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The Future of ERP Systems: look backward before moving forward

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Abstract

This paper explores the enterprise resource planning (ERP) systems literature in an attempt to elucidate knowledge to help us see the future of ERP systems' research. The main purpose of this research is to study the development of ERP systems and other related areas in order to reach the constructs of mainstream literature. The analysis of literature has helped us to reach the key constructs of an as-is scenario, those are: history and development of ERP systems, the implementation life cycle, critical success factors and project management, and benefits and costs. However, the to-be scenario calls for more up-to-date research constructs of ERP systems integrating the following constructs: social networks, cloud computing, enterprise 2.0, and decision 2.0. In the end, the conclusion section will establish the link between the as-is and to-be scenarios opening the door for more novel ERP research areas.

Keywords: ERP; development of ERP systems; future of ERP systems.

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1. Introduction

Enterprise resource planning (ERP) systems attempt to integrate data and processes in organizations. The data is centrally stored in a single database. This database functions as a hub that stores, shares, and circulates data from within the different departments and business functions. ERP systems are one of the most adopted information technology (IT) solutions in organizations [1]. Besides the potential cost savings, one of the main drivers for an ERP adoption would be the technical and operation integration of business functions to harmonize the information stream with the material flow of goods or services [2]. This will happen through integrating the internal value chain of the firm [3], and providing a seamless business processes streamlining, which could potentially sustain the firm's market competitiveness and responsiveness [4]. According to Beheshti [2], enterprise competitiveness could be achieved through the use of ERP systems, as they can provide reporting capabilities to management with cost and operational information needed to aid in strategic decisions related to the enterprise's competitive position. On the other hand, in order for the management and employees to utilize the use of the competitive capabilities of ERP systems, they must have a basic understanding of the principles of ERP, so that it can be used to the maximum potential. In addition, acquisitions, mergers, and joint ventures could be drivers of organizations to adopt ERP systems, in order to unify, utilize and manage the huge information and work flow among them.

Because of their scale and substantial resources consumption, it is not surprising that ERP systems have been a center of focus by both researchers and practitioners. Moreover, ERP systems require many organizational changes which could impose high risks if the implementations are not thoroughly planned, executed, and managed, as statistics from literature and practice show high rates of implementation failures [5]. Through the years, many communication technologies and infrastructural changes have evolved and been introduced to ERP systems, like web enablement, service oriented architecture (SOA), cloud computing, etc.

In this paper, we will provide a suggested future research roadmap for ERP research and practice. ERP systems and their corresponding implementations must change to cope with the new trends in technology e.g. SOA, cloud, in-memory analytics, social networks, and crowd sourcing. We could not project the future of those systems without taking a close look at how ERP systems emerged and matured over the years. This paper is organized as follows, sections 2-6 focus on the mainstream literature of ERP research, section 7 introduces the research problem, sections 8-10 discuss the as-is and the to-be situations, and finally section 11 introduces potential future work.

2. Related Work

While many enterprises are still adapting to their newly reengineered business processes as a result of their initial ERP implementations, other organizations are already seeking to upgrade and extend their current ERP systems [6]. In 2000, Gartner Research has published a report [7] announcing the "death" of the current generation of ERP systems, and stating that ERP II is the future and standard for next generation of ERP systems. In principal ERP II is basically an extension of the traditional ERP systems to incorporate and include e-commerce and supply chain operations [3, 7]. Moreover, companies adopting ERP II would cross the business-to-business (B2B) and business-to-customer (B2C) e-commerce boundaries and would be engaged in collaborative-commerce (c-commerce) processes with their value chain partners [8]. The quality of the information that organizations can publish for consumption by collaborating partners, could gain a competitive edge for these organizations [8]. Physically this will happen through the vertical and horizontal integration of e-business, customer relationship management (CRM) systems and supply chain management (SCM) systems with the local ERP systems within enterprises [3, 8]. This extension would allow firms to share accurate and up-to-date data with their customers, vendors, and partners in the value chain

independently of location and language, which has raised the calls for creating standard data formats for cross communications [8]. Some ERP vendors have already provided systems with partial integrations, like the open source Dolibarr ERP. Dolibarr includes its own CRM system, but it doesn't provide an e-commerce application, but still it provides a built-in integration interface to OSCommerce (an open source web store management application). On the other hand, other vendors have provided a more of complete solutions, which include traditional ERP capabilities, SCM, CRM, material resource planning, e-business and web-store interfaces. The open source software Adempiere would be a good example for a comprehensive ERP system.

