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A keyword-based organizing framework for ERP intellectual contributions

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Abstract

Purpose – The purpose of this paper is to develop a keyword-based organizing framework for enterprise resource planning (ERP) intellectual contributions, and use the proposed framework to derive major areas of emphasis in ERP research.

Design/methodology/approach – Using keyword persistence, a time-based measure, and keyword dominance, a frequency-based measure, the authors constructed an empirical framework to classify ERP intellectual contributions.

Findings – Four major ERP themes were identified using the proposed framework; namely, emerging/phantom, intermittent, trendy, and core. Further examination of the keywords in each of these themes revealed that whereas the business aspects of ERP systems are discussed in an intermittent manner, its technical aspects are discussed in a trendy fashion.

Research limitations/implications – The main limitation of this research is that it only used keywords from papers published in scholarly journals, and did not include conference proceedings, books, and other outlets. In this paper, the authors developed an objective keyword-based organizing framework. The proposed framework is simple, flexible, and is based on dimensions that are research domain independent, and thus can be used as an organizing framework for any research domain.

Practical implications – The proposed framework may help managers to better focus consulting engagements on ERP implementations through identifying areas that are not well covered by researchers to ensure that such areas they are well covered by consulting services.

Originality/value – The main contribution of this paper is the development of an objective keyword-based framework that can be used as an organizing tool for intellectual contributions. The framework can be used to derive insights in the macro characterizations of the research in a given domain, and is thus valuable to researchers – both academic and practitioner. To the best of the authors' knowledge, this is the first such keyword-based research organizing framework.

Keywords Dominance, Persistence, Enterprise resource planning (ERP), Intellectual contributions, Keywords, Organizing framework

Paper type Research paper

1. Introduction

Enterprise resource planning (ERP) systems are integrated, complex innovations (Umble *et al.*, 2003; Kumar *et al.*, 2003; Ngai *et al.*, 2008; Grabski *et al.*, 2011), and comprehensive information systems that are used to support, in real time, the information needs of all the business functions, including accounting, finance, human resources, operations, sales, marketing, customer information, and supply chain (Woo, 2007). To do so, ERP systems use a set of integrated core business processes and an integrated shared database (Schlichter and Kraemmergaard, 2010). They have been characterized as: first, the most important development in the corporate use of information technology (IT) in the 1990s (Davenport, 1998); second, a key part of the information infrastructure of modern businesses; third, the largest information system project investment in companies worldwide, a trend expected to continue for years to come; and fourth, for

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many organizations, they are the largest systems they have worked with in terms of the financial resources invested, the number of people involved, and the scale of implementation (Chang *et al.*, 2008). In short, an ERP system provides foundation applications for an enterprise's operations, if these applications fail, so does the enterprise (Hsu *et al.*, 2006).

ERP systems evolved over the years to become the major infrastructural component of many organizations' information systems landscape. They provide online transaction processing systems that support the day to day transactions and operations; and, in many cases, they also provide online analytical processing capabilities that support the decision-making process in every type of industry. A key distinguishing characteristic of ERP systems is that they encompass both technical and business process innovations. To reap the benefits of ERP systems, organizations have to explicitly attend to both of these elements of innovation when adopting ERP systems.

ERP systems have not only grabbed the attention of the corporate world globally, but have also been the subject of active research from both academics and practitioners from every continent. While some researchers studied various aspects of ERP systems, such as their justifications, benefits, risks, and impacts, others tried to frame the ERP literature using some organizing framework. Both the understanding of ERP systems in general and the understanding of the research contributions on ERP are important goals. Not least, one would be able to identify coverage gaps in ERP research. The goal of this paper is to develop a novel keyword-based framework for organizing ERP intellectual contributions published in scholarly journals during the period 2000-2013.

The rest of the paper is organized as follows: Section 2 provides a literature review, Section 3 discusses the proposed framework and shows how it can be used as an organizing framework for ERP research, Section 4 describes the research methodology, Section 5 presents and discusses the results, and Section 6 offers conclusions, limitations, and future directions.

2. Literature review

Among the most important features of ERP systems is their ability to: automate (Sayana, 2004) and integrate business processes, enable the implementation of "best practice" business processes, share common data and practices across the entire enterprise, produce and access information in real time, and necessitate business process reengineering (BPR) (Schlichter and Kraemmergaard, 2010).

ERP systems are costly whether they succeed or fail. Their adoption is typically accompanied with considerable investments in terms of time (sometimes in the order of several years), money, and effort (Laukkanen *et al.*, 2007). Their actual implementation costs can be staggering, especially with hidden costs such as consulting, reengineering, testing, training; and, as such, may result in risks related to business operations, controls, systems, and security (Hsu *et al.*, 2006). ERP systems cost estimates vary from an average of US$20 million, to "tens of millions" of dollars for a medium-sized company and all the way to US$300-500 million for large international corporations; in all cases, they lead to a heavy financial burden to companies (Woo, 2007). Underestimating an ERP system costs might have profound long-term effects on the ERP adopter, including failure to meet growth targets, loss of market edge, and/or even bankruptcy (Daneva, 2010).

An ERP system successful implementation leads to the realization of many operational, managerial, infrastructural, organizational, and strategic benefits (Shang and Seddon, 2002), including better information sharing, improved planning and decision quality, smoother coordination between business units resulting in higher efficiency,

quicker response time to customer demands and inquiries, improved customer relationship management, stronger customer satisfaction and loyalty, and larger market share (Chang *et al.*, 2008). Furthermore, ERP systems promise significant increases in management control, competitive advantage, reductions in the costs of business operations, and flexibility in production and distribution processes (Boersma and Kingma, 2005).

