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The integration of ERP and inter-intra organizational information systems: A Literature Review

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Abstract: This paper provides an initial systematic review of journal publications on ERP and Information Systems (IS) integration. Three essential types of integration are proposed to analyze the body of the literature (Technical, Business and Socio-Organizational). To complete the review, three additional axes of study are synthesized (Implementation Stage, Company Size and Research Methodology). Finally, results are discussed and opportunities for future research are presented.

Keywords: Enterprise Resource Planning (ERP), System Integration, Data Integration, Process Integration.

1. INTRODUCTION

The new industrial revolution (Industry 4.0) has transformed the relationship between stakeholders in an entire supply chain. Indeed, the implementation of Industry 4.0 initiatives looks for, among many things, monitoring industrial processes, simulating and optimizing production processes and increasing the agility of information flows (Moeuf, et al. 2017).

In order to increase the speed of information flows, (Moeuf, et al. 2017) point to technologies like cloud computing platforms, web interfaces, virtual reality, Big Data and IOT (Internet of Things), which have been connected with enterprise production planning and control systems like ERP (Enterprise Resource Planning). The integration of these technologies presents multiple benefits including operational optimization, increased collaboration between stakeholders, raised industrial efficiency and more flexibility in decision-making processes.

Furthermore, concepts such as collaborative planning, forecasting and production (CPFR), integration of ERP with SCM (Supply Chain Management) Systems as well as with SCRP (Supply Chain Resource Planning) Systems show the relevance of system information and business process integration (Chung & Hung-Lian Ahmad 2011) (Reimers & Guo 2014).

ERP systems were initially conceived as integrators of information flows coming from different functional units of the same enterprise. When implementing an ERP, enterprises seek increased productivity, access to information and

managerial performance in decision-making (Pellerin et al.2007). Nevertheless, as (Kovács & Paganelli 2003) have expressed, ERPs are based on a logic of single centralized organizations. Therefore, ERPs are characterized by the following principles: hierarchy, embedding business processes and centralized data management. These principles are not consistent with new production scenarios where decentralization and flat models are privileged, neither with the integration with suppliers' and sub-contractors' through IS.

Enterprises that have implemented an ERP system have to deal with projects for optimally integrating it with other inter and intra-organizational information systems so that they can deal with external pressures. The aim of this paper is to conduct a systemic review of scientific literature about the integration of ERP and other information systems. The following research question has directed the study: **What is the existing offer regarding ERP integration with another IS in an Industrial context?**

This paper starts by describing the methodology of the systematic review. In the third section, results of the review and a detailed analysis via references to the literature within the scope of the four axes of analysis are presented. Based on the results of the review, research implications as well as opportunities for future studies are presented.

2. RESEARCH METHODOLOGY

The scientific literature was consulted in online databases and research focused on journal publications only. An initial search was done to determine the scope of the literature review. We retain research articles published in the last ten years, as

research about ERP and IS integration has been mostly published since 2007.

The proposed framework for literature review analysis is based on three types of integration studied by (Kähkönen 2017): technical Integration, Business Integration and Socio-Organizational Integration. The author defines technical integration as the ability to make applications or systems to exchange data. When referring to business integration, the author clarifies that it is needed when a business process is automated, as different sources of information are integrated to complete the process. Finally, socio-organizational integration concerns the interactions between stakeholders from different organizational units. Change Management is studied under this perspective.

The major sources of information were Science Direct and Scopus. Only the following research string containing “Data Integration”, “System Integration” and “Process Integration” conducted the research:

Search String 1: “ERP” (TITLE-ABS-KEY) AND “Data” OR “System” OR “Process” AND “Integration” (TITLE-ABS-KEY) AND pub-Date>2005 AND content type <>Books.

