Critical Successful Factors (CSFs) for Successful Implementation of Lean Tools and ERP Systems

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***Abstract*—Due to market competition and continuous pressure on businesses, there is always a need to adopt innovative tools and techniques, to reduce waste and concentrate on value adding activities. Consequently, the integration of lean tools and Enterprise Resource Planning (ERP) systems currently seem to be in high demand for both manufacturing and service organisations. However, the implementation of lean tools and ERP systems can lead to undesirable outcomes if implemented incorrectly and these can adversely affect improvements in the process. This research investigates the critical success factors (CSFs) involved in implementing lean tools and ERP systems with the aim of understanding how these CSFs have changed over time and, so as consider possible future directions. That will enable us to indicate which CSFs have already been addressed as well as indicate which areas may require further research. To achieve this aim, a comprehensive review of the published literature was conducted to identify the CSFs and achieve a depth of understanding of the various CSFs already identified by other researchers. The findings of this work support both manufacturing and service organisations seeking to implement lean tools and ERP systems by determining the CSFs of both ERP systems and lean tools which can be a valuable step toward enhancing chances of implementation of these techniques successfully. Moreover, decision makers will be able to formulate better strategies to enhance lean tools and ERP systems implementation, as well as to identify which elements of the implementation process most emphasis should be placed upon.**

***Index Terms*— Critical Success Factors, Enterprise Resource Planning, Lean Tools.**

I. Introduction

CURRENTLY, enterprises are struggling hard to maintain competitiveness in the market; therefore, lean tools and ERP systems have been receiving great attention, to assist enterprises to survive in such environments. This combination of lean tools and ERP systems will reduce overall waste in business processes and link the entire company department together to improve the communication and availability of real information flow within and between departments. Many companies have realised that in order to remain profitable and to improve competitiveness, they need to adopt lean tools, some researchers believe that utilising lean tools; is an important new management system that many manufacturing and service businesses now try to follow. On the other hand, ERP systems have been increasingly adopted by organisations across various industries but, nevertheless, numerous studies and reports have demonstrated that the expected benefits of ERP systems cannot be easily derived. Consequently, the idea of applying lean tools and ERP systems is not an easy task. Companies will face many obstacles and difficulties due to requirement of lean tools and ERP system implementation, as both need considerable investment and depend on many factors to be implemented successfully. Therefore, this research aims to outline the CSFs already identified as critical in the last decade by other research so as to consider the degree of change. Once CSFs of lean tools and ERP systems over the last decade identify, the direction of the research can be determined. This will provide the indicators of what CSFs have already been addressed and what have not, the results that can then lead to uncover a new area requiring further research.

Manuscript received March 2012. This work was supported by Ministry of Higher Education Libya. CSFs for Successful Implementation of Lean Tools and ERP Systems.

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II. Literature Review

A. Critical success factors

Critical success factor (CSFs) were proposed by Daniel in 1961[1], and popularised by Rockart's in 1979 [2].Study of information systems, over the past two decades demonstrate that the CSFs method has been widely adopted and used in a variety of fields of study to determine the most critical factors influencing enterprise success[3].However, there is no one particular definition of success, as the definition of success is different from one person to another, depending on the perspective of the person who defines it. CSFs were defined by Rockmart as "*the limited number of arrears in which results, if they are satisfactory, will ensure successful competitive performance for the organisation*"[2], moreover, Bruno and Leidecker have defined CSFs as "*those characteristics, conditions or variables that, when properly sustained, maintained, or managed, can have a significant impact on the success of a firm competing in particular industry*" [4].Study of CSFs will permit

ISBN: 978-988-19252-2-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

companies to focus their efforts on some areas to meet the CSFs, or even allow companies to decide if they have the capability necessary to meet CSFs requirements. Boynton and Zmud, regard CSFs as one of the few things that ensure success for an organisation [5]. Furthermore, the CSFs concept is the most important for overall organisational objectives, mission and strategies [6].