On the other hand, an faulty or failed ERP system implementation is problematic, lays heavy burdens on an organization (Boersma and Kingma, 2005), and may lead to huge losses, project abandonment, or, even worse, bankruptcy (Huang *et al.*, 2004). There are well-publicized alarming cases where ERP systems chronically exceeded budgets and deadlines, caused serious disruptions of business processes (Boersma and Kingma, 2005), and even resulted in complete failures (Chang *et al.*, 2008). Most notable among these cases are those of Hershey (resulting major losses), Dell (resulting in project abandonment), and FoxMeyer (resulting in bankruptcy). Hershey Foods experienced stock shortages, US$150 million in lost sales, and a 19 percent drop in earnings as a result of incompetent ERP implementation (Hsu *et al.*, 2006). Dell Inc. abandoned its ERP project after committing two years and expending US$200 million (Wu *et al.*, 2008). FoxMeyer filed for bankruptcy, claiming a failed ERP implementation resulted in incorrect orders and excess shipments which, FoxMeyer argued, eventually led to the financial ruin of its business (Beheshti, 2006). Among the most cited reasons of ERP implementation failure are technical, organizational, and people-related problems; for example, failed ERP system (Muscatello *et al.*, 2003), poor selection of ERP systems and vendors, lack of top management support, resistance from employees, marginal end results (Vogt, 2002), lack of availability of adequate skills (Simon *et al.*, 2010).

In the quest to understand why some firms succeed in their ERP implementations while others fail, it is critical to understand that, although the technical capabilities of ERP systems are relatively well proven, implementing these systems is not a simple matter of purchasing and installing the technology. Many, such as Muscatello *et al.* (2003) believe that managerial issues present major barriers to the effective adoption of ERP systems.

Although a great deal of research has focussed on ERP systems, many open questions and controversies surrounding ERP systems are still unsettled. For example, it is still an open question whether ERP systems actually produce a competitive advantage (Beard and Sumner, 2004), there is still an ongoing controversy on the amount of customization that should be performed on an ERP system (arguments ranging all the way from none to full customization) (Light, 2005) and how to assess the return on the significant financial investment on ERP systems. Even reconciling contradictions in their adoptions is perplexing on a cursory examination. For example, as noted above, ERP systems are among the fastest growing information systems despite: first, at least 90 percent of their implementations end up late or over budget, 40 percent achieve only partial implementation, almost 20 percent are scrapped before completion as total failures, and that many ERP adoptions can be considered failures in one way or another (Laukkanen *et al.*, 2007); second, competitive positioning was ranked least among the benefits expected from an ERP implementation, with only 28 percent of achievement level (Poon and Yu, 2010); and third, 65 percent of executives believing ERP systems have a moderate chance of hurting their business because of potential implementation problems, and ERP implementations are said to be "the single business initiative most likely to go wrong" (Verville *et al.*, 2007). Nonetheless, businesses continue to implement ERP systems as the potential benefits far outweigh the risks (Woo, 2007).

Despite the controversies and open questions, there are many points of agreement on ERP systems, including their strategic nature, complexity, high cost, riskiness, long-term commitment, significant impact, and their handsome potential benefits if implemented correctly.

Given the significance of ERP systems and the importance of understanding them, many academics and practitioners, justifiably so, have researched various aspects of ERP systems, including BPR, critical success factors (CSFs) for the implementation of an ERP, systems justification, and risk management (Ngai *et al.*, 2008; Schlichter and Kraemmergaard, 2010). Many researchers have attempted to organize the ERP systems literature using their own frameworks or adopting others'. Previous literature review papers, their scope, and their limitations are summarized in Table I. "Even though these reviews bring about some insight into the ERP field, none of the reviews focussed on the entire ERP field until 2009" (Schlichter and Kraemmergaard, 2010). The classifications provided by previous ERP researchers either used no frameworks (Esteves and Pastor, 2001), or mostly used self-developed frameworks (Shehab *et al.*, 2004; Cumbie *et al.*, 2005; Botta-Genoulaz *et al.*, 2005; Esteves and Bohorquez, 2007; Moon, 2007; Aloini *et al.*, 2007; Nazemi *et al.*, 2012). Only Schilchter and Kraemmergaard (2010) and Amani and Fadlalla (2014) used a literature-based classification framework. This paper proposes a novel keyword-based approach to organizing ERP research. To the best of our knowledge, this is the first such framework. The proposed framework is flexible, simple, and generalizable to other research domains. The concepts of persistence and dominance, and their intersections, represent dimensions that are applicable in any research domain. Thus intellectual contributions from other disciplines can be captured and analyzed using the proposed framework. For example, intellectual contributions in accounting, finance, and marketing can be organized on the quadrants defined by the framework in a straightforward mapping.

3. The proposed framework

Organizing frameworks are used to provide a more understandable view of complex relationships, in this case the multitude of ERP research concepts. The proposed framework is based on keywords. In this paper, we use keyword to mean an index term that captures the essence of the topic of a document. Keywords encode the essence of the research from the researcher's point of view, and thus they provide a powerful tool for juxtaposing a portrait of the key ERP research themes.