The following figures help illustrate the difference between the three types of integration target research:

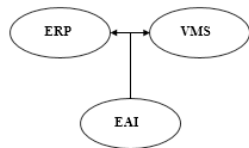


Fig. 1. System Integration

VMS: Vendor Management System, EAI: Enterprise Application Integration

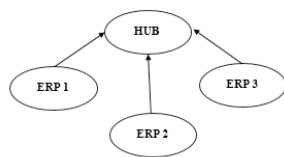


Fig. 2. Data Integration

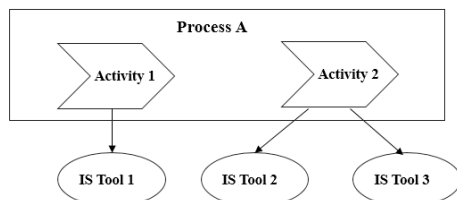


Fig. 3. Architecture Integration

A review of abstracts enabled the exclusion of publications whose research domain was not engineering, information systems or management. Then, for articles that were found in both databases, one copy was excluded. Fig. 4 summarizes the research strategy:

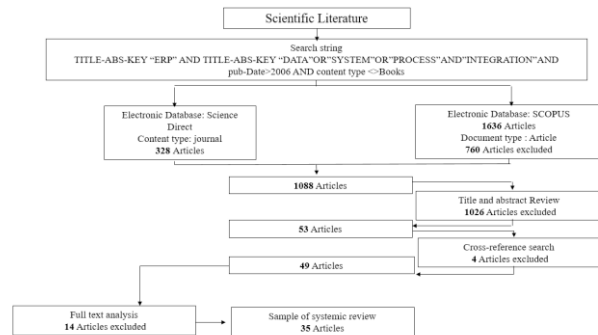


Fig. 4. Mapping the Literature Research Strategy

As was previously mentioned in this section, the types of integration proposed by Kähkönen were the basis for the full text analysis of the 35 selected articles. Although, for the purpose of this research Technical Integration was classified in three types, previously presented in figures 1 through 3: system integration, data integration and architecture integration. Table 1 displays the integration focus of the research.

Table 1. Summary of relevant articles by integration type

Reference	Integration Analysis				
	S	D	A	B	S-O
(Aguirre Mayorga et al. 2012)	X			X	
(Bamidele & Van DerPoll 2013)	X				
(Bose et al. 2008)	X			X	X
(Bouزيد et al. 2015)			X	X	
(Brehm & Gómez 2010)		X			X
(Chen et al. 2015)		X			
(Chung et al. 2011)	X				
(Colombi et al. 2016)	X				
(De Maria et al. 2010)	X			X	
(Ding & Sheng 2010)	X				X
(Ekman et al. 2014)			X		X
(Ferro et al. 2017)	X				
(Gholamzadeh et al. 2017)					X
(Gholamzadeh et al. 2014)	X				
(Grabot et al. 2014)	X				X
(Grant et al. 2013)	X			X	X
(Han et al. 2014)	X				
(Hon & OU-Yang 2008)	X			X	
(Hsu 2013)	X				
(Hvolby & Trienekens 2010)	X	X			
(Kähkönen et al. 2016)	X			X	
(Lv et al. 2016)	X				
(Malhotra & Temponi 2010)				X	X
(Nofal & Yusof 2013)	X				
(Ponis & Spanos 2009)			X	X	X
(Popa & Vaida 2016)		X			
(Prashanth & Venkataram 2017)	X				
(Roh & Hong 2015)	X			X	X
(Ruivo et al. 2017)	X				
(Sadigh et al. 2016)			X		X
(Sanaranayake 2009)			X	X	
(Serdeira et al. 2012)	X			X	
(Shafiei et al. 2012)			X		
(Sprenger & Mönch 2014)			X	X	
(Zhai & Xu 2017)	X			X	X
Total	23	4	7	14	12

S: System Integration, D: Data Integration, A: Architecture Integration, B: Business Integration, S-O: Socio-Organizational Integration

3. RESULTS

After conducting the research strategy, the 35 articles identified created the scope of analysis. Results are presented in a four-axis analysis: type of integration, implementation stage, company size and research methodology. Tables 2 and 3 complete the integration analysis that had been proposed in Table 1 by adding the three last axes of analysis.