ERP is considered to be at the top list of IT-enabled business innovations [6]. It was selected as the second most important key category for investment by IT executives. ERP systems implementation and upgrades are identified as one of the top five IT priorities among global CIOs according to independent surveys conducted by Morgan Stanley and Deloitte & Touche/IDG Research Services Group [6].

Currently, cloud computing, software as a service (SaaS), and open architectures are gaining a considerable attention in IS literature. The emergence of cloud computing has enabled many companies with a handy and on-demand network access to share a bundle of resources. The resources could include networks, servers, data storage devices, applications (e.g. ERP), etc. This bundle of resources could be provided and "implemented" with minimal management effort from the customer side [9].

Although cloud computing providers are facing several architecture and design challenges, however, security concerns, interoperability, data lock-in are on top of those challenges [10]. Most of the clouds are vendor-locked, as several cloud providers offer APIs (application programming interfaces) that are well-documented, but are mainly proprietary and exclusive to their implementation and thus not interoperable [10]. Thus, cloud customers will face challenges extracting and moving their data and applications from a cloud to another. Moreover, interoperability problems have motivated many organizations and government institutions (e.g. NIST) to work on cloud standardization and compliance projects, and were the motives behind establishing the Cloud Computing Interoperability Forum - CCIF (cloudforum.org). OpenStack is an example of the interoperability-solution projects, which provides free open source software. Using open standards, OpenStack is mainly an open platform controller and middleware that can facilitate the communications between clouds [11]. SaaS and cloud providers claim that ERP total costs of ownership would be dramatically reduced through the use of their service delivery models. In ERP literature, there is an apparent gap in cloud computing for ERP applications research, as it has been discussed in IS literature, but was rarely discussed in an ERP context.

3. Development of ERP systems

Through the years, ERP systems have evolved and advanced since the emergence of material requirements planning (MRP) and manufacturing resource planning (MRPII) systems. The primary difference between an ERP system and its predecessors is that ERP spans the whole organization and business function processes, not only the production related operations.

ERP systems can be traced back to the early accounting and inventory systems in the 1960s. The latter systems have evolved during the 1970s to material requirements planning (MRP) systems. MRP systems have been heavily used within manufacturing companies in order to handle production and inventory planning operations.

During the 1980s, manufacture resource planning systems (MRPII) came into the frontlines. MRPII is an extended and more comprehensive version of MRP, which covered other operations and business processes in manufacturing companies [12]. Besides manufacturing planning, the extension handled financial, order handling, inventory management, distribution and procurement processes. MRPII can also handle business processes within, and between several entities within large companies, like plants, warehouses, and

distribution centers. Although MRP implementations were non trivial, however, MRPII were more time and resource consuming, as they were broader in scope and have a larger impact on business processes and people.

In the 1990s, ERP systems were introduced as an extension to its predecessors MRPs. ERP systems span the whole organization but focus on key business function processes, not only the production related operations. Moreover, ERP systems provide a central data storage and integration hub between the several departments within organizations.

4. ERP implementations

ERP implementation projects vary in scale and arrangement, each project obliges careful and timely management decisions during its lifecycle phases [13]. ERP system implementations require dedication, commitment, significant amount of resources, and organizational changes. Many variables affect implementation complexity and scheduling. For example, these variables could be related to the adopting organization's structure, size, and technological status, or related to external factors like vendor's implementation methodology and market-specific contextual factors.

In ERP literature, ERP implementation methodologies and life-cycle phases may vary in name, number of stages, and level of detail. In research, ERP implementation models usually include several analogous phases e.g., adoption, selection, implementation, go-live, use and maintenance, and evolution. Some researchers extended these models to include a retirement phase [14]. The retirement phase is the point when an ERP system is replaced with another ERP or any other information system [14]. In practice, most major ERP vendors have their own implementation methodologies e.g., SAP follows the ASAP methodology, Oracle ERP follows the AIM methodology, as well as several other open source ERP systems follow their own methodologies.

Although sometimes they are used interchangeably, however, some researchers and practitioners differentiate between an implementation methodology and implementation strategy, the latter term would describe the process of how and when the system will go-live. The ERP implementation strategies would include a) Phased rollout, b) Pilot study, c) Parallel adoption, and d) Big bang or direct cutover. Each of these strategies has its own pros, cons, associated costs and risks. Some organizations prefer to combine strategies during the implementation process.

