Erp Systems Critical Success Factors

ICT Perspective

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Abstract—**The Enterprise Resources Planning (ERP) systems are one of the highly complex systems in the information systems field; the implementations of this type of systems need a long time, high cost, and a lot of resources. Many factors affect the successful implementation of ERP system. The critical success factors (CSFs) can be categorized as general, ICT related and software engineering or system life cycle (SLC) related. This paper is a survey paper that identifies ERP systems CSFs in general and software engineering CSFs in specific. Also an agile methodology for ERP systems' implementations will be presented. Many existing ERP systems were surveyed and presented from ICT / software engineering point of view.**

Keywords—ERP; Information and Communication Technology; System Life Cycle; Critical success factors; Agile methodology

I. INTRODUCTION

Enterprise resource planning system (ERP) is an information system software that aims to integrate all business processes and functions in a central database; that boosts the management of business resources (finance, production, human resource, materials…etc.) in an effective, efficient, and productive way [1,2,3]. ERP is not a new term; it began in the early of 1960s [4] where the development of ERP starts with Inventory Control (IC) which is an accounting software, then the package is developed to Material Requirements Planning (MRP) during 1970s which gave support for planning and control of production cycle, later MRP was advanced into Manufacturing Resource Planning (MRP II)in 1980s, that aimed to increase the efficiency of manufacturing by technologies integrations for information, the extend of MRP II produce ERP systems[4,5]. Table 1 below depicted the development of ERP systems [6].

TABLE I. DEVELOPMENT OF ERP SYSTEMS [6]

Year	Chronology
2009	ERP Cloud
2000s	Extend ERP
1990s	ERP
1980s	MRP II
1970s	MRP
1960s	IC

To keep pace with technology, the mobile ERP systems were introduced with the cloud technology [7]. ERP systems have two major advantages [8]: 1.the integrated enterprise show the all business functions and departments; and 2. The centered database eases all business transactions such as the recorded, monitored, and processed. ERP benefits are mentioned in [9] to achieve business benefits by using ERP systems; operational benefits, managerial benefits, strategic benefits, IT infrastructure benefits, and organizational benefits, each main benefits include sub-benefits. Also [7] pointed to eight of mobile ERP systems advantages.

According to [10] there are 67%-90% ERP system failure rate and 35% of ERP implementations are cancelled. Therefore, it is very important to highlight that factors which help and ensure the success of the system; many researches are done to focus on critical success factors (CSFs). The ERP system is a system with a high complex process [11]; critical success factors are used to indicate to the key issues that must be focused by the organizations to ensure a successful system and affects to the implementation process [5]. With a pool of benefits of using ERP systems a lot of studies focused on the impact of using ERP systems on business performance; [12] showed the identification and assessment of the ERP systems' implications and benefits on job performance. In the study the author focus on five factors that can be improved by using ERP systems to achieve outstanding job performance the factors are: 1. Task productivity and innovation, 2. Customer satisfaction, 3. Management control, 4. Interdepartmental communication and cooperation, and 5. Data analysis and conversion.

Many efforts are being made to improve the performance in business and a lot of models are implemented to guarantee gaining a best performance; [13] develop a theoretical model to explain the relationships between each CSF proposed and business performance; the study done for Indians Small Medium Enterprises (SMEs); the authors determine four main CSFs: 1. Approach. 2. Culture. 3. Communication. 4. Support. For each factor have sub-factors. Also five main performance measures are determined in the paper: 1. System quality. 2. Information quality. 3. Organization impact. 4. Workgroup impact. 5. Individual impact. In research [14] they improved a framework include five independent variables financial resource availability, employees perceptions, organizational complexities, regulatory requirements, and having a top management support; and study how these variables affect implementation of an ERP system effectively; and which will have effect on the performance of the firms. The next section will focus on the influence and importance of ICT dimension on this success and in which degree it will help to success. Section three talks about the critical success factors in general

those confirm to gain a successful ERP system also mentioned, and the success factors in system life cycle phases in specific; which phases are taken in consideration to support the structure that followed during the implantation journey. Section four proposed agile methodology for ERP systems' implementation is discussed as attempting to find a procedure that is the fastest and requirements changeable to get the user satisfaction and meet the organization requirements. Section number five includes the discussion. Then the conclusion