Table 2. Summary of relevant articles by Implementation Stage and Company Size Analysis

Reference	Is				Cs			
	Pre	I	Post	All	L	SME	D	NS
(Aguirre Mayorga et al. 2012)		X						X
(Bamidele & Van DerPoll 2013)		X			X			
(Bose et al. 2008)		X			X			
(Bouzid et al. 2015)		X				X		
(Brehm & Gómez 2010)		X				X		
(Chen et al. 2015)		X						X
(Chung et al, 2011)	X							X
(Colombi et al. 2016)			X		X			
(De Maria et al. 2010)		X			X			
(Ding & Sheng 2010)			X					X
(Ekman et al. 2014)		X			X			
(Ferro et al. 2017)		X					X	
(Gholamzadeh et al. 2017)				X				X
(Gholamzadeh et al. 2014)				X				X
(Grabot et al. 2014)		X						X
(Grant et al. 2013)			X					X
(Han et al. 2014)		X						X
(Hon & OU-Yang 2008)	X	X						X
(Hsu 2013)			X				X	
(Hvolby & Trienekens 2010)	X							X
(Kähkönen et al. 2016)			X		X			
(Lv et al. 2016)		X						X
(Malhotra & Temponi 2010)		X				X		
(Nofal & Yusof 2013)		X						X
(Ponis & Spanos 2009)		X						X
(Popa & Vaida 2016)			X					X
(Prashanth & Venkataram 2017)		X						X
(Roh & Hong 2015)		X						X
(Ruivo et al. 2017)		X					X	
(Sadigh et al. 2016)		X				X		
(Sanaranayake 2009)		X						X
(Serdeira et al. 2012)			X		X			

(Shafiei et al. 2012)		X						X
(Sprenger & Mönch 2014)		X			X			
(Zhai & Xu 2017)		X						X
Total	3	24	7	2	8	4	3	20

Is: Implementation stage (Pre: Pre-Implementation, I: Implementation, Post: Post-Implementation, All: All Implementation Stages).

CS: Company size (L: Large Company, SME: Small and Medium Enterprises, D: Diverse, NS: Not Specified).

Table 3. Summary of relevant articles through the Research Methodology Analysis

Reference	Rm				
	Ql	Qn	C/T	M	L
(Aguirre Mayorga et al. 2012)			X		
(Bamidele & Van DerPoll 2013)	X				
(Bose et al. 2008)	X				
(Bouzid et al. 2015)	X				
(Brehm & Gómez 2010)			X		
(Chen et al. 2015)			X		
(Chung et al, 2011)				X	
(Colombi et al. 2016)			X		
(De Maria et al. 2010)			X		
(Ding & Sheng 2010)			X		
(Ekman et al. 2014)	X				
(Ferro et al. 2017)				X	
(Gholamzadeh et al. 2017)				X	
(Gholamzadeh et al. 2014)					X
(Grabot et al. 2014)			X		
(Grant et al. 2013)				X	
(Han et al. 2014)			X		
(Hon & OU-Yang 2008)			X		
(Hsu 2013)	X				
(Hvolby & Trienekens 2010)				X	
(Kähkönen et al. 2016)	X				
(Lv et al. 2016)			X		
(Malhotra & Temponi 2010)	X				
(Nofal & Yusof 2013)					X
(Ponis & Spanos 2009)			X		
(Popa & Vaida 2016)				X	
(Prashanth & Venkataram 2017)			X		
(Roh & Hong 2015)	X				
(Ruivo et al. 2017)			X		
(Sadigh et al. 2016)			X		
(Sanaranayake 2009)			X		
(Serdeira et al. 2012)	X				
(Shafiei et al. 2012)			X		
(Sprenger & Mönch 2014)			X		
(Zhai & Xu 2017)			X		
Total	9	0	18	6	2

Rm: Research Methodology (Ql: Qualitative, Qn: Quantitative, C/T: Conceptual-Theoretical Design, M: Mixed Method, L: Literature Review).

3.1 Integration Type

Technical integration seems to be the focus of research; 34 out of 35 articles were related to this type of integration. Among the three types of technical integration, the most studied was system integration (23 articles out of 35). This integration type is followed by business integration, with fourteen articles that developed this topic. Socio-organizational integration appears to be the least studied type of integration (12 articles).

Articles could be classified twice and even three times in a type of integration, as technical integration is the basis of business and socio-organizational integration.