Some of the critical challenges organizations face when adopting ERP systems are the degree of business process re-engineering (BPR), customization, and change management required to best fit with their adopted ERP system. On the other hand, some organizations adopt a vanilla implementation, which could be the least risky implementation approach [6]. A vanilla implementation usually keeps the BPR to the minimum, and follows the core ERP functionalities and process models, instead of customizing the ERP to accommodate and fit the unique processes of the enterprise [1]. The fit typically needs a two way approach by combining BPR along with system customization in order to accommodate business needs and core unique competencies in some corners with standard process in others.

Whether it is a vanilla or a complex implementation, in a small or a large organization, ERP implementations require careful project management (PM) and a committed team. Moreover, organizations usually pass through a "shakedown" phase which they face challenges while adapting to the newly reengineered processes [13]. This might result in business disruptions or a reduced productivity for a certain period of time.

5. CSF

One of the mainstream definitions of a successful implementation is when an ERP implementation is finished on time and within budget [15]. This definition might be too strict when applied to actual ERP implementations. Many organizations have struggled with their ERP implementation budgets and schedules; however, based on field-experience and literature, some organizations still consider their implementations successful. Nevertheless the view, degree, and perception of a successful implementation may vary among stakeholders within the same organization.

Research and practice have identified several critical success factors (CSF) that would dramatically affect the implementation process. In the following section, we will briefly shed the light on some of these CSFs. Moreover, we will briefly discuss the factors that might result in potential ERP implementation failure.

5.1. Success factors

A large number of studies have explored the CSFs for ERP implementations. Most of these studies have compiled a similar list of factors, but with different CSFs rankings. Usually the rankings differ according to the cases studied, context, culture and many other variables. Several studies have found that top management support and commitment to the ERP implementation are on the top of CSFs, and they directly contribute to the implementation success or failure [2].

As ERP systems introduce a lot of changes to adopting organizations, and then it is not surprising to find that change management has been also identified as one of the top CSF [16]. The degree of fit between the organization and the ERP systems is very critical. That is why BPR, software customization and configuration have been found as CSFs [1]. On the other hand, other studies found that a minimal ERP customization effort through a vanilla implementation could be considered as a CSF [17].

Table 1 provides a more comprehensive list of CSFs ranked according to their citations as top CSFs in literature. The list was developed through a literature review by Finney & Corbett [4]. This review covered all ERP CSF related articles in major IS journals to the date of article. Although very few articles have found that ERP selection, and project cost planning and budgeting are CSFs, however, some studies state that user involvement in the ERP selection process is highly critical [18], and that ERP implementations could fail due to faulty or optimistic cost estimations [5, 19]. Moreover, organization size, industry, complexity, and structure have been argued to be influential in ERP implementation success [17].

Table 1. Frequency analysis of CSF in literature. Adapted from (Finney & Corbett, 2007)

CSF Category	Number of instances in literature
Top management commitment	25
Change management	25
Training and job redesign	23
Project team	21
Implementation strategy	17
Communication plan	10
IT infrastructure	8
Managing cultural change	7
ERP selection	6
Vanilla ERP	6
Project management	6

5.2. Failure factors

Some researchers have focused on implementation success factors, and others have focused on failure factors. Several studies have stated that ERP implementation failures are considerably high, which in some cases have led companies to bankruptcy [19]. A number of studies state that failures happen because of the unrealistic project deadlines and budget estimations [5]. In addition, F.D.Ted [8] argues that unrealistic deliverables could lead to project failures. Moreover, other studies have stated that implementation failures and early ERP retirements could happen because of a misfit between the ERP system and the organization, which mainly happens due to a wrong ERP selection in first place [18]. According to a survey conducted and published by SAP, 30% of implementations fail due to the lack of proper project planning, while 10% only fail because of technology driven causes.

5.3. The benefits realization

Organizations spend a large amount of money on ERP adoptions while seeking future returns. ERP vendors have promised to deliver benefits to adopting organizations. These benefits are usually realized in the long run and vary from one firm to another. In general, organizations expect that their BPR efforts should improve and enhance business process, which should control and reduce costs [20]. Moreover, organizations would have a substantial cost savings through cutting the large amount of paperwork, labor costs, and the sizeable hours of work [2]. On the other hand, realizing total benefits from ERP investments is not a trivial task. In IS literature, many articles argue that accurate capital budgeting and cost estimating for IS and ERP implementations are very difficult procedures, especially in projecting indirect costs [21, 22]. Similarly, estimating potential benefits and realizing post implementation benefits are very complex tasks that require organizations to follow formal benefits realization practices [2, 20].