We define two dimensions for our framework – persistence and dominance. Persistence is a time-based measure and relates to the continuity of a given concept over time, and can be measured in absolute terms as the number of years that the concept was used as a keyword, or in relative terms as the percentage of years, out of the total number of years covered by the research, that the concept was used as a keyword. We call the former measure persistence count and the latter measure persistence percent. For example, since the span of time covered in this research paper is a total of 14 years (2000-2013), a concept that is used as a keyword in five of the 14 years (regardless of how many articles that concept was used as a keyword in those five years) will have a persistence count of five, and a persistence percent of approximately 36 percent (5/14). It is obvious that persistence count ranges from 1 to 14, whereas persistence percent ranges from about 7 percent (1/14) to 100 percent (14/14). Furthermore, persistence may be continuous or intermittent – continuous when it spans contiguous years, intermittent when it does not. More specifically, in this paper, we consider persistence to be continuous when 50 percent or more of

Author(s)	Classification criteria	Scope and limitations
Esteves and Pastor (2001)	None	Annotated bibliography on Information systems (IS) journals and covered only three years
Shehab *et al.* (2004)	Vendors, selection criteria, and implementation	Focussed on IS literature (13 years) and only three aspects of ERPs
Cumbie *et al.* (2005)	Content (topic and focus) and processes (methods)	Focussed on IS and operations management journals (five years)
Botta-Genoulaz *et al.* (2005)	Implementation, optimization, management, the software, supply chain management, and case studies	Focussed on IS literature (five years)
Esteves and Bohorquez (2007)	ERP-lifecycle-based framework: adoption, acquisition, implementation, usage, evolution, retirement, education, and general	IS literature-focussed self-developed framework (seven years)
Moon (2007)	Implementation, using ERP, extension, value, trends, and education	Focussed on ERP risk in IS literature (6.5 years)
Aloini *et al.* (2007)	Two dimension: first dimension – ERP selection, implementation, risk management, and general ERP projects; second dimension – research type and methods	Focussed on IS literature (ten years)
Schilchter and Kraemmergaard (2010)	Methods: case studies, archival, theoretical, survey, experiment, descriptive, design science, combined, and not mentioned; Topic: implementation, optimization, management, the ERP tool, supply chain management, studying ERP, education, the market and industry, and others	Focussed on IS literature (five years)
Nazemi *et al.* (2012)	ERP-lifecycle framework proposed by Esteves and Pastor (1999) and categorized the publications on ERP issues not related to ERP lifecycle phases into six main topics: research issues, organizational knowledge, business modeling, ERP product development issues, ERP and business intelligence, and ERP performance modeling	Focussed on IS literature (14 years)
Amani and Fadlalla (2014)	A topology of four generic types of conceptual contributions: envisioning, explicating, relating, and debating	Adopted MacInnis framework. Sampled a broad ERP literature from 2000 to 2011

Source: Adapted from Amani and Fadlalla (2014)

Table I. Summary of previous ERP literature review research

its count spans contiguous years; otherwise, we consider the persistence to be intermittent. For example, each of the keywords "Organizational Change" and "Knowledge Management" has 57 percent (8/14) persistence, i.e. both have persistence count of eight since they have been used as keywords in eight out of the 14 years. However, "Knowledge Management" has continuous persistence since it appeared consecutively in four years (2006-2009) out of the eight years (2001, 2002, 2003, 2006, 2007, 2008, 2009, and 2011) of persistence, whereas "Organizational Change" has intermittent persistence as it appeared consecutively in only two years (2000 and 2001, similarly in 2005 and 2006) out of the eight years (2000, 2001, 2003, 2005, 2006, 2008, 2010, and 2012) of persistence – see Table II.

Table II.
Continuous vs intermittent persistence

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Persistence count	Persistence %
Knowledge management (Continuous persistence)		2	1	1			7	2	1	2		2			8	57
Organizational change (Intermittent persistence)	1	3		2		1	4		1		1		1		8	57

Dominance is a frequency-based measure and relates to the frequency of a concept being used as a keyword over time, and can, similar to persistence, be measured in absolute terms as the number of articles that used the concept as a keyword, or in relative terms as the percentage of articles in which the given concept was used as a keyword (regardless of the time dimension). We call the former dominance count and the latter dominance percent. Dominance is an indication of how much attention by the research community is given to that concept. A concept with high dominance indicates that it is considered as a key theme in many papers; conversely, a concept with low dominance is discussed in few papers. We will define high dominance to mean a dominance count greater than the average dominance count (ADC) of keywords that have dominance greater than one. For example, if there are 100 articles in total and only 60 of them used ERP as a keyword, then we will say that dominance of ERP is 60 percent. It is obvious that dominance percent ranges from about 0.19 percent (1/505) to 100 percent (505/505). Specifically, the keyword "Knowledge Management" appeared in 18 articles out of 505 articles during the period 2000-2013, a dominance percent of 3.6 percent (18/505), and the keyword "Organizational Change" was used in 14 articles during the same period, representing a dominance percent of 2.8 percent (14/505) (see Table III).

Using the persistence/dominance dimensions, we define the following two-dimensional framework for organizing ERP key concepts. The framework defines four combinations: low-persistence low-dominance, low-persistence high-dominance, high-persistence low-dominance, and high-persistence high-dominance. Each combination represents distinct characterizations for key concepts. We call key concepts with low-persistence low-dominance emerging or phantom concepts. Generally, concepts initially start as emerging. If a concept died early, we call it phantom. If a concept passes the phantom phase, it moves into the low-persistence high-dominance quadrant, in which case we call it trendy. Trendy concepts are discussed in many articles, but their discussion does not continue for a prolonged period of time. An emerging concept may as well move to the high-persistence low-dominance quadrant and become an intermittent concept, which is a concept that is being discussed in an on-off manner. These are concepts that either the researchers have not settled about yet, or are tackling relatively frequently changing topics – they come and go every now and then. Further research may be needed to clarify and/or solidify these concepts. Finally, concepts that are discussed by many articles and continuously persist over the years represent core concepts. These are concepts, for one reason or the other; achieved the status of defining core themes in ERP research. Figure 1 shows this framework.

