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ERP Integration with Performance Analytics: a Systematic Literature Review

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Abstract. Enterprise Resource Planning (ERP) systems have considerably become traditional as a part of organizations' IT systems in the last decades. ERP systems' research field have involved technology, project management and organizational learning since its birth. With the new big data era, ERP systems have been also progressively exposed to an extensive volume and variety of data in a short amount of time. Since then, a new study field regarding the linkage of these commercial systems with performance analytics to improve decision directions has emerged. Based on a systematic literature review methodology, the purpose of the present paper is to analyze recent research studies connecting ERP Systems to performance analytics. Proknow-C method was applied for a first iteration in Scopus. Results present a bibliographic portfolio analysis composed by 30 papers, being 70% journals and 30% conference papers. The interaction of both themes revealed that diverse environments have integrated analytics in ERP Systems to achieve smart management decisions. Although most studies have not reached many citations over time, the conjunction of both themes has been an important research issue worldwide. Author key-word analysis directed further research suggestions, identifying some possible extra key-words for ProKnow-C following iteration. The contribution of this paper is two-fold, a bibliometric analysis of the current scenario of ERP systems with performance analytics along with a summarized lessons learned of the present portfolio, connecting emergent technologies to cyber-security, organizational learning, hidden knowledge findings, active communication and multiple audit facilities as common output drivers for competitive performance.

Keywords: ERP Systems, Data Analytics, Performance Analytics, Decision-making, Systematic Literature Review.

1 Introduction

Organizations are increasingly investing in a competitive database with the capability to provide assertive decision-making processes. Investment in corporate management systems, also known as ERP Systems, aims to optimize operations, integrate internal departments and unite corporate databases. Over time, they have been associated to their ability to provide directions for decision support, since ERP became intensively exposed to expansive and diversified data structures in a fast environment and demanded the exploration of analytical features such as Business Intelligence (Holsap-

ple *et al.*, 2019). This connection between ERP and big data analytics has enabled faster decision making by providing near real-time statistical data and consistent dashboards of the organizations' current scenario as well as reporting historical events (Cadersaib *et al.*, 2018).

The scientific literature on ERP systems has focused on diverse fields of study since its birth in the end of the last century, exploring implementation challenges (Ismail and Zamre, 2015), implementation approaches (Nordin and Adegoke, 2015), ERP learning and performance (Plaza and Rohlf, 2008) and also technological, structural, behavioral changes and benefits experienced by organizations during ERP projects (Nwankpka, 2015). With the new technological field, some studies have investigated the connection between ERP Systems and performance analytics, exploring the benefits of ERP commercial packages on decision support (Shi and Wang, 2018; Holsapple *et al.*, 2019). Based on the described context, this paper proposes to explore both themes with a systematic literature review and answers the following research question: how is the current scientific scenario of ERP Systems integration with Performance Analytics?

The research question was used as a guidance for this investigation to find the linkages between ERP and performance analytics through a systematic literature review with Proknow-C method (Essnlin *et al.*, 2010).

2 Literature review

This chapter shows the literature review, starting with ERP Systems and Performance Analytics individual definitions, the chosen axes for this study.

2.1 ERP Systems

Historically, ERP Systems originated with MRP, Material Requirements Planning, in the early 1970s, which made it possible to calculate the amount of materials needed at each point in the production stage according to backlog orders. In the 80s, computers and the technological universe remarkably increased and, following this evolution, MRP I turned Material Resource Planning, commonly known as MRP II, providing complementary modules such as purchase control, shop floor control and capability resource planning. ERP is MRP II successor, because in addition to the manufacturing process, it encompasses the integrated planning of all other organizational departments (Correa *et al.*, 2011).

ERP Systems facilitate information flow among company activities, simplify processes and eliminate the need for parallel and inefficient controls. Benefits are not limited to process optimization, because they also improve risk management and business process security through transactions' traceability along with profiles consistent with their respective accesses and usage permissions (Nordin and Adegoke, 2015, Holsapple *et al*., 2019). Despite benefits diversity, ERP systems face complex implementation projects demanding rigid structural changes and companies are usually directed towards a department hierarchical view. The transition from a functional to a process-based view is a great challenge. However, with the proper implementation

approach, encompassing organizational cultural aspects, it is possible to increase successful cases (Al-mashari, 2003; Shi and Wang, 2018).