Major ERP vendors e.g., SAP, claim that customers could spend around three to seven times more money on the implementation process and its supplementing services than the initial ERP license costs [22]. This substantial costs escalation is often because of unanticipated hidden costs. Many organizations overlook their expected human resources costs during and after the ERP implementation. Moreover, unplanned system

customizations and requirements can significantly increase implementation total costs. Several vendors claim that organizations tend to ask for many changes and *"nice to have"* features during the implementation, which were not previously agreed upon in the signed contract nor financially estimated. Moreover, extra customization costs could occur because of changes in business requirements. Furthermore, poor system requirements analysis and system design processes could also increase the implementation costs dramatically. This mainly happens if the key employees were not fully engaged during those two phases [18].

Recently, several cloud ERP providers argue that organizations would avoid hidden costs and substantially decrease their total costs of ownership (TOC), if they use their products. For example, Consona claims that organization could save up to 80% of their TOC when they adopt their open source cloud-based Compiere ERP system. Moreover, Lawson Software states that their cloud ERP will cut direct infrastructure, implementation and maintenance costs.

6. Problem statement

The literature discussed in the previous sections clearly indicate that the majority of research undertaken in the ERP domain mainly focused on implementations, CSF, PM, costs, benefits, upgrades, etc. Nevertheless, other rather important areas were little researched e.g., social networks, enterprise 2.0, etc. From our analysis perspective, multiple reasons are behind that lag between mainstream ERP research and the state-of-art topics: 1. Organizations which implement ERP systems want to secure their investment by pushing, or solely focusing on, the go-live; 2. Vendors' number-one objective is to grow their sales, and so they do whatever needed to meet that objective. In the light of that, we do think that the current situation looks as if we are racing in two different grounds. So the research question that we seek to explore its answer is *"what is the future of ERP systems? How does it compare to today's mainstream literature?"*

7. As-Is scenario

Indeed one cannot foresee or predict the future without looking backward and analyze the past. From our analysis, and based on the literature introduced in the previous sections, we could visualize past research on ERP systems as in the following diagram, figure 1.

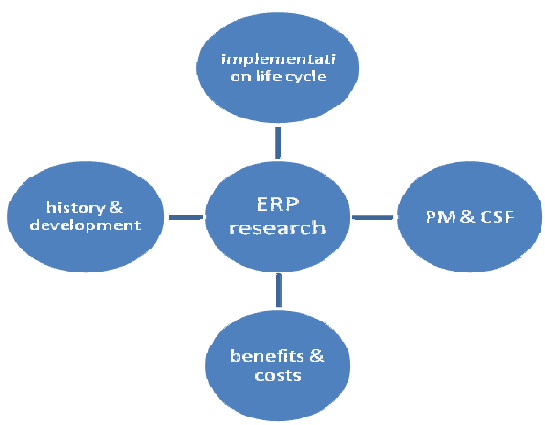

Fig. 1.Mainstream ERP as-is research

It is clear from the figure that the focus has been too much on the implementation areas. This is why, there has been a parallel, looks like unseen, research related to enterprise 2.0, social networks, etc which did not draw enough ERP research attention. In the next section, we suggest a rather forward thinking ERP research agenda.

8. To-Be scenario: The future of ERP systems

In this section, we introduce the to-be scenario of the future of ERP research. The following figure 2, explains the major potential constructs of this scenario. The potentials of integrating ERP systems into those constructs, in explained as:

- Social networks: with the widespread use and adoption of social networks, supported by the very fast adaptability of people to use them. The dream is to see ERP systems integrated into social networks. This will simply indicate shorter implementation lifecycles, higher ROI, and fewer investments. The success which salesforce.com has achieved in CRM needs replication in ERP systems as well.
- Cloud computing: one of the most important trends in the recent years is cloud computing. It has the potentials to reshape the way IT services are consumed. Cloud computing is defined as both the applications delivered as services and the hardware and systems software in the data centers that provide those services [10]. Those services referred to as Software as a Service (SaaS). Others use the term IaaS (Infrastructure as a Service) and PaaS (Platform as a Service) to describe their products. More recently, some ERP vendors have moved some of their offerings to the cloud e.g., SAP By Design. However, there is still a lot to be done in order for the customers to see more and more services and suites moving to the cloud. Therefore, more research efforts are still needed in order to elucidate knowledge on the marriage of the two.
- Enterprise 2.0: enterprise 2.0 (E2.0) is defined as the use of Web 2.0 technologies. E2.0 tools and applications have the potentials for achieving better collaboration, content creation and overall performance. E2.0 can be seen as social software that enables its stakeholders to connect, meet and collaborate through computer-mediated communication as well as form online communities. Offering digital environments, known as platforms, E2.0 allows all contributions and interactions by the users to be transparent and visible to everyone within the organization until deleted. Although organizations are using ERP systems to solve their niche problems, yet alone they might not fully utilize an organization's workforce abilities and knowledge. While these systems are cross-functional, they allow for minimal flexibility. However, E2.0, encompasses a different complementary approach. E2.0 emphasizes "freeform", that is, it does not predefine workflows and it is indifferent to formal hierarchies [23]. Therefore, we believe that more integration is required between ERP systems and E 2.0 tools and applications.
- Decision 2.0: Traditionally ERP systems have merely focused on the support of key business processes and functions resulting in a standardized way of running the business. To a great extent, they have succeeded in doing that. However, nowadays, they need to focus on how to support the decision making process, as well-informed decisions can have far reaching consequences, affecting almost all business aspects. There are many decision making models, notable among them is Simon's decision making model. Starting with the intelligence phase, the design phase, the choice phase followed by the implementation phase. A decision implementation is only considered successful when it actually solves its intended problem and fulfills the objectives that were initially set for it. However, it is worth mentioning that on average, 50% or more of the decisions made by individual decision makers were found to be a failure, despite effectively following the decision making process [23]. Therefore, a new trend in decision making is to involve the crowd achieving the so called crowd sourcing. This will enhance the intelligence as well as the choice