The proposed framework captures the large variety of existing ERP intellectual contributions, and is flexible enough to represent any additional dimensions that are deemed necessary by other researchers. It is worth noting that, the methodology of this framework is not limited to ERP domain, but can be used to discern similar conceptualizations in other fields of research. In addition, the simplicity of the framework

Table III. Dominance count and dominance percent example

	Article 1	Article 2	Article 3	Article 4	[…]	[…]	[…]	[…]	[…]	Article 504	Article 505	Dominance count	Dominance %
Knowledge management	0	0	0	1	0	0	1	0	0	1	1	18	3.6
Organizational change	0	0	1	1	0	0	1	1	0	0	1	14	2.8

makes it easy to understand and adopt in other contexts. Evidence from prior research supports the assertion that the most effective modeling techniques are those that are graphical and simple (McGee, 1976).

4. Methodology

We conducted a search on Ohio Library and Information Network (OhioLINK), which is a consortium of 88 Ohio college and university libraries, and the State Library of Ohio, that provides access to, among many resources, millions of electronic articles from 17,000 electronic journals, 140 electronic research databases, and over 81,000 e-books (OhioLink website, 2013). In particular, we searched the OhioLINK's Electronic Journal Center, a collection of full-text research journals that contains more than 9,000 scholarly journal titles from 101 publishers across a wide range of disciplines (see https://databases.ohiolink.edu/ap/3?230418263184185:::3 for list of databases included in OhioLINK). Our search methodology involves four steps and is summarized in Table IV.

The search condition in step 1 filters out articles having ERP in their titles, but are not about enterprise resource planning, for example articles discussing event-related potential (ERP) in psychology. We insisted on articles having ERP and/or Enterprise Resource Planning in their title to make sure that ERP was the overarching topic in the article. This title-based emphasis may have excluded some articles that do not satisfy the search criterion, but are still relevant. We have no reason to believe that this represents a detrimental omission of relevant literature because papers with Enterprise Resource Planning and/or ERP in their title, although admittedly not the only ones, but are the most relevant papers.

5. Results and discussion

In this section we will first explore the ERP research across multiple dimensions, including time, outlet, geography, and keyword. We will then use the proposed framework to map the ERP research during the period 2000-2013.

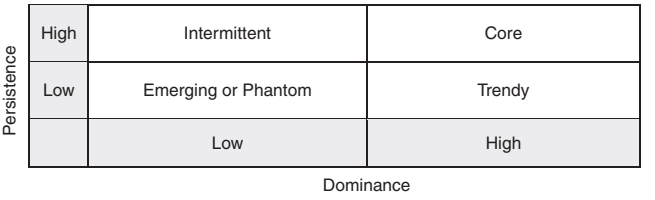

Figure 1.
An organizing framework for ERP intellectual contributions

Step	Title includes	Title or Keywords or Abstract include(s)	Publication year	Result: number of journal articles
1	ERP	"Enterprise Resource Planning"	⩾2000 and ⩽2013	398
2	"Enterprise Resource Planning"		⩾2000 and ⩽2013	182
Total				*580*
3	Remove duplicates whose titles include both enterprise resource planning and ERP			39
4	Remove articles without keywords			36
Analysis set				*505*

Table IV.
Intellectual contributions inclusion-exclusion criteria

Figure 2 shows the number of ERP articles published per year from 2000 to 2013. There are two obvious major trends in the number of published papers – an upward trend from 2000 to 2005 and a downward trend from 2006 to 2011, with one exception in each trend; namely, 2002 and 2008. It seems these exceptions are the aftershocks of the burst of the dotcom bubble in 2001 and the major international economic meltdown that resulted from the global financial crisis that began in 2007. Note both exceptions reflect a publication lag where a publication relating to a business phenomenon, usually temporally follows that phenomenon. The drop in the number of articles in 2002 may be explainable by the drop in business activity including reduced spending on costly information systems projects such as ERP systems. Empirical evidence corroborates this hypothesis if one assumes, not unreasonably, that the number of published ERP case studies is a proxy measure for the level of ERP adoptions. The number of ERP case studies dropped by more than 20 percent in 2002 compared to 2001. On the other hand, the increase in 2008 may be partially attributed to an increased interest in using ERP systems as a tool to achieve more control, better compliance, and improved business efficiency – measures that become prominent during times of crisis in corporate governance that led to the global financial woes that began in 2007 and are not yet completely overcome. The figure also indicates that there is an uptick in ERP articles in the last two years (2012-2013), going back to the level of publication in 2010.

The highest number of articles was published in 2005, 52 in total. This peak may be a reflection of the emergence of China as a new manufacturing powerhouse during this time, and a big adopter of ERP systems to support its manufacturing base. China appeared as a keyword in the ERP literature for the first time in 2004 and persisted ever since. In addition, it appears that ERP systems started to expand beyond large enterprises into small to medium-sized enterprises (SMEs) from 2005 onwards. Overall, the period 2003-2010 and 2012-2013 witnessed high ERP research activity, averaging more than 30 articles per year. This high research volume may reflect the movement of SMEs toward adoption of ERP systems.