Technological developments have made it possible for organizations to use enterprise resource without infrastructure high costs. Cloud ERP has an extra advantage for being online with organizational data stored in the cloud. This measure not only guarantees the information security, but also allows the system to be accessed from anywhere. Thus, business performance indicators can be monitored more closely and provide efficient external sales. According to Gupta *et al*. (2018) cloud ERP has led to a constant creation of large data of structured and unstructured natures and consequently defended there has been a need to analyze such complex data sets within the integration of cloud ERP and big data predictive analytics.

2.2 Performance analytics

Big data analytics examines massive amounts of data to uncover hidden patterns, correlations and other analyses. Individual data can possibly be considered not extremely relevant for business strategies, however, big data analytics cases are progressively increasing, since a collection of spread individual data can provide competitive information, which any hidden knowledge can be found once collected into large volumes (Kim and Yu, 2015). Data analytics are also commonly divided into descriptive, diagnostic, predictive and prescriptive (Appelbaum *et al*., 2017).

The term big data is commonly introduced as a technology for analyzing results from a large amount of structured and unstructured data set beyond the ability of reporting, saving and simulating decisions with traditional database administration resources (Holsapple *et al*., 2019). Big Data term is also referred as a set capable of handling data generated within the 3V concept: variety, velocity and volume, structured or not with different formats. The challenge is directed to capture, treat and examine this mountain of information sources fast enough to provide strategic decisions. With the current technology, organizations have also used another famous approach for analytics named as business intelligence, an effort that is slower and gets forthwith analyzes with instantly reports (Nofal and Yusof, 2016).

Big data analytics is mostly related as an organizational tool with the ability to provide competitive knowledge for smart business decisions or even a system that supplies data architecture as an input and transforms information as output strategic guidelines (Olszak, 2016; Karimanzira and Rauschenbach, 2020).

Performance analytics has contributed to multidisciplinary environments, providing faster and more effective diagnostics in healthcare systems (Charleonnan *et al.*, 2016; Raglio *et al.*, 2020) and bringing competitive knowledge in organizational setting (Sabbeh, 2018; Jayadi *et al.*, 2019). However, big data analytics demand structured project plans involving cross-functional teams, innovative visualization technologies and leadership involvement to change management processes (Dutta and Bose, 2015). The present research investigates the current scientific scenario of data analytics linkage to ERP projects.

3 Research Design

The method selected to achieve the research purpose is Knowledge Development Process-Constructivist, also known as ProKnow-C (Ensslin *et al*., 2010). The process approach, simplified by Figure 1 with an overview of the main steps, consists on a complete structured process for bibliographic portfolio selection and literature analysis.

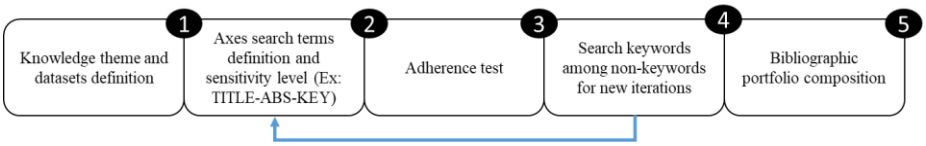


Figure 1. ProKnow-C main steps.

ProKnow-C methodology begins with the research theme definition within its field of study and the respective search databases. Secondly, search terms are defined to obtain the desired theme through axes' interaction along with search sensitivity level. An adherence test is following applied to test if search results matched its intended target. If the match is positively verified, the first bibliographic composition is available. The method involves extended iterations involving the search of new keywords in the first iteration's research papers for bibliographic composition continuously improvement.

The present study used ProKnow-C method to build exclusively the first literature composition of the both research themes: ERP Systems and Data analytics and limited Scopus database for this first iteration. Bibliometric analysis followed the sequential steps: publication over the years, citation overview, portfolio subject areas, predominant authors and finally, the key-word analysis.