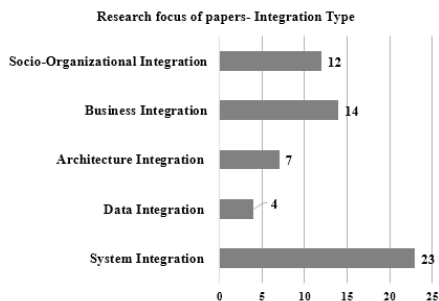


Fig. 5. Integration type focus of studies (scope: 35 articles, multiple selections were admitted)

3.2 Implementation Stage

Figure 6 illustrates the distribution of the implementation stage. Research has mostly focused on the implementation stage. Compared to this stage, pre-implementation and post-implementation stages have been poorly developed.

It was possible to classify one article in different implementation stages. The multiple classifications concerned the pre-implementation and implementation stages as well as implementation and post-implementation.

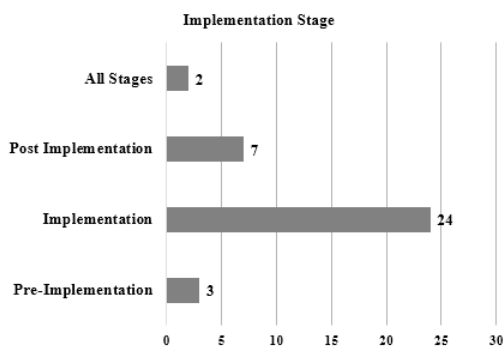


Fig. 6. Implementation stage focus of the studies (scope: 35 articles, multiple selections were admitted)

3.3 Implementation Stage and Integration Type

A cross analysis between the implementation stage and integration type is presented in Table 4. Independent of the integration type, the implementation stage with the most research was found to be implementation. Few papers have studied all stages of the same research. Data integration has not been very well studied.

Table 4. Implementation Stage and Integration Type focus of the studies

Integration Type/ Implementation Stage	S	D	A	B	S-O	Total
Pre	3	1	0	1	0	5
I	13	2	7	10	9	41
Post	6	1	0	3	2	12
All	1	0	0	0	1	2
Total	23	4	7	14	12	

Scope: 35 articles, multiple selections were possible.
 Rows: Pre: Pre-Implementation, I: Implementation, Post: Post-implementation.
 Columns: S: System Integration, D: Data Integration, A: Architecture Integration, S-O: Socio-Organizational Integration.

3.4 Company Size Focus

A large portion of the articles studied did not specify the company size. Large companies are the most studied when a company size is specified.

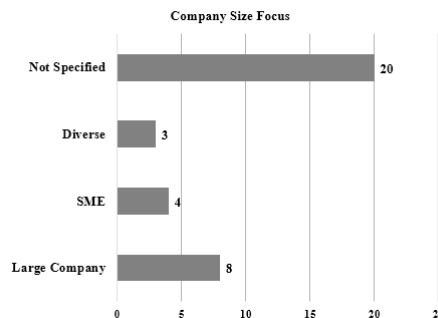


Fig. 7. Company size focus of studies (scope: 35 articles)

3.5 Research Methodology

The most common research methodology is conceptual or theoretical design. Qualitative studies, such as a case study or interviews consist of the second largest portion. Mixed methods refer to articles in which a literature review and qualitative/quantitative studies were combined.



Fig. 8. Research Methodology focus of studies (scope: 35 articles)

4. CONCLUSION

Not a lot of research has been done on data and architecture integration. Data integration has been a good alternative for new industry groups with IS integration plans (Inter and Intra-Organizational Integration), as often each stake holder or business unit has developed its own information system. Architecture integration is also a good option for inter-organizational Integration because a process can be followed by different departments of the same company with different IS tools. These two areas present a good opportunity for research.

Little research has studied all of the implementation stages during an integration IS project. When planning an ERP, IS integration enterprises need information that enables them to plan how to proceed with each stage in terms of technical, business and socio-organizational integration. This might be one of the reasons why enterprises must engage in consulting projects when implementing the integration of IS.

There is coherence between the most common types of integration (Technical Integration) and the most used methodology of research (conceptual/Theoretical). Very little quantitative research has been done. This research methodology could help enterprises when integrating an ERP with other(s) Information Systems.

Many studies do not specify a company's size or system conditions such as level of expertise, project budget, purpose of integration and timing. These conditions are very different within large companies and SMEs. Nowadays, SMEs are commonly part of large companies' Supply Chain. Integration of IS of different company size requires investment to reach the ERP level of big customer. It is therefore important to develop more research about IS-integration between large companies and SMEs.