The most prominent outlet is the *Business Process Management Journal* which took the lead as the top journal in terms of the number of ERP articles published during 2000-2013, averaging more than four articles per year. The *Journal of Enterprise Information Management* followed next with an average of over three articles per year. *Industrial Management & Data Systems* took the third place with a total number of

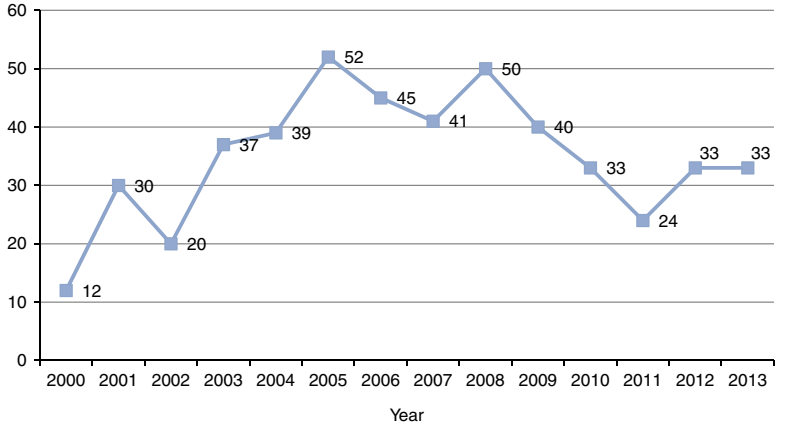

Figure 2.
Number of ERP articles per year: 2000-2013

45 articles. These three journals combined published more than 29 percent of the ERP papers covered in this study. It seems that these three journals are becoming the de facto outlets for ERP research. *International Journal of Production Economics*, *Computers in Industry*, *International Journal of Operations & Production Management*, *Information & Management*, *International Journal of Accounting Information Systems*, *Expert Systems with Applications*, *European Journal of Operational Research*, *Information Systems Journal*, *The International Journal of Advanced Manufacturing Technology*, *Systems Research and Behavioral Science*, and *Journal of Manufacturing Technology Management* each published between 10 and 20 articles each. The remaining journals published between 6 and 8 articles per journal (see Figure 3 for more details).

It is worth noting that ERP research is indeed an international endeavor that seems to attract the attention of authors from all over the globe. The USA is by far the highest country of affiliation for ERP authors with a total of 260 US-affiliated authors, followed by the UK (99 authors), China (89 authors), Taiwan (78 authors), Australia (50 authors), Canada (42 authors), Greece (31 authors), the Netherlands (29 authors), and Korea and Iran (27 authors) – Figure 4. It is clear that all the top ten countries are industrialized

Figure 3.
Top journals by number of ERP articles published: 2000-2013

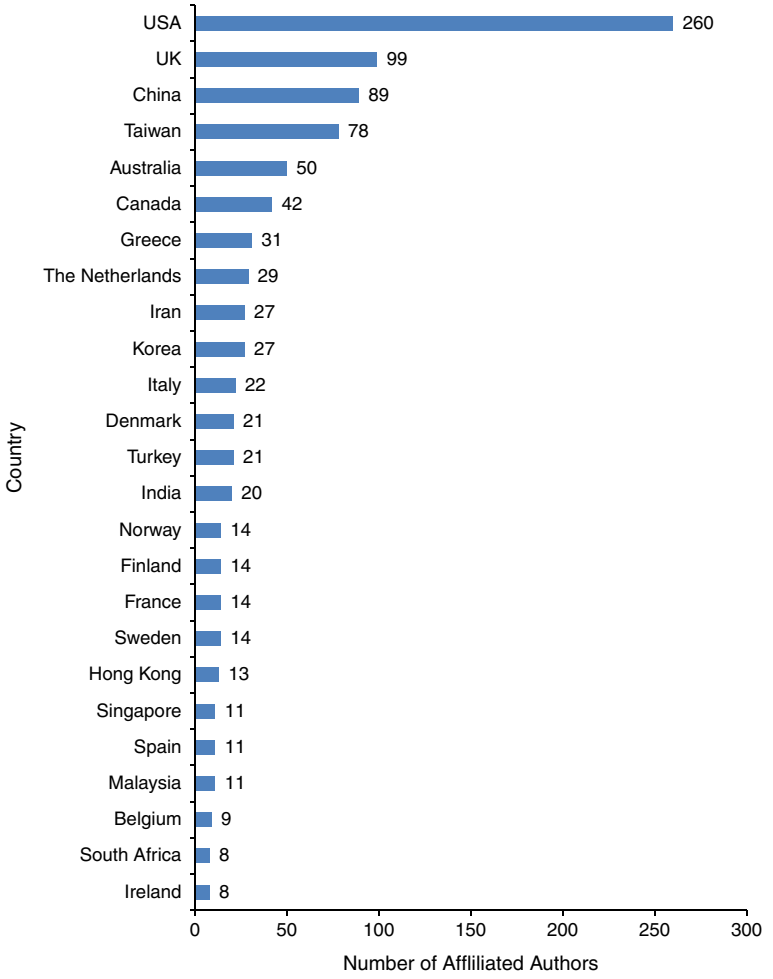

Figure 4.
Top country affiliations of ERP authors: 2000-2013

countries with huge manufacturing base, representing all continents – except for Latin America. A puzzling absence from the top 25 countries, is that of Germany which is both a manufacturing giant and the home of SAP, the world leading ERP system.

