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QUALITY PAPER

Critical failure factors of Lean Six Sigma: a systematic literature review

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Abstract

Purpose – Lean Six Sigma (LSS) is a continuous improvement methodology that aims to reduce the costs of poor quality, improve the bottom-line results and create value for both customers and shareholders. The purpose of this paper is to explore the critical failure factors for LSS in different sectors, such as manufacturing, services, higher education, etc.

Design/methodology/approach – The following research is based on a systematic literature review of 56 papers that were published on Lean, Six Sigma and LSS in well-known academic databases from 1995 to 2013.

Findings – There are 34 common failure factors of LSS cited in this paper. There are some common factors for failure, such as a lack of top management commitment and involvement, lack of communication, lack of training and education, limited resources and others. Many gaps and limitations are discussed in this paper and need to be explored in future research.

Originality/value – The paper is one of the first systematic literature reviews to explore the critical failure factors of LSS and discuss the top failure factors from different angles, i.e. countries' evolution, organisations' size (small- and medium-sized enterprises and large organisations) and industry nature.

Keywords Six Sigma, Systematic review, Failure, Lean, Lean Six Sigma

Paper type Literature review

1. Introduction

Today, Lean and Six Sigma are the most popular business strategies for enabling continuous improvement (CI) in the manufacturing, service and public sectors. CI is the

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main goal for any organisation wishing to achieve quality and operational excellence and to enhance performance (Antony *et al.*, 2012a; Thomas *et al.*, 2009). Therefore, the integration of the two approaches improves efficiency and effectiveness and helps to achieve superior performance faster than the implementation of each approach in isolation (Antony *et al.*, 2012a).

This interest in LSS has led to many attempts to produce a comprehensive approach to achieve CI. There are noticeable limitations in the fields of research into areas of LSS (Chakravorty and Shah, 2012; Laureani and Antony, 2012), but the benefits of applying Lean and Six Sigma in parallel are noted in many case study papers in both the manufacturing and the service sector. It is also significant that the number of available papers on LSS, though still small in comparison with other quality improvement methods, has shown exponential growth since the first papers were published in 2003. As a consequence, this paper includes research papers on both Lean and Six Sigma to take into account more failure factors for LSS.

1.1 Critical failure factors

Garg and Garg (2013) and Ganesh and Mehta (2010) have defined CFFs in term of enterprise resource planning (ERP) as " the key aspects (areas) where 'things must go wrong' in order for the ERP implementation process to achieve a high level of failure". They also have defined failure as "an implementation that does not achieve a sufficient return on investment (ROI) identified in the project approval definition". According to Al-Mashari (2001) study in ERP as well, "strategy development is critical to ERP implementation, as its absence has resulted in poor outcomes" Moreover, a number of academic papers have targeted CFFs such as the study done by Yeo (2002) in CFFs in information system (IS) project. Yeo (2002) has studied the interaction between some factors such as organisational, financial, technical, human and political factors which then these factors named CFFs for IS project. However, Yeo (2002) study did not define the term CFFs but only defined some situations when project defines as a failure. Other study done by Belassi and Tukel (1996) in projects management CSFs/CFFs has only listed some factors that lead projects to success or fail with no any definitions for CFFs.

Furthermore, there seems to be insufficient research investigation on the critical failure factors of Lean, Six Sigma and Lean Six Sigma (LSS). Hence, authors argue that this paper will be valuable in term of identifying CFFs of LSS.

1.2 LSS

LSS was defined by Snee (2010) as "a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom line results". Organisations give many reasons for implementing LSS, for example to improve business performance and operational efficiency, to improve product quality, to reduce production costs and to improve customer satisfaction, especially considering the growth of global markets (Antony *et al.*, 2007, 2012a; Snee, 2010).

The first integration of Lean and Six Sigma occurred in 1986 in the US-based George group (Salah *et al.*, 2010). However, the term LSS was first introduced into literature around 2000 (Antony *et al.*, 2012a; Laureani and Antony, 2012; Snee, 2010). The popularity and deployment of LSS are notable in the industrial world, especially in large western organisations such as Motorola, Honeywell, GE, Du Pont, Merck, Johnson & Johnson, Bank of America and others (Laureani and Antony, 2012; Snee, 2010) and in some small- and medium-sized manufacturing enterprises (SMEs) (Antony *et al.*, 2005; Kumar *et al.*, 2011).