In what concerns the way authors validated the proposed conceptual and theoretical models, a considerable part of the studied articles that used as research methodology conceptual/theoretical design, confirmed their propositions through a validation model (62%, 13 articles out of 21). In order to validate the proposed models authors privilege applications on real enterprises, being large companies the

preferred ones. Simulation on virtual enterprises is also used as a validation tool, not as accurate as the preceding one (14%, 3 articles out of 21).

On the other hand statistical studies such as: sensitivity tests, confirmatory factor analysis using partial least squares, ANOVA and MANOVA (Univariate and Multivariate analysis), and benchmarking allowed some authors to validate their propositions.

Future research could examine the possibility to apply a diverse type of validation tools to provide more reliable and explanatory models.

Results show that literature reviews of ERP and IS integration has not been very well developed. Further research seeks to know whether it is an opportunity to develop, or if there is a lack of information that has not allowed researchers to focus on this research methodology.

REFERENCES

- Aguirre Mayorga, H.S. et al., 2012. Evaluation of Integration Approaches between ERP and BPM Systems. *Research project Design of a Business Process Automatization Learning*, 16(2), pp.415–431.
- Bamidele, M. & Van DerPoll, M.H., 2013. Integrating ERP and MFCA systems for improved waste-reduction decisions in a brewery in South Africa. *Journal of Cleaner Production*, 40, pp.136–140.
- Bose, I., Pal, R. & Ye, A., 2008. ERP and SCM systems integration : The case of a valve manufacturer in China. *Information & Management*, 45, pp.233–241.
- Bouزيد, M.R., Kraiem, N. & Ghezala, H. Ben, 2015. ERP integration a reuse based approach, evaluation and prospect. *Journal of Software Engineering*, 9(2), pp.203–216.
- Brehm, N. & Gómez, J.M., 2010. Federated ERP-systems on the basis of Web Services and P2P networks. *International Journal Information Technology and Management*, 9(1), pp.75–89.
- Chen, C., Liang, W. & Hsu, H., 2015. A cloud computing platform for ERP applications. *Applied Soft Computing*, 27, pp.127–136.
- Chung, S., Hung-Lian, T. & Ahmad, I. 2011. Modularity, Integration and IT Personnel Skills Factors in Linking ERP to SCM Systems. *Journal of Technology, Management and Innovation*, pp.1-3.
- Colombi, J.M. et al., 2016. Enterprise Systems Integration using Collapsing Design Structure Matrices. *CrossTalk, Integration and Interoperability*, (June), pp.33–37.
- De Maria, F. et al., 2010. Simulation models for back-office & retail store management integration in ERP. *WSEAS Transactions on Systems*, 9(4), pp.396–408.
- Ding, Y. & Sheng, B., 2010. ERP and PDM integration technology to support collaborative product development. *International Journal of Business Information Systems*, 5(4), pp.440–459.
- Ekman, P., Thilenius, P. & Wndahl, T., 2014. Extending the ERP system: considering the business relationship