The articles reviewed listed a total of 2,202 keywords, of which 895 are distinct. Table V shows the number of keywords per persistence count, and Table VI shows the number of keywords per dominance count. The average persistence count (APC) of keywords with persistence count greater than one is four, and the ADC of keywords with dominance count greater than one is six. Without loss of generality, we consider a concept to have high persistence if it has a persistence count$\geqslant$APC, otherwise the concept has low persistence. Similarly, we consider a concept to have high dominance if it has a dominance count$\geqslant$ADC, otherwise the concept has low dominance. Using these definitions, Tables VII and VIII show that there are 40 keywords with high persistence (Table VII) and 45 keywords with high dominance (Table VIII).

Table V.
Number of keywords per persistence count

Persistence count	Number of keywords
1	690
2	112
3	33
4	20
5	14
6	2
7	4
8	5
9	5
10	2
11	2
12	1
13	2
14	3

Note: 77 percent of the keywords appeared in only one year

Table VI.
Number of keywords per dominance counts (missing dominance counts indicate that there are no keywords corresponding to the missing count – e.g. there are no keywords with dominance counts of 15 and 16)

Dominance count	Number of keywords
1	663
2	113
3	44
4	15
5	15
6	7
7	6
8	3
9	6
10	1
11	2
12	2
13	3
14	2
17	1
18	1
19	1
22	1
27	1
32	1
33	1
37	1
39	1
60	2
132	1
265	1

Note: 74 percent of the keywords appeared in only one article

A closer examination of this dominance-persistence mapping in Figure 5 reveals the emergence of two major strands of research, one focussing on the ERP business dimension, and the other focussing on the ERP technology dimension. This dual focus is a reflection of the very nature of ERP systems, which represent technology solutions that

Keyword	Persistence count
Implementation, Resource management	14
Supply chain management (SCM), Business process reengineering (BPR)	13
Critical success factors (CSFs)	12
Manufacturing, Information systems (IS)	11
Project management, Integration	10
Small and medium size enterprises (SMEs), Case study, China, Computer software, Modeling	9
Knowledge management, Organizational change, Information technology (IT), Selection, Customization	8
Innovation, Benefits, Change management, Decision making	7

Table VII. High-persistence keywords

Keyword	Dominance count
Manufacturing	132
Implementation, Resource management	60
Critical success factors (CSFs)	39
Information system (IS)	37
Supply chain management (SCM)	33
Small and medium enterprises (SMEs)	32
Business process reengineering (BPR)	27
Project management	22
Case study	19
Knowledge management (KM)	18
Integration	17
Organizational change, Modeling	14
Computer software, Decision making, Management information system (MIS)	13
China, Information technology (IT)	12
Enterprise information system (EIS), Selection	11
Change management	10
Innovation, e-Commerce, Maintenance, Communication technologies, Benefits, Customization	9

Table VIII. High-dominance keywords

encapsulate "best practice" business processes. The technology dimension of ERP systems relates to the technology and technical aspects of implementing the system. This is consistence with the concept of duality of information systems as discussed by Bingi *et al.* (1999) and Orlikowski (1992). It appears that research that addresses this dimension of the ERP systems is mainly encapsulated in the low-persistence high-dominance quadrant, where we find such keywords as Systems Science, Systems Research, and Packaged Software (Figure 5). It seems that the technology aspects of ERP systems are generally trendy topics for ERP researchers. This is consistent with the dynamic and constantly and rapidly changing nature of technology in general – including ERP systems technologies.

On the other hand, the business dimension of an ERP system relates to the business aspects of implementing the ERP system. Figure 5 reveals that research that handles this dimension of the ERP systems is mainly encapsulated in the high-persistence low-dominance quadrant, where we find such keywords as Organizational Culture, Stakeholder Analysis, and Success. These business aspects of ERP systems are discussed