B. Enterprise resource planning

ERP systems are complex systems that integrate data and business processes. Many companies began setting up ERP systems in order to reduce the non-integration of systems and enhance interactions and communications with their customers and suppliers [7]. Although ERP implementations have been known to have a high rate of failure, ERP continues to be adopted and expanded into new areas. The high failure rate of ERP implementation calls for a better understanding of its critical success factors [8]. According to Wong, B. & Tein, D. in information systems implementation research, there has been a lot of attention given to measuring success in implementation [9]. However, the concept of CSFs is well established and widely used in both ERP systems and information systems research [10]. Nevertheless, many researchers have tried to identify critical success factors that have affected ERP implementation. Rasmy has defined CSFs in ERP implementation as "*factors needed to ensure a successful ERP project*" [11]. According to Ramaprasad and Williams's survey, the CSF method is used in three key areas including project management (63.49 %), information systems implementation (49.21%), and requirements (47.62 %) [12]. Furthermore; Kenneth J. emphasis the continuing use of CSFs in order to help focus on the benefits of ERP systems [13]. There are mixed expectations about the actual CSFs of ERP, discrepancies over the number of CSFs for ERP, such as [14] (12 CSFs), [15] (11 CSFs), [16] (9 CSFs), [17] (10 CSFs) and [10] (22 CSFs), there are also numerous CSFs which are similar but they represent by dissimilar terms. In spite of the contrast in the number of CSFs, there is common ground among the majority of these identified lists; there are similarities of the most CSFs highlighted, such as great level of communication, top management support, data accuracy, business process reengineering (BPR) and legacy systems management.

C. Lean tools

The term lean manufacturing was first introduced by Womack and Jones in 1990 in their book *The Machine That Changed the World*, which describes the Toyota production system (TPS) [18]. Lean tools start from the premise that adding value to processes and reducing waste are the primary goals of any business. Many companies have reported some benefits when they have moved toward becoming lean by adapting different lean tools, such as Just-in-Time (JIT), setup reduction, 5S, Total Productive Maintenance (TPM) [19]. Results of the survey carried out by Strozniak, demonstrate that 32% of manufacturers use predictive or preventive maintenance; moreover, 23% of manufacturers use continuous-flow production, and 19% of manufacturing firms have adopted cellular manufacturing, were less than 20% of manufacturers adapted other lean tools such as lot-size reductions, bottleneck/constraint removal, and quick-changeover techniques [20]. Past literature showed most practitioners and researchers had highlighted the lean tools which could reduce inventories, lead times, rapid product development processes are workface management, Set-up time reduction (SMED), Pull system (Kanban),TPM, Mistake Proofing (Poka Yoke), 5S, Value Stream Mapping, JIT, Visual Management, One Piece flow (Takt time), Standardised Procedures/work, Kaizen [21]. There are a lot of companies that are implementing lean tools. However, many of these companies are still coping with mastering the idea of a lack of understanding of its core concepts. In fact, companies are faced with some of the challenges and difficulties, which could be avoided and overcome by identifying the CSFs of lean tools; in other words, there are so many CSFs if identified and well understood, that will support the overcoming of these obstacles and difficulties [22]. Therefore, studying and understanding CSFs of lean tools are very essential.

III. METHODOLOGY

This study provides a comprehensive literature review; hundreds of articles from journals and conference papers were searched, using key words identified in initial research in the literature. The aim of this research is to investigate the CSFs involved in implementing ERP systems and lean tools in order to understand how these factors have changed over time and to consider future directions; consequently, content analysis seems to be an appropriate method for this research; as suggested by Silverman, content analysis is the most common technique when analysing texts [23], and defined as "*fundamentally empirical in its orientation, exploratory, and predictive in its intent*" [24]. In addition to this, Harris and Attour claim that content analysis is a proper technique when the phenomenon to be observed is communication (statement, notes, and contact), rather than behaviour or physical objects [25]. In this work, the following steps of content analysis were carried out.