4 Results

This chapter presents the research results, which is segmented by bibliographic portfolio composition and its sequential bibliographic analysis.

4.1 Bibliographic portfolio composition

The research themes used in the axes consisted of "ERP" and "analytics", respectively. The following search expression presented by Table 1.

Table 1. Search expression.

1st axis: ERP	Boolean Operator	2nd axis: analytics
("enterprise resource planning" OR "ERP system*" OR "Cloud ERP")	AND	("analytics" OR "business intelligence" OR "big data")

The search, made on July 14th at 11:25 a.m., was restricted for open access articles, Journals and Conferences, written in English and published between 2015 and 2019, considering exclusively Scopus database for bibliographic analysis. The search expression insertion in their respective database provided a preliminary result of 188 articles.

Table 2. Adherence test.

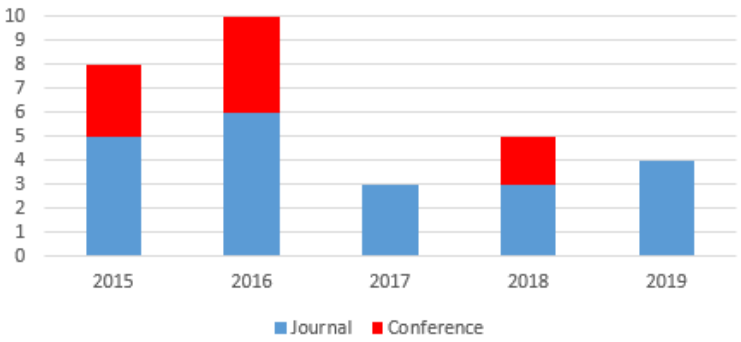
	Articles description
1	APPELBAUM, D., KOGAN, A., VASARHEYLI, M., YAN, Z.: Impact of business analytics and enterprise systems on managerial accounting", International Journal of Accounting Information Systems, v. 25 (No.March), pp. 29–44 (2017).
2	SHI, Z., WANG, G.: Integration of big-data ERP and business analytics (BA). Journal of High Technology Management Research, v.29 No., pp. 141-150 (2018).
3	DUSSOYE, H., CADERSAIB, Z.: Sentiment analytics framework integrating Twitter and Odoo ERP", 2017 International Conference on Infocom Technologies and Unmanned Systems: Trends and Future Directions, ICTUS 2017, v.2018(n.jan), pp. 145–151. (2018).
4	NYCZ, M., PÓLKOWSKI, Z.: The ERP system as a basic system for business analyses, Proceedings of the 2014 6th International Conference on Electronics, Computers and Artificial Intelligence, ECAI 2014, IEEE, pp. 63–66 (2015).
5	ROUHANI, S., MEHRI, M.: Does ERP have benefits on the business intelligence readiness? An empirical study. International Journal of Information Systems and Change Management, v. 8 (n.2), p. 81 (2016).

A considerable number of these articles were rejected for being book chapters, since the intended restriction was specified to limit Journals or Conferences studies and some others were also excluded due to availability, presenting as non-open access. On the next step, to verify if the selected search expression is adequate or if there was the need to find substitute terms that better represent the research themes, the recommendation of five articles reading was applied, as presented by Table 2.

Positive adherence by search expression could be observed, resulting in articles dealing with both research themes simultaneously, besides similar key words with the search expressions. Therefore, the raw bibliographic portfolio of 74 papers was originated. Sequentially, the refinement phase was applied reading the 74 articles titles and abstracts discarding 44 considered either non-aligned or not specifically addressing both topics, resulting in 30 final articles presented by Appendix Section.

4.2 Bibliographic portfolio analysis

The selected portfolio is predominantly composed by journals, counting 70% with the other remaining 30% composed by international conferences. In addition, bibliographic portfolio over the years, exhibited by Figure 2, reveals a noticeable stronger impact in the researched field in 2015 and 2016 comparing to other yeas.



Year	2015	2016	2017	2018	2019	Total	% Total
Journal	5	6	3	3	4	21	70%
Conference	3	4	0	2	0	9	30%

Figure 2. Bibliographic portfolio over the years.