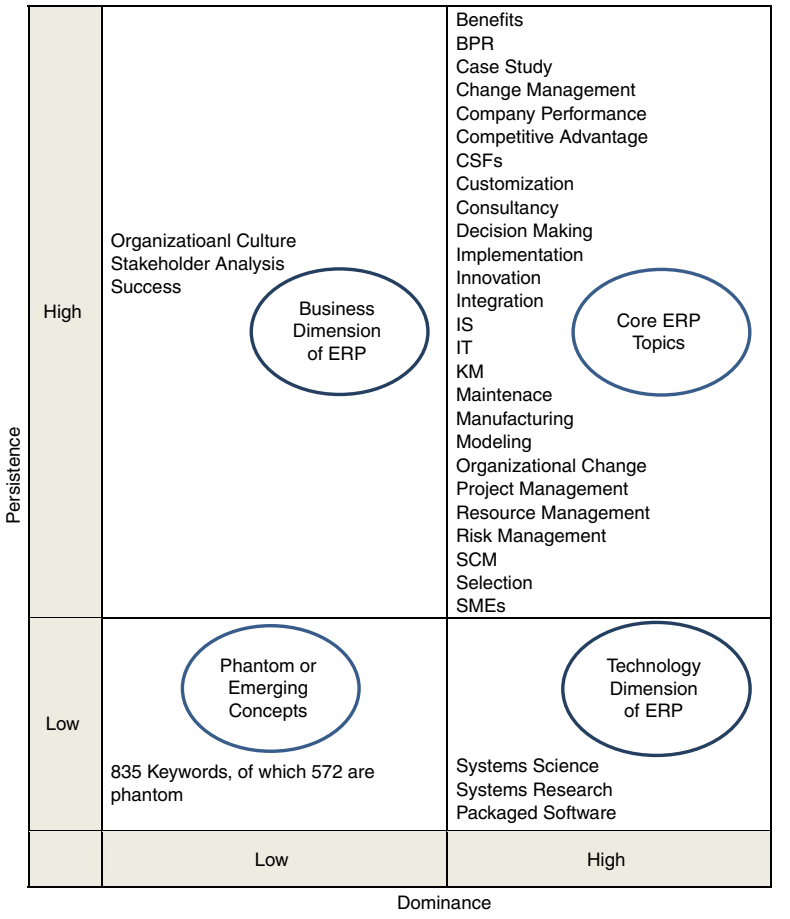

Figure 5.
Mapping of ERP concepts using the proposed framework

in an intermittent manner by researchers, possibly because business impacts of ERP projects are usually medium to long term and thus are not continuously an annual subject of discussion.

The high-persistence high-dominance quadrant in Figure 5 shows topics that achieved the status of being core ERP research topics over the last decade. These core topics have been persistently and widely discussed in the ERP literature. Table IX provides a brief justification for each of the core ERP research topics that emerged from our proposed framework.

Table X shows phantom keywords distribution by year and reveals that most (more than 95 percent) of the ERP research keywords are either used purely for indexing purposes or are used to describe a very narrow and specialized aspect being addressed by the research at the time. It is not surprising that keywords describing the core ERP research topics are a minority in comparison to the total number of keywords.

Through examination of the most frequent keywords, we get insights into many ERP characteristics. For example, what are the aspects of ERP most discussed by

Core topic	Justification
Benefits	A key business driver of acquiring an ERP systems
BPR	Essential prerequisite for a successful ERP implementation
Case study	The most common method in ERP research
Change management	Necessary for a successful ERP implementation
Company performance	Necessity of measuring the impact of ERP systems on company performance
Competitive advantage	The role of ERP in supporting companies to achieve competitive advantage
CSFs	To successfully implement an ERP system, it is imperative to study and understand the critical success factors of ERP implementation
Customization	Improving the fit between the company business processes and the pre-packaged processes in an ERP system
Consultancy	The significant role of consultancy in the implementation of an ERP
Decision making	The central role of ERP systems as a source of real time information to enable effective decision making
Implementation	The strategic nature of ERP systems, their complexity, and their high cost makes their implementation one of the most researched topics
Innovation	The role of the ERP as an enabler of business process innovation
Integration	The single most important justification for adopting an ERP system
Knowledge management	Significant knowledge is essential for selecting, implementing, and sustaining an ERP system
IS	ERP is the most comprehensive business information system
IT	ERP systems have major information technology ramifications
Manufacturing	Certainly the father of ERP systems and remains to be the biggest domain for ERP implementations
Modeling	Essential for leveraging the vast ERP data and capabilities
Organizational change	Is a certainty if ERP systems are to be successfully implemented
Project management	The complexity of ERP projects necessitates properly managing them as such
Resource management	A key business justification for implementing an ERP system
Risk management	The complexity of implementing an ERP system necessitates the importance of managing different types of risk
SCM	The need for going beyond intra-enterprise integration into inter-enterprise integration
Selection	ERP organizational fit is a key success factor and selection is essential for ensuring such fit
SMEs	The newest, and possibly the hottest, battle ground for ERP systems

Table IX.
Emerged core ERP research topics for the period: 2000-2013

academics, what the critical ERP topics are, and what the current trends in ERP are? Excluding the keywords "Enterprise Resource Planning/ERP" for obvious reasons, "Manufacturing Resource Planning" was the most frequent keyword – used 132 times. The high occurrence of the "Manufacturing Resource Planning" clearly points to the strong link of ERP to its manufacturing roots – as ERP is historically a descendant of Material Resource Planning (MRP I), and Manufacturing Resource Planning (MRP II). "Resource Management" keyword occurred 60 times, indicating the critical importance of and the critical role that, ERP systems play in the management of resources. "ERP Implementation/Implementation" also appeared 60 times indicating that implementation of ERP systems is one of the key ERP research strands that has been the focus of many academics and ERP practitioners (Botta-Genoulaz *et al.*, 2005; Worley *et al.*, 2005). "Critical Success Factors" (CSFs) occurred 39 times as a keyword indicating the importance of understanding the CSFs when implementing ERP systems in order to

Table X.
Phantom keywords for the period: 2000-2012

Year	Number of phantom keywords	Example
2000	10	Requirements engineering
2001	32	User opportunity cost
2002	21	Managerial competences
2003	44	Re-order levels
2004	44	Loosely coupled systems
2005	56	Human-based process modeling
2006	52	Time study
2007	66	Main memory virtual DB
2008	58	Performance-based budgeting
2009	36	Middle managers
2010	33	Localization differences
2011	43	Generic product model
2012	77	Static code analysis

Note: It is too early to judge if single-occurrence of keywords in 2013 are phantom

avoid the costly failures that many firms witnessed. The significant occurrence of "Critical Success Factors" keyword is evidence of the complexity and challenges of ERP implementation, and the potentially horrific consequences of the risk of a failed implementation.

Unlike the finding of Esteves and Bohorquez (2007), one of the most current trends in ERP research is the deliberation on the suitability of ERP for SMEs. Another current trend is the use of ERP systems to achieve integration with external business partners; i.e., integrating the relationship between the firm and its business partners, and improving its supply chain management – a trend also referred to as ERP II. These trends are indicated by the keywords "Small to Medium-Sized Enterprises/SME/SMEs" and "Supply Chain Management" which appeared 33 and 32 times, respectively as keywords. Thus SMEs and ERP II are not just competitive battle grounds in the ERP market, but are also active research topics in the ERP field.