II. ICT ROLE FOR INCREASING ERP SYSTEM SUCCESS

A model is assumed in [15] to find the degree of fitness between an organizational dimensions and ERP systems and if they have a power on utilization. In this study they consider the technology is one of the cornerstones to achieve the optimal point and success. They suppose three hypotheses: Technology-Organization Compatibility and Utilization (H1), Technology-Human Compatibility and Utilization (H2), and Human-Organization Compatibility and Utilization (H3). They proved that compatibilities of these dimensions are very important and have a great role on utilization of ERP systems. The adoption of ERP system depends on the process of software selection [6]. The adoption of ICT in the business management increases the efficiency, competitive, and productivity [16].

ICT has a critical role in success of the ERP system; the rate of success of adoption ERP systems in the developing counters is slow and poor when comparing it with others; and this refers to the badness of infrastructure, limited ICT capabilities, and ICT costs. The technical factors are ranked in [10] as one of the critical failure factors in developing counties. One of the most considerable factors in ERP systems implementation is technical complexity [16]. Seeing that risks which related to the ERP project noticed that the technological and implementation issues have the largest share; [17] divide the risks into six major categories, three of them are related to technological and implementation issues: software system design, user involvement and training, and technology planning/integration. Those give us a sight to consider the importance of ICT in developing ERP systems. R.Rajnoha et al. [18] the possible risks during the system life cycle in the ERP system design, implementation, and operation & maintenance phases. All these issue courage us to pour attention to technologies' capabilities, skills, and system implementation methodologies to increase the successful and acceptance of the new ERP systems in the organizations.

In the case study in [1] the National Prawn Company implemented the ERP system two times in 2007 which failed and in 2010 succeeded and met the company requirement; the failure causes that reported are three; two of them refer to software implementation life cycle: 1. No clear vision, goals, and system benefits. 2. Immoderate requirement customization; in the other hand the successful ERP system in 2010 as reported the factors which also related to the technical and software engineering practice, such: more analysis and evaluation steps before the implementation is begin; extra post implementation support "maintenance", more

planning issues; training, conversion strategy, and user involvement and stockholders' feedback. Software is one of the ICT components; and the implementation life cycle is a core of success practice of any software the paper will focus on the CSFs in general of the ERP system in the next section and more specific on SLC related success factors. In the table 2 showed the success factors which are related to ICT issues according to the authors.

According to the researches ICT factors are mentioned in the papers as successful factors; which are affected in direct way with ERP systems success; software, communication, network, application development, and project management are some of ICT components which found as a success factors.

III. ERP CRITICAL SUCCESS FACTORS (CSFS)

Although a large number of researches about CSFs, there is no one standard or identical CSFs; each study mentioned a set of different factors than others. This difference occurred within reason of different researches samples and setting [5]. E.Umble et al. [8] proposed nine CSFs, implementation procedure, software selection steps, and a case study for Huck international Inc; and illustrate how the company's ERP system was successful according to the proposed CSFs. In FNah et al. [3] the researchers take 1000 companies' perceptions about CSFs of ERP systems and all factors were evaluated by chief information officers; the results are 11 main CSFs with attached sub-factors and suggest 5 most critical factors: 1. Management support. 2. ERP teamwork and composition. 3. Project management and change management program. 4. Project champion. 5. Change management program and culture. Also the researchers reviewed papers which used the proposed CSFs in their papers. E.Ziemba et al.[19] listed the four groups of critical success factors that are in public administration: 1. Factors related to public procurement procedure. 2. Factors related to government processes management. 3. Factors related to project team competences. 4. Factors related to project management. Each group has underlying factors. Also in [19] showed that CSF for ERP systems according to three different studies; first study: Somers, T. M., & Nelson, K.: "The impact of critical success factors across the stage of ERP Implementation", 2001, they listed 22 CSFs that are related to ERP implementation and did some analysis of these factors according to different phases during the implementation [5]. Second study: Hairul, M., Nasir, N., & Sahibuddin, S. "Critical success factors for software projects: A comparative study", 2011, they divide the CSFs into three groups each one has a number of factors: People related factors, process related factors, and technical related factors. Third study is [20], this study achieves the CSFs that related in implementing lean tools and ERP systems to understand how these CSFs changed over time. E.Ngai et al. [5] represent the literature review of CSFs in complex and systematic way; gather the sub-factors into number of CSFs set according to [3], and reported the CSFs and ERP's performance across countries and regions. R. Addo-Tenkorang [21] showed the literature review of ERP published work in journals between 2005 and 2010.