Although notable success stories of LSS deployment in the industrial world can be seen in many academic papers, not all organisations can gain real benefits from LSS implementation; a poor attempt at LSS implementation can actually render it ineffective (Chakravorty, 2009; Glasgow *et al.*, 2010; Kumar *et al.*, 2007, 2008a).

1.3 Lean and Six Sigma failures in the literature

A number of authors have argued that although companies have successfully deployed CI initiatives such as Lean and Six Sigma, a significant number of companies have failed to gain any benefits from their deployment and other companies have failed to achieve the expected results (Kumar *et al.*, 2008a, b; Martinez-Jurado and Moyano-Fuentes, 2012).

According to Ringen and Holtskog (2011), of every three CI initiative projects in general, two fail to attain the expected results. Moreover, Pedersen and Huniche (2011) reported that up to 70 per cent of the companies implementing Lean have failed. In 2006, research conducted in UK organisations implementing Lean showed that fewer than 10 per cent of the organisations have implemented it successfully (Bhasin and Burcher, 2006).

Many authors, such as Chakravorty (2009) and Kumar *et al.* (2007, 2008b), have reported a survey of aerospace companies carried out in 2005. The results of the survey showed that respondents' satisfaction with Six Sigma results was lower than 50 per cent, while only 20 per cent were satisfied and 30 per cent were dissatisfied. Feng and Manuel (2007) stated that their survey of health-care companies showed that 54 per cent of the surviving companies do not anticipate implementing the Six Sigma strategy.

A review of 47 studies in health care undertaken by Glasgow *et al.* (2010) concluded that 62 per cent of Six Sigma and Lean initiatives failed as a result of a lack of stakeholder acceptance.

These failures and dissatisfaction with the results are not because of a shortage of improvement programmes. Most of the companies failed to pay attention to the critical success factors during implementation, such as top management commitment and involvement, communication with the shop floor workers, selection of projects, training and so on. Hence, a significant number of CI projects have failed (Chakravorty, 2009; Laureani and Antony, 2012; Snee, 2010). Moreover, LSS implementation success and failure depend on how and where it is applied (Duarte *et al.*, 2012). The search of the reviewed papers illustrated that there is a clear limitation in the publication of the factors that lead to LSS failure. Therefore, this research aims to narrow the gap in the literature by exploring the most common CFFs of LSS.

2. Methodology

This paper explores the most common factors that lead to LSS failure in different industries, which have been published in academic journals, by systematically reviewing the literature. According to Okoli and Schabram (2010), a systematic literature review is "a systematic, explicit, comprehensive and reproducible method for identifying, evaluating, and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners". Tranfield *et al.* (2003) stated that the systematic review has become a "fundamental scientific activity".

To date, only two systematic reviews have been published regarding LSS, which were carried out by Glasgow *et al.* (2010), on health care, and Zhang *et al.* (2012), who conducted a general review. Authors have argued that there is a clear need for more

systematic reviews to be carried out in the area of LSS failures to bridge the gap in the previous literature.

This paper aims to present a systematic literature review of all the journal papers that exist in a number of academic databases regarding Lean, Six Sigma and LSS from 1995 to 2013. These dates were chosen to ensure that the results and findings are up to date.

2.1 Approach and phases

In this paper, the approach includes a systematic literature review process as shown in Table I. These ten steps are fundamental and need to be followed in a systematic review. Three phases underlie these ten steps, as shown in Figure 1. The processes and phases in this approach have been adapted from several academic sources, such as Okoli and Schabram (2010), Thomas *et al.* (2004) and Tranfield *et al.* (2003).

2.2 Criteria

The inclusion and exclusion criteria are stated in order to make it clear to readers why some articles with which they are familiar may have been excluded from the review (Booth *et al.*, 2012). Okoli and Schabram (2010) argued that simplifying research by criteria by, first, reviewing the title, and then the abstract when needed, helps the researcher to save time and effort. Adopting this approach, the authors examined papers by title and then abstracts when required, and by this means included all the papers that meet the inclusion criteria; however, the use of this method meant that it was not possible to exclude all unrelated papers (see Table II). Moreover, a research inclusion and exclusion criterion is very critical to assess the quality of papers. Searching for relevant papers was limited to papers was published between 1995 and 2013 to make sure that all information are up to date. Furthermore, only well-known academic databases have searched, academic journals and papers that based on strong and deep analysis of findings.

