowledge as an Asset", The Journal of Marketing vol. 55:4, pp. 1-19, 1991.

[2] M.E. Porter, and V.E. Millar, "How Information Gives You Competitive Advantage", Harvard Business Review, vol. 63:4, pp. 149-160, 1985.

[3] S. Mithas, N. Ramasubbu, and V. Sambamurthy, "Information Technology Infrastructure Capability and Firm Performance: An Empirical Analysis", Working Paper, Robert H. Smith School of Business, University of Maryland, College Park, 2008.

[4] K.C. Laudon, and J.P. Laudon, Essentials of Management Information Systems, 5th ed., Upper Saddle River, New Jersey: Prentice Hall, p. 21.

[5] A. Kumar, and P. Palvia, "Key Data Management Issues in Global Executive Information Systems", Industrial Management & Data Systems, vol. 101:3/4, pp. 153-164, 2001.

[6] R. Khan, and S.M.K. Quadri, "Dovetailing of Business Intelligence and Knowledge Management: An Integrative Framework", Information and Knowledge Management, vol. 2:4, pp. 1 – 6, 2012.

[7] R.T. Herschel, and N.E. Jones, "Knowledge management and business intelligence: the importance of integration", Journal of Knowledge Management, vol. 9:5, pp. 45 – 55, 2005.

[8] R. Shehzad, and M.N.A. Khan, "Integrating Knowledge Management with Business Intelligence Processes for Enhanced Organizational Learning", International Journal of Software Engineering and Its Applications, vol. 7:2, pp. 83-93, 2013.

[9] Moscoso-Zea, O., Luján-Mora, S., Cáceres, C. and Schweimanns, N., "Knowledge Management Framework using Enterprise Architecture and Business Intelligence", Proceedings of the 18th International Conference on Enterprise Information Systems (ICEIS 2016), Vol. 1, pp. 244-249, 2016.

[10] N.A. Rostami, "Integration of Business Intelligence and Knowledge Management – A literature review", Journal of Intelligence Studies in Business, vol. 4:2, pp. 30-40, 2014.

[11] R.S. Sharma, D. Tan, and W. Cheng, "Two Heads Are Better Than One: Leveraging Web 2.0 for Business Intelligence", International Journal of Systems and Service-Oriented Engineering, vol. 1:2, pp. 1-20, 2010.

[12] R. Sharda, D. Delen, and E. Turban (Eds.), Business Intelligence: A Managerial Perspective on Analytics. Pearson, 2014.

[13] I. Nonaka, and H. Takeuchi, The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press, 1995.

[14] L. Cheng, and P. Cheng, "Integration: Knowledge Management and Business Intelligence", Conference paper presented at the 2011 Fourth International Conference on Business Intelligence and Financial Engineering, 2011.

[15] H. Alrumaih, and N. Zemirli, "Investigation of Knowledge Management Support for Business Intelligence in the Saudi Public Sector", Paper presented at the EKCM 2014, Portugal, 2014.

[16] C. Niesel, Information integrity: A proposal to improve the integration of knowledge management and business intelligence for better decision-making. Open University of the Netherlands, 2018.

[17] K. Kasemsap, "The Role of Data Mining for Business Intelligence in Knowledge Management", Integration of Data Mining in Business Intelligence Systems, pp. 12-33, 2015.

[18] K. Chang, W.J. Kettinger, and C. Zhang, Assimilation of Enterprise Systems: The Mediating Role of Information Integration of Information Impact. ICIS 2009 Proceedings, Paper 90, pp. 1 – 12, 2009.