TABLE II.   Csfs that Related to ICT Issues

	F.Nah et al. [3]	E.Umble et al. [8]	E.Ziemba et al.[19]: Somers and Nelson (2001).	E.Ziemba et al.[19]: Hairul, Nasir, and Sahibuddin (2011).
Software			√	√
Communication	√		√	
Network			√	√
Application development		√	√	
Project management	√	√		√

After a wealth of information about CSFs in general, it turned out to be the largest share of success is for ICT dimensions and software engineering issues and methodologies, hence they can be considered as the backbone of the success of ERP systems. Table 3 mentioned the CSFs that related to SLC issues.

The authors in the table highlighted the factors that are used in software life cycle (SLC) and if you study the system development methodologies you will see and notice the importance of these factors that affect and insure the systems' success in general and ERP systems in special [18]. In other hand some studies that concentrate on the Critical Failure Factors (CFFs); in [10] the aim of the study is to identify CFFs and classify them to avoid ERP systems' failure on Iranian industries fail to help the organization to make an appropriate decision making of ERP implementation and considering these factors would limit the ERP systems failures; they ranked the factors into seven groups: Organizational, Project Management, Human Resources, Managerial, Vendor and Consultant, Processes, and Technical factors.

Project planning and specification it is a phase that related on specification high level of system requirements, business scope, set priorities, complexity, detailed step, duration and work plan, describe the current and new system with risk management plan, data analysis, feasibility studies, Requirements elicitation and analysis, and Requirements validation[22]. In [20], [19: Hairul et al.], and [5] the authors ranked a selection of development processes/methodologies as one of the CSFs. A different methodologies are existing and business needs an importance is various too, therefore the managers should decide to choose the appropriate approach follow, by balancing between technological and business strategies [5]. Project complexity, size and duration mentioned in [19: Hairul et al.] under critical technical-related factors. Understanding of goals, objectives, and business plan: most papers pointed to this factor as a critical one. This factor one of the primary stages that must do [23]. In [5] should be harmonize between the ERP systems missions and business plan, vision, and needs. [8] Clear goals would ensure customer satisfaction, employee will empowered, and facilitate suppliers. Data analysis, conversion, and accuracy; any mistake in data that affects in negative way at the whole final system, the right data entry should have a high priority during the ERP system implementation [8]. Design and development include implementation team, user involvement, and software development. Implementation team is the cornerstone of the ERP system success. All researches mentioned it as a most critical factor the success team refers to the number of members, skills, knowledge, experiences, balancing between technical and business capabilities, and trusted with decision making[3,5,8,19,23]. User involvement increase the acceptance of the new ERP system [23] so it refers to changing management factors too, two types of user involvement reported in [23] the first is involvement in the definition phase and the second in the implementation; hence the user must be involved during all the life cycle phases to increase his satisfaction. Verification and validation are including testing, maintenance, and evaluation. This phase is essential to show the performance of the system[8] and how the operational processes are worked [3], and determination the progress of the system implementation is critical too[5]. Verification and validation generally show the fitting and matching between system and specified requirements in satisfactory manner with users [22]. Education, ERP system is not easy to use by users with limited IT skills [23] and the users of ERP systems are the major cause of success and failure because they will use the system during its life and if they don't know how to use it the rate of failure will increase [8]. In [24] the study done to explain the effects of education on ERP success the study done on 326 firms and the results are all indicated to the importance and positive effects of educations. 1. Increasing the education will increase the ERP success. 2. The increasing of ERP success will increase the organization performance. 3. Statistically education has important effects. Despite of various methodologies for implementing software systems; focus on agile methodology and are highly recommended to be used for ERP development systems because of wide range of flexibility it offers.

IV.   Proposed Agile Methodology for ERP Systems' Implementation

Why Agile? Because the developers are in need to have an ERP system in shortest time and with fastest implementation method; and they need to be flexible with requirements change; with ease of management. Agile can do that. Figure 1 explains the proposed methodology. The above CSFs are considered as the main development phases. The proposed agile method depends on multi development groups' (used two groups), and five phases for each iteration. At the beginning the, small groups were a big one group and they planned the whole project and divided it into increments and iterations. In this stage the group determines the Complexity, project size, duration of the implementation times.