- portfolio. *Business Process Management Journal*, 20(3), pp.480–501.
- Ferro, R., Ordóñez Cooper, E.R. & Anholon, R., 2017. Analysis of the integration between operations management manufacturing tools with discrete event simulation. *International journal of Production Engineering*.
- Gholamzadeh, A. et al., 2014. Sustainable enterprise resource planning : imperatives and research directions. *Journal of Cleaner Production*, 71, pp.139–147.
- Gholamzadeh, A., Ariani, F. & Klemes, J.J., 2017. Development of a roadmap for Sustainable Enterprise Resource Planning systems implementation (part II). *Journal of Cleaner Production*, 166, pp.425–437.
- Grabot, B. et al., 2014. ERP 2 what for and how ? *Computers in Industry*, 65, pp.976–1000.
- Grant, D., Hwang, Y. & Tu, Q., 2013. An empirical investigation of six levels of enterprise resource planning integration. *Computers in Human Behavior*, 29(6), pp.2123–2133.
- Han, J., Lee, S. & Nyamsuren, P., 2014. An integrated engineering change management process model for a project-based manufacturing. *International Journal of Computer Integrated Manufacturing*, pp.1–7.
- Hon, S.J. & OU-Yang, C., 2008. Developing an agent-based APS and ERP collaboration framework. *International Journal Advanced Manufacturing Technology*, 35, pp.943–967.
- Hsu, P., 2013. Integrating ERP and e-business : Resource complementarity in business value creation. *Decision Support Systems*, 56, pp.334–347.
- Hvolby, H. & Trienekens, J.H., 2010. Challenges in business systems integration. *Computers in Industry*, 61(9), pp.808–812.
- Kähkönen, T., 2017. *Understanding and Managing Enterprise Systems Integration*.
- Kähkönen, T., Smolander, K. & Maglyas, A., 2016. Lack of integration governance in ERP development : a case study on causes and effects. *Enterprise Information Systems*, pp.1–35.
- Kovács, G.L. & Paganelli, P., 2003. A planning and management infrastructure for large , complex , distributed projects — beyond ERP and SCM. *Computers in Industry*, 51, pp.165–183.
- Lv, Y. et al., 2016. Multi-level ontology integration model for business collaboration. *International Journal Advanced Manufacturing Technology*, 84(1–4), pp.445–451.
- Malhotra, R. & Temponi, C., 2010. Critical decisions for ERP integration : Small business issues. *International Journal of Information Management*, 30, pp.28–37.
- Moeuf, A. Lamouri, S., Pellerin, R., Eburdy, R. et Tamayo, Simon, 2017. Industry 4.0 and the SME : a technology-focused review of the empirical literature. Saarbücken, IESM 7th Conference.
- Nofal, M.I. & Yusof, Z.M., 2013. Integration of Business Intelligence and Enterprise Resource Planning within Organizations. *Procedia Technology*, 11, pp.658–665.
- Pellerin, R., Léger, P.-M. & Babin, G., 2007. The impact of Board Interlocks in the Diffusion of enterprise resource Planning Systems. *Cahier du GRESI*, 7(7).
- Ponis, S.T. & Spanos, A.C., 2009. ERP II systems to support dynamic , reconfigurable and agile Virtual Enterprises. *International Journal Applied Systemic Studies*, 2(3), pp.265–283.
- Popa, S. & Vaida, M., 2016. A Practical Strategy for ERP to Cloud Integration. *Studies in Infomatics and Control*, 25(3), pp.26–28.
- Prashanth, B.N. & Venkataram, R., 2017. Development of Modular Integration Framework between PLM and ERP Systems. *Materials Today: Proceedings*, 4(2), pp.2269–2278.
- Reimers, K. & Guo, X., 2014. Supply Chain Resource Planning Systems : A Scenario of Future Enterprise Systems Systems. *Communications of the Association for information systems*, 35.
- Roh, J.J. & Hong, P., 2015. Taxonomy of ERP integrations and performance outcomes : an exploratory study of manufacturing firms. *The Management of Operations, Production Planning and Control*, 26(8), pp.617–636.
- Ruivo, P., Oliveira, T. & Mestre, A., 2017. Enterprise resource planning and customer relationship management value. *Industrial management and Data Systems*, 117(8), pp.1612–1631.
- Sadigh, B.L. et al., 2016. An ontology-based multi-agent virtual enterprise system (OMAVE) : part 1 : domain modelling and rule management. *International journal of Computer Integrated Manufacturing*.
- Sanaranayake, P., 2009. Business process integration , automation , and optimization in ERP Integrated approach using enhanced process models. *Business Proces Management Journal*, 15(4), pp.504–526.
- Serdeira, P., Romão, M. & Rebelo, E., 2012. Advantages , Limitations and Solutions in the Use of ERP Systems (Enterprise Resource Planning) – A Case Study in the Hospitality Industry. *Procedia Technology*, 5, pp.264–272.
- Shafiei, F., Sundaram, D. & Piramuthu, S., 2012. Multi-entreprise collaborative decision support system. *Expert Systems With Applications*, 39(9), pp.7637–7651.
- Sprenger, R. & Mönch, L., 2014. A decision support system for cooperative transportation planning : Design , implementation , and performance assessment. *Expert Systems With Applications*, 41(11), pp.5125–5138.
- Zhai, Y. & Xu, L., 2017. The Establishment of ERP System to Support Management and Control Mode of the the Group. *Revista de la Facultad de Ingenieria U.C.V.*, 32(8), pp.14–21.