A. Data collection.

This phase involves the researcher who makes a decision as to the extent of the sample, and whether to search for a single word, or a set of words or phrases; likewise, Berg states that the initial step of content analysis is to determine at what level the sample will be chosen and what units of analysis will be counted [26]. For this research, the unit and level of analysis involved a plethora of journal articles and conference papers and subsequently carrying out extensive search into related databases such as:

- Scopus
- Science Direct
- Emerald Intelligence
- IEEE Transactions
- Google scholar

Initial research into the literature review was conducted in order to select keywords, which would be utilised in searching for related topics, to help focus on the needed topics. Also, the alternative keywords or phrases that describe the concept were determined; this provided a number of different keywords which can be combined to

ISBN: 978-988-19252-2-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

search for information. Importantly, this enables the researcher to gain more information as journal articles may not use the same terms for describing a topic; alternative terms or American English spellings and plurals were taken into account. To ensure that search processes within databases will obtain the best results, several techniques were used such as Boolean operators AND, OR and NOT; wildcards and phrase searching keywords and terms. For instance, ERP systems like many others information systems have many synonyms such as integrated standard software packages, enterprise systems, enterprise wide systems, integrated vendor systems all those terms were considered. In addition, another effective technique was used, when a good result was found it, was used as a launch pad to examine closely any record which is particularly relevant for the subject by searching their references which led to other good references.

TABLE I
SEARCH TERMS FOR LEAN TOOL IN JOURNALS AND DATABASES

Keywords	Boolean operators	Alternative
Critical success factors	AND/ OR/ NOT	Lean tools
Lean techniques	AND/ OR/ NOT	Critical success factors
Critical success factors	AND/ OR/ NOT	Lean manufacturing
Lean tools	AND/ OR/ NOT	Success

TABLE II
SEARCH TERMS FOR ERP IN JOURNALS AND DATABASES

Keywords	Boolean operators	Alternative
Critical success factors	AND/ OR/ NOT	Enterprise resource planning
Critical success factors	AND/ OR/ NOT	ERP
Critical success factors	AND/ OR/ NOT	ERP success
ERP implementation	AND/ OR/ NOT	Enterprise resource planning implementation
ERP Factors adaptation	AND/ OR/ NOT	Success

B. Open coding

Once the articles were presented, they were classified into groups according to the year of publication, and then search for CSFs as they emerged in literature. The focus was on the words themselves and not on their meaning at this stage. After the first CSF was found and listed against the year of publication, reading continued until identified the second CSF was identify, and then compared with the first one to make sure the new CSF was adding value to the list. This process was conducted with the appears of any new CSFs. Also it was decided to code for the existence of a concept CSFs as well as its frequency. Open coding was used as the initial pass through the raw material when the researcher places themes and allocates primary codes or labels in a first attempt to compress the mass of data categories [27].

C. Axial coding

In this step the second reading of raw data to examine the CSFs took place. Work around the essential axis of the themes was conducted until the themes became clear and referred to the related article for more information when needed. Additional or new themes could emerge during this step; re-reading raw data for axial coding was very important [27].

D. Selective coding

At this stage, the third reading of the raw data was important to select facts that illustrated or justified themes; comparison between CSFs was conducted, and contrasts and similarities between CSFs were identified in order to map all CSFs and investigate relationships across CSFs to build up CSFs classification. Two criteria were taken into account to identify the homogeneity among CSFs; the initial criterion was to consider the meaning of one CSF and to compare with the rest of the CSFs cited in the same year of publication. The second determined to what extent one particular CSF was different from the other CSFs which had been cited in the same year of publication [27]. For example (top management support) (support from senior managers) are the same factor but expressed differently; one of them was ignored and the other which had comprehensive meaning was kept.

IV. FINDINGS

By implementing the method explained previously and reviewing ERP system literature, 22 CSFs for ERP systems were identified, and they are:

TABLE III
CSFs of ERP systems

Top management support	Project team organisation and competence
User training and education on software	Legacy system management
business process reengineering (BPR)	Change management
Project management	Vendor support
Effective communication	Project champion
Change culture	System technological
Clear goals and objectives	ERP package selection
Use of consultants services	Data accuracy
Interdepartmental cooperation	Sponsorship
Upgrading infrastructure	Minimal customisation
Financial resources	Project manager

As the aim of this study is to understand how CSFs have changed over the last decade and consider its future directions, CSFs of ERP systems findings were categorised into three groups according to their degree of change. The first category consists of 12 factors that have decreased

ISBN: 978-988-19252-2-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

greatly over time as shown in Figure (1); the second category consists of 7 factors which have a declined slightly as shown in Figure (2); and the third category demonstrated 3 factors which have increased as shown in Figure (3). Overall, the studies of CSFs in ERP systems have decreased. In Figure (1) the percentage of citation CSFs of ERP systems through 2001-2011 periods has steadily reduced by an approximate average of 25 per cent from the first half of the period to the second half. This agrees with the study carried out by R.Bjarne & K.Pernille which investigated the number of publications within the period 2000-2009 [28].