TABLE III.   CSFS THAT RELATED TO SLC ISSUES

	F.Nah et al. [3]	E.Umble et al. [8]	Hairul et al. [19]	Somers et al. [19]	O. Alask. et al. [19,20]	E. Ngai et al. [5]	E.Ziemba et al [19]	K.Al-Fawaz [23]
Project planning and Specification(requirements)								
Select a development processes / methodologies.			√		√	√		
Complexity, project size, duration.			√					
Risk management.			√				√	
Understanding of goals, objectives, and business plan.	√	√	√	√	√	√	√	√
Data analysis, conversion, and accuracy.		√	√	√	√	√		
Design and development								
Implementation team.	√	√	√	√	√	√	√	√
User involvement.			√	√		√	√	√
Software development.	√					√		
Verification and validation								
Testing, and troubleshooting.	√					√		
Monitoring and evaluation of performance.	√	√	√			√	√	
Education								
Education and training.		√		√	√	√		√

Risk management is also taking into account. After that the one big group will break into small groups and the teams again gather the requirements from the user for iteration separately understanding the requirement considered the backbone of the success. Each group starts with to implement the independent iteration. But the next group will start when the next finished the first phase; to ensure the ingoing implementation work. And when the group one arrives to the training phase the second constant implemented; thus the implementations will not stopped until the training end. The one iteration takes 1-4 weeks. As knowing the agile can deal with changes and manage it especially requirements' change; each change done by the user the team able to deal with it and modified. Planning the iteration include the requirements that are needed from the iteration. The team will prepare themselves by tools, technologies, and experience. The development team is one of the CSFs that mentioned above during SLC. Time during the life of the phase must be under control any little delay will influence the total project release time. Prototyping is the quick phase to arrange the ERP system requirements in technical from. The user must involve in all software development phases, the regular meetings between the team and users; even the requirements changes remain under control. The next CSF the model support is validation (testing and maintenance), and the additional important phase is the user Education on the developed system. This proposed phase as is essential phase to increase the users' technical abilities of their ERP system [24]. The major goal of ERP systems is to ease the information flow through the organizational then if the users were not educated on the system and trained to solve problems independently the rate of failure will increase. The users are the persons who will use the system and must highlights attention on the way of using it. Also this phase helps the developers to evaluate their work.
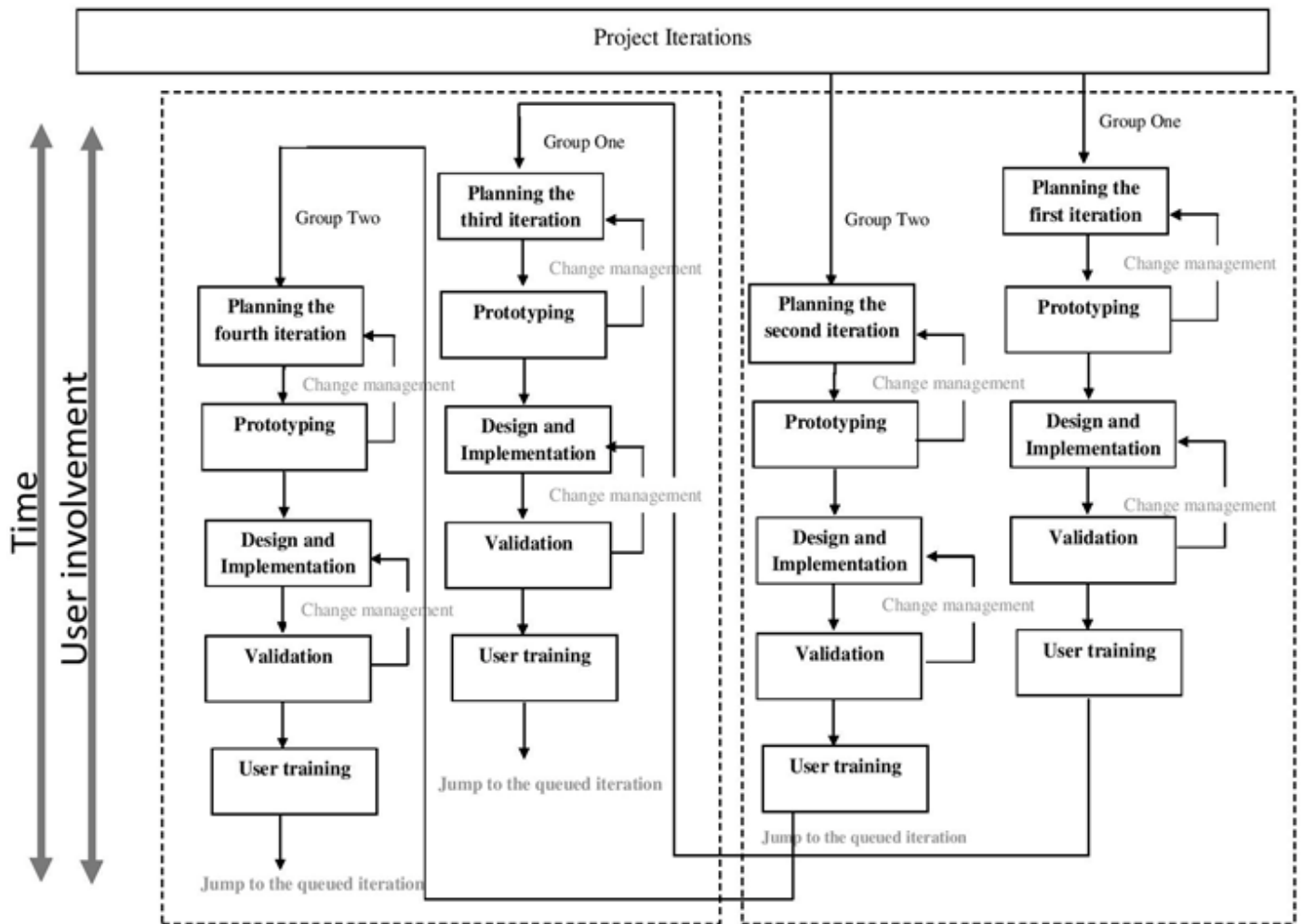
Fig. 1. Proposed Agile Methodology For Erp Systems' Iplementation