phases of the decision making process. Integrating the crowd into ERP to facilitate the decision making process is a long-waited for ERP enhancement.

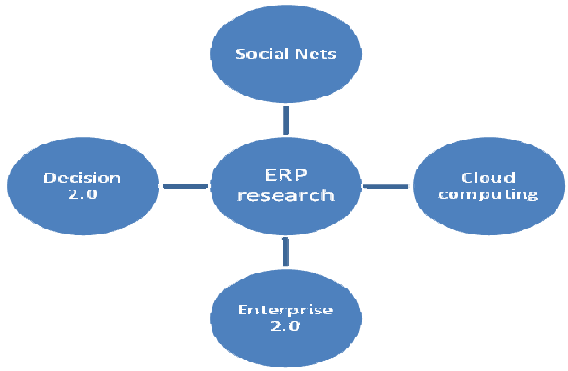

Fig. 2. The future of ERP to-be research

9. Conclusion

In this paper we presented an as-is ERP research model, in contract to what we believe is the future of ERP research. In the below figure, we relate and map the constructs of both figures 1 and 2. That is:

- The implementation lifecycle will definitely change with the emergence of social networks and cloud computing. This is due to the fact that social networks have been outside the lifecycle scope and also cloud computing will shorten and change the activities of the lifecycle.
- CSF/PM: the CSF will change to reflect the interaction between people and their new sort of connectivity i.e., social networks. This might reduce resistance to change, or at least reshape the way communication is managed throughout the project. Also, the PM team formulation will surely be less in terms of members needed, as when the ERP is hosted in the cloud; organizations need by far less (technical) team members.
- Benefits/costs: when it comes to costs, the adoption of cloud computing would rephrase, and potentially cut, the associated costs. On the other hand, the utilization and integration of ERP and social networks, E 2.0, and decision 2.0 will introduce new benefits package to beneficiary organization adopting or implementing ERP systems.
- All the above, adds to the development of ERP systems and it is related to all the to-be constructs.

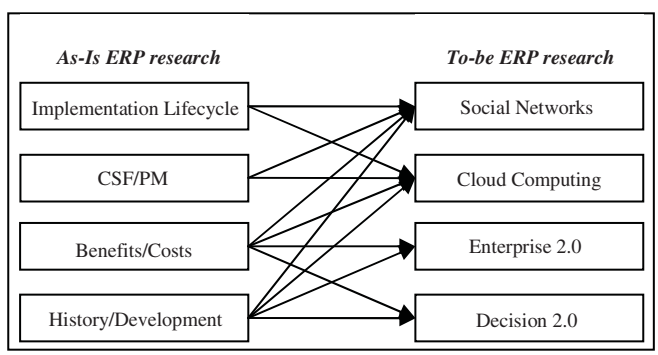

Fig. 3. The ERP research mapping

10. Future work

For decades, ERP mainstream research focused on implementation CSF, upgrades, PM, etc. Future research is needed to explore the potentials of ERP systems to be linked to social networks and enterprise 2.0 tools in general. Specifically, how could ERP systems expand beyond integrating processes and functions of organizations to reach the so far out of scope areas e.g., social networking, decision 2.0, crowdsourcing, and others. Last, ERP vendors and partners need to adapt to those changes in order to be able to deliver value to their current and potential customers.

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