Regarding scientific relevance, it was perceived few citation quantity, with most of the papers counting less than five citations. Figure 3 indicates only two articles have exceeded 20 citations. One possible explanation for the low impact is search restriction for studies written between 2015 and 2019 and therefore time exposition is still relatively short.

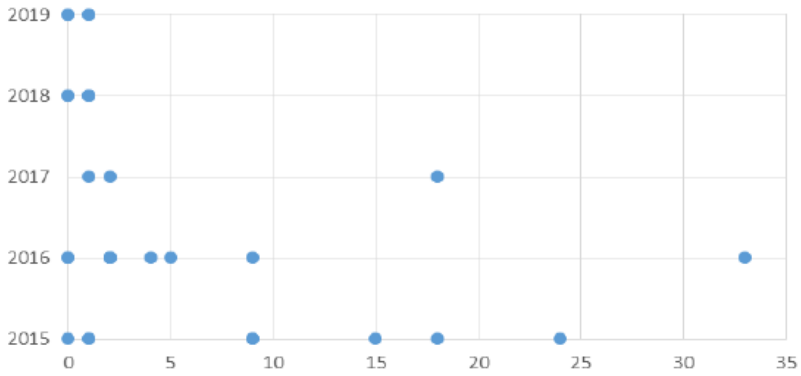


Figure 3. Citation overview.

Sequentially examining scientific relevance, the journals composed in the portfolio were also analyzed according to their respective SJR indicators, Table 3. There is no specific journal dominating the bibliographic portfolio composition, presenting consistent diversity. However, some journals are high rated regarding their SJR qualifications, increasing the portfolio scientific value.

Table 3. SJR indicators.

Journal	SJR
Journal of Information Technology	2,1
International Journal of Operations and Production Management	2,1
Journal of Business Research	1,7
Computers in Industry	1,2
International Journal of Advanced Manufacturing Technology	1,0
Computers and Electronics in Agriculture	1,0
Management Decision	0,7
Information Processing in Agriculture	0,6
Business Process Management Journal	0,6
Information Systems Management	0,5
International Journal of Accounting Information Systems	0,5
Information Technology and Management	0,4
Journal of Supercomputing	0,4
Kybernetes	0,3
International Journal of Business Information Systems	0,3
Journal of High Technology Management Research	0,3
Library Hi Tech News	0,3
International Journal of Software Engineering and its Applications	0,2
International Journal of Information Systems and Change Management	0,1
International Journal of Internet Manufacturing and Services	0,1
International Journal of Intelligent Information and Database Systems	0,1

The remaining conference papers in portfolio composition are also diverse, counting International Conference on Enterprise Systems, International Advanced Computing Conference, Global Conference on Communication Technologies and many others involving industrial engineering and computational intelligence.

Examining the studies' scope classified by subject areas presented by Figure 4, it can be observed that most of papers addressing data analytics with ERP Systems deal with Computer Science (34,4%), Business, Management and Accounting (17,2%) and Decision Sciences impacts specifically (15,6%) research fields. The specificity and diversity involving the remaining subject areas can be explained by the specificity of some contributions involving agricultural, social sciences and energy environments.

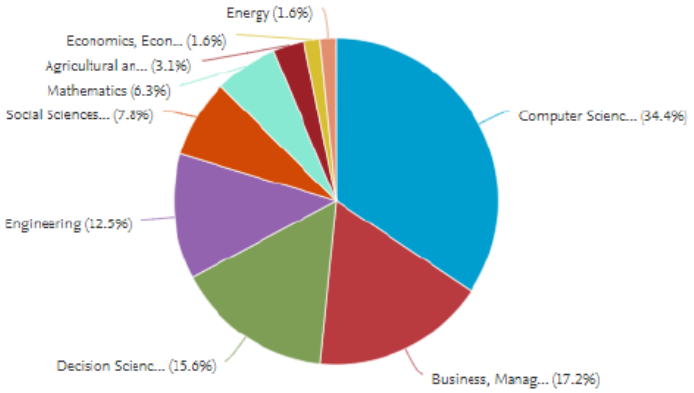


Figure 4. Portfolio subject areas.