Process	Definition
1. Research purpose and objective	The purpose and objectives are clearly identified after a review of the most common gaps that appear in the literature
2. Develop research protocol	The protocol includes the study scope, strategy, criteria, quality assessment, data extraction and so on. This protocol will be followed during the systematic literature review process
3. Establish relevance criteria	The research criteria help to ensure that we include only the papers most relevant to the research question and exclude unrelated papers
4. Search and retrieve the literature	Electronic search for relevant articles in top academic and specialist journals, and hand research in bibliographic lists if needed
5. Selection of studies	Dependent on research criteria
6. Quality assessment for relevant studies	Using appropriate tools to assess articles for quality. Each article should be scored for its quality depending on the methodology used
7. Data extraction	Extract the relevant data from each study included in the review
8. Synthesis of studies (analysis)	Using appropriate techniques, such as quantitative or qualitative analysis or both, to combine the extracted facts
9. Reporting	Reporting the systematic literature review in detail as well as the results of the review
10. Dissemination	Publishing the systematic review in an academic journal to make a contribution to the knowledge in the field

Table I.
Research processes and definitions

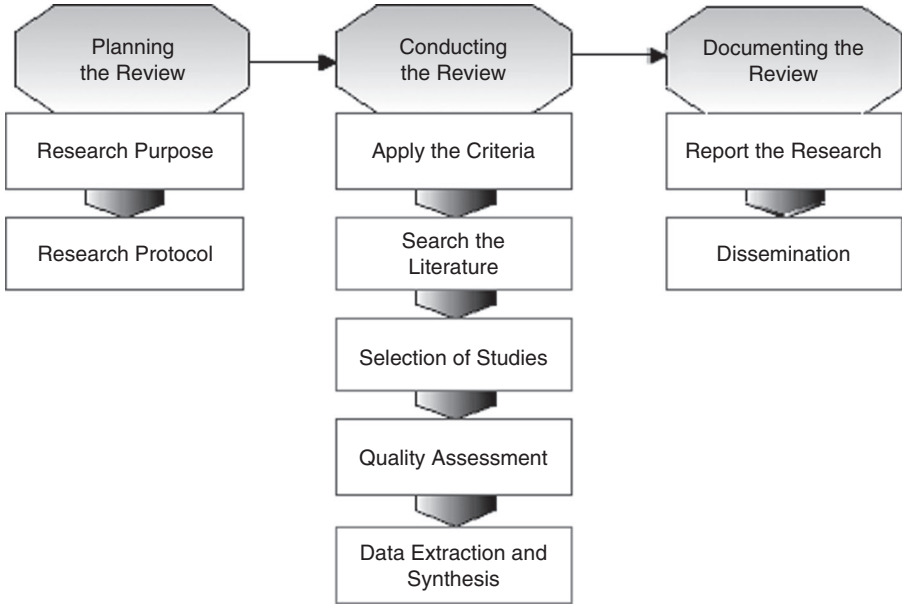

Figure 1.
Summary of research phases and processes

Sources: Okoli and Schabram (2010), Thomas *et al*. (2004), Tranfield *et al*. (2003)

Inclusion	Exclusion
Articles published between 1995 and 2013	Any publication before the year 1995
Search well-known databases, which are Emerald, Elsevier, ProQuest and Taylor & Francis	Non-academic databases
Papers based on quantitative or qualitative analysis, or a mix of the two methods	Papers based on weak analysis
Academic journals	Books, online sites and grey literature (conferences, reports, working papers from research groups, technical reports, etc.)

Table II.
Research criteria

2.3 Material and outcomes

The "journal" search for research literature was undertaken through four well-known academic databases: Emerald, Elsevier, ProQuest and Taylor & Francis. Search strings were used as follows: [(lean) or (six sigma) or (lean six sigma) AND (continuous improvement) AND (failure)]. Meanwhile, the literature search was limited to the English language only. This search of databases illustrated that no research articles related to LSS were to be found before 2003 and the first paper on LSS failure factors was published in 2009 by Thomas *et al.* The review resulted in 56 papers published on Lean, Six Sigma and LSS failure in different sectors: manufacturing, services, public, health care and higher education. These studies were conducted in various countries, including the USA, the UK, Brazil, Denmark, Australia and some Asian countries. The top five most common failure factors will be discussed in the discussion section as well as the common failure factors according to countries' evolution, organisations' size and

industries' nature. The data collected for analysis and the key findings of this paper are presented in table form to facilitate understanding.