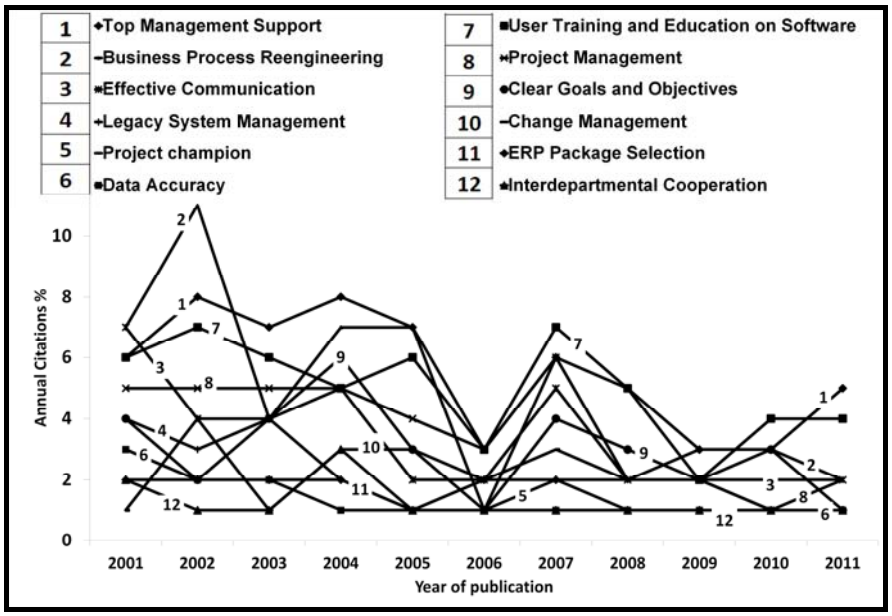

Fig. 1. Factors have decreased over time.

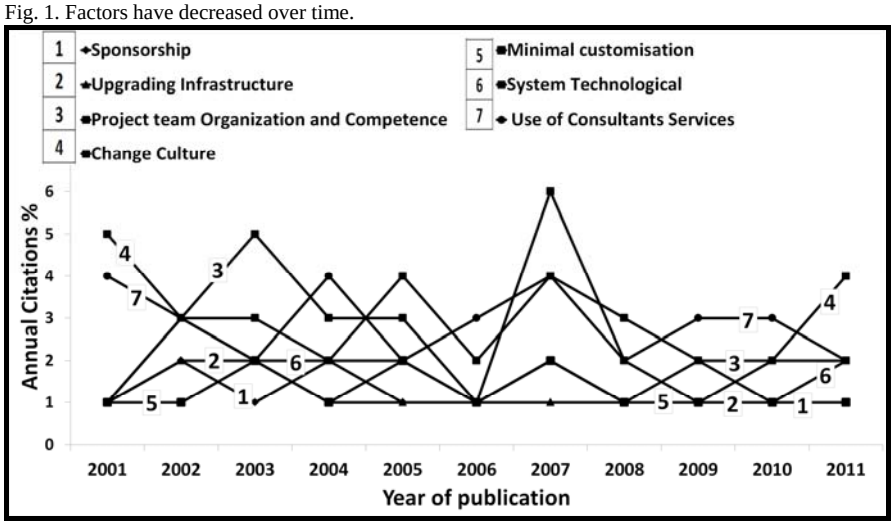

Fig. 2. Factors have declined over time.