"Business Process Re-engineering" (BPR) appeared as a keyword 27 times, highlighting the significance of BPR for a successful ERP implementation. Similarly, "Project Management, Integration, Knowledge Management, Modeling, Case Study, and Organizational Change" appeared between 14 and 22 times. These keywords point out that understanding of project and knowledge management and organizational change are essential dimensions of a successful ERP implementation. Integration is considered to be the most essential deliverable from implementing an ERP system. Because ERP systems are the most complex information systems ever undertaken, it is imperative that they are formally managed as projects to ensure their success. Complexity of ERP systems as well as complexity of their implementation (Amoako-Gyampah, 2007) makes knowledge management (its capture, storage, sharing, and usage) a key topic researched by ERP literature. This is especially true as those who become experts in ERP systems are highly sought after and, many times, lured away by competitors, vendors, and others seeking to add ERP talent to their human capital. Another frequent keyword is "Case Study," which turned out to be the most common method used by ERP researchers (Schlichter and Kraemmergaard, 2010) as many researchers draw their conclusions based on the thorough examination of real ERP case studies. The keyword "China" occurred 12 times (18 if we included Taiwan), reflecting the fact that China is now a manufacturing Mecca and a major hub for manufactures from many developed countries, and also reflecting the role of ERP

systems as key manufacturing and supply chain support systems. Further areas of ERP research emphasis revealed by keyword analysis include: "Organizational Culture," "Change Management," "Management Information Systems," and "Electronic Commerce" demonstrating the organizational, managerial, and technological dimensions of the ERP systems. The keywords and their distribution on the various framework quadrants provide a macro view on ERP systems research to ERP students, researchers, and practitioners.

Using the proposed framework, it becomes easy to identify newly emerging topics of discussion in the ERP research. For example, topics that appeared for the first time as keywords by ERP researchers in 2013 include: Cloud Computing, Continuous Auditing System, Continuous Monitoring Scenarios, Critical Success Strategies, ERP-based Lean Implementation, ERP III, Global Integration, Inter-Organizational Collaboration, SaaS, Skills Shortages, Strategic Alliances, System Alignment, Value-Focussed Thinking, etc. According to the framework, some of these keywords might evolve to become core concepts, intermittent, trendy, or simply vanish into phantomship. Some of these keywords may be leading indicators of major future trends of ERP research as predicted by other researchers (Robert Jacobs, 2007; Dospinescu *et al.*, 2008; Elragal and Haddara, 2012; Zutshi, 2012). Indeed some of the key future trends of ERP discussed by these researchers are revealed in our framework as late comers from 2008 to 2013 (Table XI). Such concepts include Web-enabled SCM, Cloud ERP, ERP with Data Mining and Intelligence Tools, Open-source Expansion, and SaaS, interestingly many of these appear to capture current technology trends.

6. Conclusions, limitations, and future direction

ERP systems are the most comprehensive business information systems that have come into existence. If implemented successfully, they provide a solid informational foundation for operational processing as well as for decision making. However, a faulty implementation involves huge risks that may be as grave as leading an organization to bankruptcy. Thus ERP systems are the most researched enterprise integration tool. This paper attempts to identify the major ERP research themes based on keyword analysis. The paper proposes a novel framework that identified four major types of ERP research topics: emerging or phantom, trendy, intermittent, and core. The framework is based on the

Keyword	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
AI										2				
ANN									1	1				
Open-source												1		1
Cloud computing														1
Fuzzy cognitive map									1					
Fuzzy logic													1	
Fuzzy payoff valuation													1	
Hybrid intelligence													1	
Open systems											1			
Rough set theory												1		
SaaS														1
SaaS ERP														1
SaaS quality														1
Web-based SCM									1					

Table XI. Emerging ERP concepts for the period: 2008-2013

persistence and dominance characteristics of keywords. The framework revealed that whereas the business-related aspects of ERP systems are discussed intermittently by researchers, technology-related aspects of ERP systems are discussed in a trendy fashion such that they dominate the literature every now and then. The core ERP topics identified by the proposed framework include: BPR, Case Study, Change Management, CSFs, Decision Making, Implementation, Integration, IS, IT, KM, Manufacturing, Modeling, Organizational Change, Project Management, Resource Management, SCM, Selection, and SMEs. The proposed framework captures the large variety of existing ERP intellectual contributions, and is flexible enough to embody any additional dimensions that are deemed necessary by other researchers. It is worth noting that, the framework is not limited to ERP domain, but can be used to discern similar conceptualizations in other fields of research. In addition, the simplicity of the framework makes it easy to understand and adopt in other contexts. Using the proposed framework it is easy to identify not only concepts that persist over time, but concepts that emerge every year, providing a glimpse of what could become major research topics in the future. This is relevant to both researchers and practitioners. The framework also provides a convenient method of capturing and organizing intellectual contributions of ERP research.

The main limitation of this research is that it only focussed on papers published in scholarly journals, and did not include conference proceedings, books, and other sources. The search criteria were title based, which may have led to missing some papers that discuss ERP, but do not use ERP or "Enterprise Resource Planning" in their title. Future research is needed to shed more light on the temporal variation in research classification using this framework, and on the nature and characterization of the phantom keywords.

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