3. Results

3.1 Growth of articles

The research showed that there are 11 papers on LSS failure, and that the first paper to discuss LSS failure was published in 2009 by Thomas *et al.* However, this number increased by four papers in both 2010 and 2012. Moreover, the search of databases for Lean failure factors resulted in 18 papers, while Six Sigma failure factors appeared in only 12 papers. Compared with other quality improvement methodologies, this number of articles is quite low.

The comparatively low volume of articles indicates that there is a crucial need for more research into the CFFs of LSS, especially as LSS implementation is rapidly growing in popularity in this area, evidenced by leading corporations citing LSS as a cornerstone philosophy for their business.

3.2 CFFs of LSS

Reviewing the papers resulted in 34 factors that lead to Lean and Six Sigma deployment failures (see Table III). Some of these factors were cited by a significant number of authors. On the other hand, other factors were cited by only one author.

4. Discussion

4.1 Most common critical failure factors

There is a noticeable increase in the popularity of LSS and the level of LSS deployment in the industrial world, especially in large organisations in western countries such as the USA and the UK and in some SMEs in developing countries such as India. This section of the research aims to shed the light on the top five CFFs of LSS deployment. These factors are as follows:

(1) Lack of top management attitude, commitment and involvement has been identified as the most CFF of LSS in this paper as it appeared in 20 of the papers found. This factor has been found to be a critical failure factor in all industries in different countries and different organisational sizes. Many authors, such as Ho *et al.* (2008), Kwak and Anbari (2006) and Snee (2010), have stated that without top management commitment and support, LSS projects easily fail. The role of top management is to ensure that all the required resources are available and that no obstacles occur during the project deployment (Martinez-Jurado and Moyano-Fuentes, 2012; Snee, 2010). Authors have argued that this factor is particularly critical to LSS success or failure as its appearance in a significant number of papers highlights its criticality.

(2) Lack of training and education has been cited as the second top factor of LSS failure. Many organisations see training as a waste of money and too costly. However, training should be viewed as a critical factor for the successful implementation of LSS and a procedure to reduce the LSS implementation time (Laureani and Antony, 2012; Snee, 2010), which can make savings for the company and reduce the labour cost (Bhasin, 2012a, b; Chakravorty, 2009).

(3) Poor LSS project selection and prioritisation: Su and Chou (2008) and Duarte *et al.* (2012) believed that selecting the wrong project can lead the entire LSS effort to fail. Therefore, selecting the right project is a critical factor for LSS