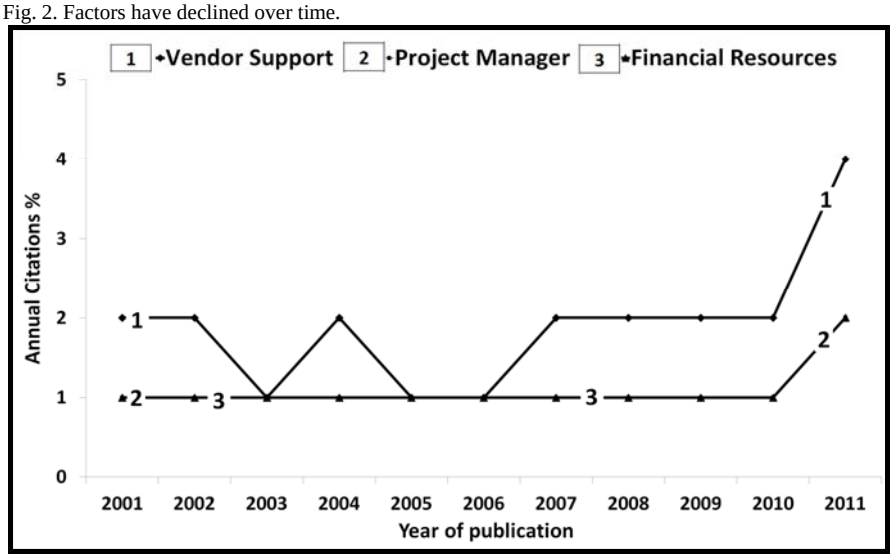

Fig. 3. Factors increased over time.

ISBN: 978-988-19252-2-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Due to the limited publication of previous studies which focus on CSFs of lean tools compared to those that focus on CSFs of ERP systems, it was difficult to calculate the rate of change according to the time, as it has been done on ERP system; therefore, the research focused on the frequency of CSFs of lean tools regardless of the year of publications. This research has identified 83 CSFs of lean tools when the focus was on the words themselves and not on their meaning, then worked around these factors and combined those which had similar meaning; consequently, the list was reduced to eighteen key main factors that are fundamentally critical for the implementation of lean tools. These factors are shown in Table IV.

As showing in Figure 4, out of these identified factors, what has been noted is the commitment of the top management, changes in organisational culture and effective leadership. These are the most critical CSFs in determining the success of implementing lean tools within the business. However, these eighteen factors are considered as the cornerstone to the success of implementing any lean tools within an organisation.

TABLE IV

CSFs of Lean tools	
Commitment of the top management.	View lean as a long term journey.
Change in organisational culture.	Visible management commitment.
Effective leadership.	Lean champions.
Effective communication.	Financial capabilities.
Comprehensive training and education.	Involve and value employees at all levels of the organisation.
Determine goals and objectives.	Getting shop floor commitment and employee trust
Continual evaluation during the lean effort is critical.	Problem solving by involving people.
Realistic timescales for changes.	Standardisation.
Views and understand lean as a philosophy rather than another strategy.	Highly motivation of staff to improve the service.