V. DISCUSSION

CSFs are the factors that organization must consider to achieve the success during implementing the ERP systems; these types of systems are complex, large and very risky where it may go over budget, and need high managerial capabilities in various levels. Indeed the ERP systems CSFs researches had a plethora of papers dealing with different aspects and characteristics including functional, technical, social, managerial, and implementation features. In this paper, the focusing centered on dimensions that related to ICT success issues and SLC success issues in addition to proposed agile methodology that attempts to improve ERP systems productivity and success. As soon as organizations thought to implement an ERP system they must achieve the best in managerial and technical aspect to gain a successful system with high maximum value.

In [22] social and organizational factors have an impact in requirements for any system, the most important one is culture which has an impact on ERP systems during the life cycle and that impact will also influence the success of the whole ERP, hence, the technical side is not the only effect on the ERP system success, but external social will affect the system as well. Hard to come by distinct ERP system success factors; the

ICT and SLC factors are a small side of the pool of factors that related to ERP success.

The high performance of ERP systems is related to the direct relation with the users' performance [24] that lead us to propose the training phase in the modified agile approach to ensure that the user will be able to use the implemented system in the valuable way; if the ERP's system users trained by technical people who implement the system, that will give us a double advantage to produce a well-trained users. In [1] in the mentioned case study the training was the main factor of success in the second successful ERP system for NPC. The importance of the training phase is as important as other phases.

According to this study, the use of ERP systems in educational organizations such universities can be seriously considered; fortune of benefits and facilities that ERP systems offer to both university's employees and students.

VI. CONCLUSIONS

Enterprise resource planning system in short (ERP) is information system software that aims to integrate all business process and functions in central database; that increase the management of business resources (finance, production,

human resource, materials…etc.) in effective, efficient, and productive way. In this survey paper a comprehensive discussion and review of how different factors affect the success of ERP systems implementations. A summary of these CSFs were presented and compared from different points of view. ICT is also a very important dimension to be considered in ERP systems, this includes software engineering where a customized agile techniques can be used in developing and implementing such systems and their SLC. Also the proposed techniques can be used in implementing ERP systems in educational organizations where huge amount of data and activities need to be managed in an efficient and consistent way.

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