In respect of the authorship 83 different authors appeared. Of these, only a single author had incidence of two publications in the portfolio, the Portuguese management researcher Oliveira T., and all the remaining stayed with one frequency. Analyzing the portfolio regarding their country, as exhibited by Figure 5, it is perceptible a domain in India, although United States remained a single paper behind and Germany together with Taiwan had a noticeable contribution. This fact indicates that the conjunction of the two themes have been researched worldwide by all continents.

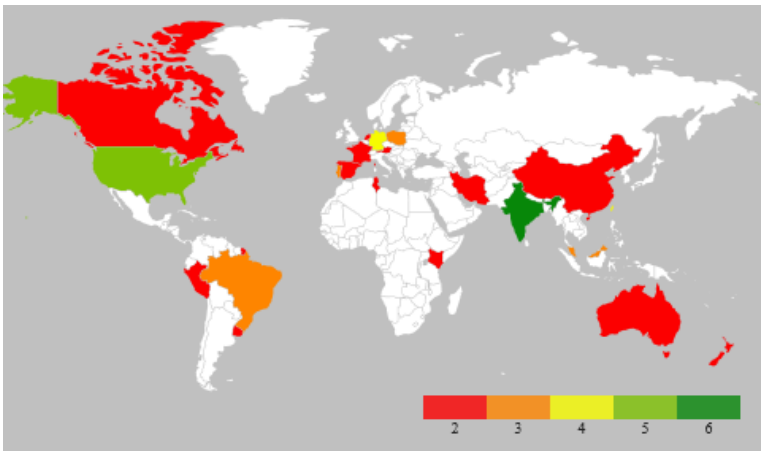


Figure 5. Portfolio geographic heat map.

Author keywords' analysis, Figure 6, revealed most of the common key-words among portfolio authors were defined by search axes.

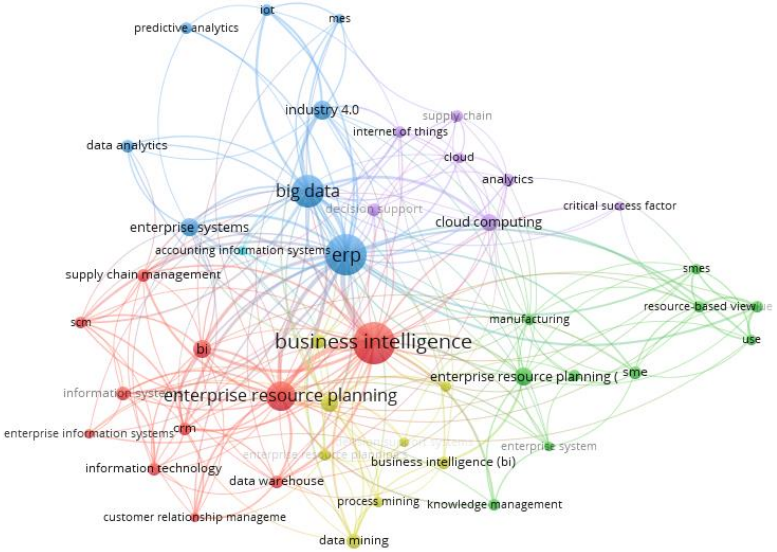


Figure 6. Author keyword analysis.

Some of non-keywords among author keywords, such as data mining, cloud computing and data warehouse, are considered relatively important for a second search iteration, following Proknow-C method steps.

4.3 Lessons Learned Portfolio Summary

The present bibliographic portfolio composition reveals diversity not only among study centers, authors and multi-sector organizations, but also of the emergent technologies connected to ERP systems. Figure 7 presents some contributions identified on ProKnow-C first iteration.