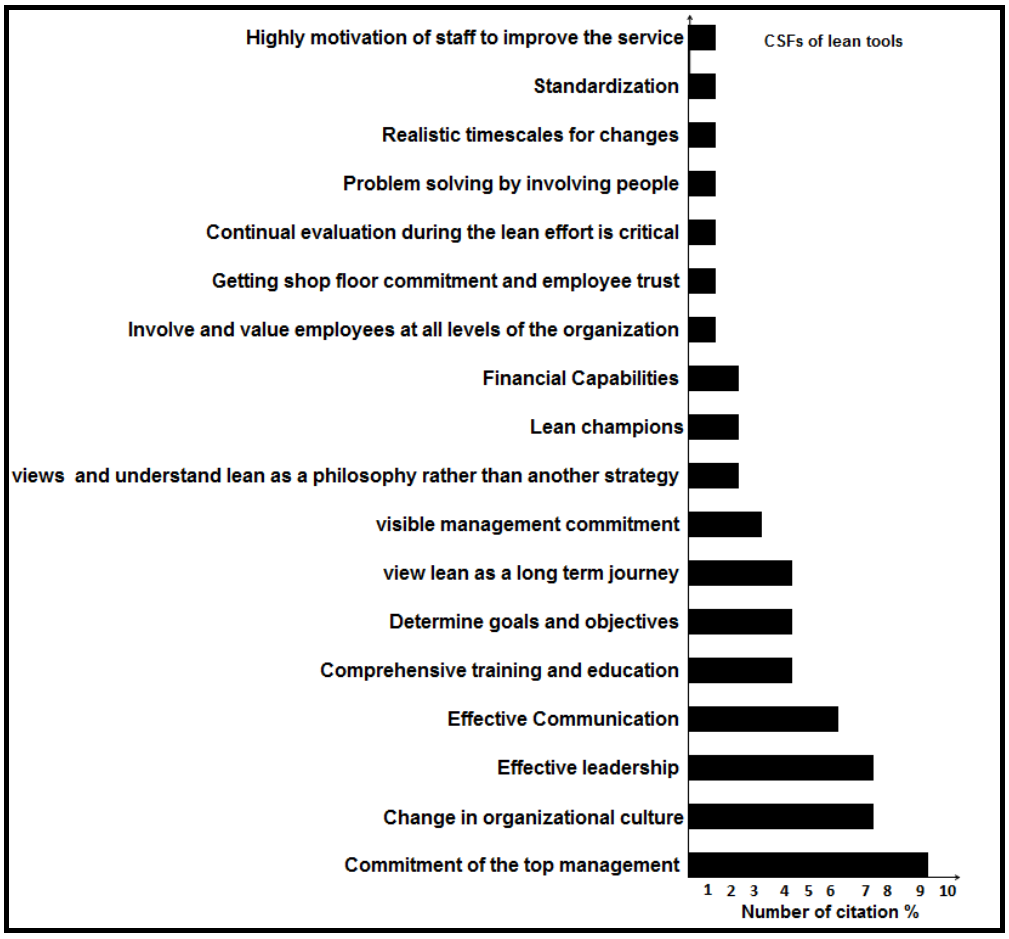

Fig. 4. Frequency of factors cited.

ISBN: 978-988-19252-2-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

V. Conclusion

There is no doubt that the study of CSFs for lean tools and ERP systems will support companies in promoting knowledge within enterprises. It will also enhance the understanding and aid the identifying of how essential CSF to increasing the chances of the successful implementation of lean tools and ERP systems. Although the numbers of the published studies which focus on CSFs on ERP systems are greater than studies that focus CSFs on lean tools, there is a substantial degree of congruence in CSFs between lean tools and ERP systems especially in the top five of CSFs. These findings can be used in determining the prioritises of CSFs of lean tools and ERP systems implementation. However, the amount of the research, carried out over the last decade in CSFs in ERP system issues, has led to dramatic changes in numbers of CSFs; for instance, business process re-engineering has been tackled over time and organisations have begun to understand that they need to re-engineer their process to facilitate ERP systems adaptation. Nevertheless, this change has kept most of the CSFs priority as it is, such as top management support which remains in the top of the ERP systems requirements to success. Also a new market necessity can play a vital role in CSFs change. In some of CSFs there is no notable change; for instance in financial resource factors. This is perhaps because ERP systems always need resources (cash, people). Moreover, new factors appeared which were not considered as important factors in the past but now have become more important, such as vendor support; this can refer to the change of ERP vendor policy, as ERP products build to satisfy their customers by supporting them to solve any application problems in order they can make more profit. Overall, it has been understood that the number of studies focused on CSFs on ERP are much more than those focused on lean tools. Determining the CSFs of both ERP systems and lean tools can be a valuable step towards enhancing chances of implementation of those techniques successfully. As well, decision makers will be able to formulate better strategies to implement lean tools and ERP systems. There is a high degree of congruence in the top five CSFs of lean tools and ERP systems. Regardless of different priorities in different sectors, it seems that some CSFs of lean tools and ERP systems have the same degree of importance. The finding sets out the priorities and justifies the CSFs of lean tools and ERP implantations that can be determined, which will help to identify future directions of CSFs of lean tools and ERP systems. Studies undertaken in CSFs of ERP systems have contributed to spreading knowledge to improve mature levels. This can lead to further research questions as to how this affects the success rate of ERP systems implementation. That will be considered as future work.

Acknowledgment

We would especially like to thank the editor for their comments and suggestions that have improved the paper, allowing us to learn more about the academic research.

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