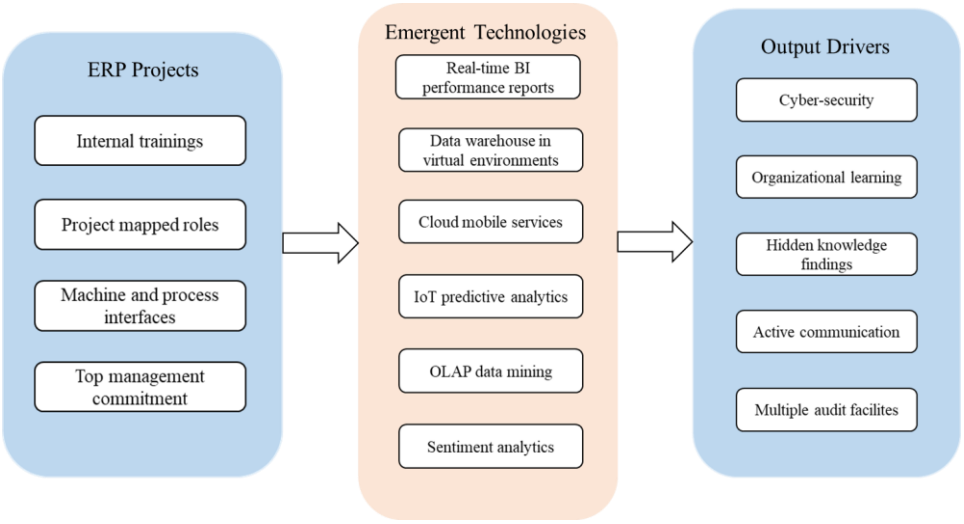


Figure 7. Summary of lessons learned.

The interaction of both axes presents a summary of common best practices among ERP projects, such as internal trainings, mapped roles, process interfaces and top management involvement. Regarding emergent technologies, business intelligence reports are the most predominant object of study (Kim and Yu, 2015; Shi and Wang, 2018, Ranjan *et al.*, 2017). On the other hand, some approaches are more unusual with distinct perspectives, revealing new trends, such as sentiment analytics using microblogging to find social media feelings (Dussoye and Cadersaib, 2018) and IoT predictive analytics for aquaponics management (Karimanzira and Rauschenbach, 2020).

Summary of lessons learned also connects the emergent technologies to competitive outputs that have supported organizations to find hidden knowledge (Kim and Yu, 2015; Nycz and Pólkowsky, 2015; Shi and Wang, 2018), build cyber-security (Tai *et al*., 2016), organizational learning (Labonte-LeMoyne, 2017), active communication (Nofal and Yusof, 2016) and multiple audit facilities (Werner and Gehrke, 2015; Gambetta *et al*., 2016).

5 Conclusion

The present systematic literature review have successfully achieved a first iteration with assertive keywords that brought relevant recent papers interacting ERP Systems with data analytics. The following step is to continue Proknow-C method trying new keywords among non-keywords to extend bibliographic portfolio composition, since this study was limited to a single first step in Proknow-C process. Another limitation is related to search restriction to Scopus, since the present first iteration can possibly be extended once new databases are included.

The interaction of performance analytics term relating to ERP Systems have reached distinct areas and contributed to management decisions for near real-time data analysis in medical institutions (Kim and Yu, 2015), bank's audit (Gambetta *et al.*, 2016), manufacturing enterprises (Ranjan *et al.*, 2017) and agriculture environment (Junior *et al.*, 2019; Karimanzira and Rauschenbach, 2019). Curiously, even polish water parks (Nycz and Pólkowsky, 2015) have been improving decision-making integrating analytics with their ERP systems.

Regarding analytics and some of its classifications, some papers specify their studies, such as sentiment analytics (Dussoye and Cadersaib, 2018) or predictive analytics (Karimanzira and Rauschenbach, 2019) while others explore the theme without explicitly classifying along their studies. The main contribution of this paper consisted on identifying the diversity integration of ERP systems with performance analytics. Common emergent technologies were listed in lessons learned, connecting to cybersecurity, organizational learning, hidden knowledge findings, active communication and multiple audit facilities as performance output drivers. This briefly summarized interrelationship can be linked to a further research with a more extensive content analysis. Complementarily, a secondary study could also enhance additional relevance and dialogue to recent research, such as the effects of capabilities and policies of strategic decision areas on manufacturing high performance (Okoshi *et al*., 2019) or even management frameworks (Giordani da Silveira *et al*., 2018), since performance analytics has brought a new scenario of management.

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Appendices – List of bibliographic portfolio composition

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