Factors	References
1. Lack of top management attitude, commitment and involvement	Aboelmaged (2011), Antony *et al.* (2007), Antony *et al.* (2012a), Arumugam *et al.* (2013), Bhasin (2012a,b), Burcher *et al.* (2010), Chakravorty (2009), Chiarini (2011), Ho *et al.* (2008), Jeyaraman and Teo (2010), Kumar *et al.* (2011), Kwak and Anbari (2006), Martinez-Jurado and Moyano-Fuentes (2012), Nwabueze (2012), Pedersen and Huniche (2011), Pepper and Spedding (2010), Pinto *et al.* (2008), Scherrer-Rathje *et al.* (2009), Snee (2010), Taner *et al.* (2007), Worley and Doolen (2006)
2. Lack of training and education	Antony (2008), Antony *et al.* (2005, 2007, 2012b), Bamber and Dale (2000), Bhasin (2012a, b), Chakravorty (2009), Gurumurthy and Kodali (2011), Hilton and Sohal (2012), Kwak and Anbari (2006), Martinez-Jurado and Moyano-Fuentes (2012), Panizzolo *et al.* (2012), Pedersen and Huniche (2011), Pinto *et al.* (2008), Serrano Lasa *et al.* (2009), Taner *et al.* (2007)
3. Poor project selection and prioritisation	Aboelmaged (2010, 2011), Antony *et al.* (2005, 2007, 2012a), Chakravorty (2009), Duarte *et al.* (2012), Kornfeld and Kara (2013), Kumar *et al.* (2007, 2008b), Nonthaleerak and Hendry (2008), Percin and Kahraman (2010), Snee (2010), Su and Chou (2008), Taner *et al.* (2007)
4. Lack of resources (financial, technical, human, etc.)	Aboelmaged (2011), Antony (2008), Antony and Desai (2009), Antony *et al.* (2005, 2012a), Bhasin (2012a, b), Kumar *et al.* (2009a, b), Pedersen and Huniche (2011), Pinto *et al.* (2008), Taner *et al.* (2007), Thomas *et al.* (2009)
5. Weak link between the CI projects and the strategic objectives of the organisation	Antony *et al.* (2012a), Bhasin and Burcher (2006), Chiarini (2011), Hines *et al.* (2006), Kornfeld and Kara (2013), Kumar *et al.* (2009a, b, 2011), Pedersen and Huniche (2011), Percin and Kahraman (2010), Psychogios *et al.* (2012)
6. Resistance of culture change	Antony *et al.* (2012a), Bhasin (2011), Bhasin (2012a,b), Bhasin and Burcher (2006), Black and Revere (2006), Burcher *et al.* (2010), Chiarini (2011), Harrison and Storey (1996), Kwak and Anbari (2006)
7. Poor communication	Antony *et al.* (2007, 2012a, b), Bhasin (2012a, b), Chakravorty (2009), Hines *et al.* (2006), Pedersen and Huniche (2011), Scherrer-Rathje *et al.* (2009), Worley and Doolen (2006)
8. Lack of leadership skills and visionary and supportive leadership	Antony *et al.* (2005, 2007, 2012a), Burcher *et al.* (2010), Chiarini (2011), Hilton and Sohal (2012), Kumar *et al.* (2011), McAdam and Lafferty (2004), Suresh *et al.* (2012)
9. Lack of consideration of the human factors	Bhasin and Burcher (2006), Burcher *et al.* (2010), Chakravorty (2009), Martinez-Jurado and Moyano-Fuentes (2012), Psychogios *et al.* (2012), Ringen and Holtskog (2011)
10. Lack of awareness of the benefits of Lean/Six Sigma	Antony *et al.* (2012a), Martinez-Jurado and Moyano-Fuentes (2012), Panizzolo *et al.* (2012), Psychogios *et al.* (2012), Scherrer-Rathje *et al.* (2009)
11. Wrong selection of Lean/Six Sigma tools	Al Amin and Karim (2013), Antony (2006), Antony *et al.* (2005), Karim and Arif-Uz-Zaman (2013), Nonthaleerak and Hendry (2008), Nwabueze (2012)
12. Narrow view of LSS as a set of tools, techniques and practices	Aboelmaged (2011), Antony *et al.* (2012a), Bhasin (2012a,b), Hilton and Sohal (2012)
13. Lack of understanding of the different types of customers/VOC	Antony and Fergusson (2004), Antony *et al.* (2012a), Burcher *et al.* (2010), Hines *et al.* (2006), Nabhani and Shokri (2009)

Table III.
Critical failure factors of LSS deployment

(*continued*)

Factors	References
14. Lack of employee engagement and participation/lack of team autonomy	Burcher *et al.* (2010), Jeyaraman and Teo (2010), McAdam and Lafferty (2004), Scherrer-Rathje *et al.* (2009)
15. Lack of process thinking and process ownership	Aboelmaged (2011), Antony *et al.* (2012a), Bhasin (2012a, b), Hilton and Sohal (2012)
16. Poor organisation capabilities	Chakravorty (2009), Kumar *et al.* (2009b), Shah *et al.* (2008), Zhang *et al.* (2012)
17. High implementation cost	Bhasin (2012a, b), Chakravorty (2009), Panizzolo *et al.* (2012), Percin and Kahraman (2010)
18. Lack of experience in Lean/ Six Sigma project implementation	Gurumurthy and Kodali (2011), Jeyaraman and Teo (2010), Panizzolo *et al.* (2012), Pedersen and Huniche (2011)
19. Lack of awareness of the need for Lean/Six Sigma	Antony *et al.* (2012a, b), Gurumurthy and Kodali (2011), Pamfilie *et al.* (2012), Psychogios *et al.* (2012)
20. Ineffective project management	Jeyaraman and Teo (2010), Kwak and Anbari (2006), McAdam and Lafferty (2004)
21. Poor selection of candidates for belts training	Hilton and Sohal (2012), Kumar *et al.* (2009b), Snee (2010)
22. Lack of clear vision and a future plan	Bhasin (2012a, b), Jeyaraman and Teo (2010), Kwak and Anbari (2006)
23. Lack of an effective model or roadmap to guide the implementation	Chakravorty (2009), Kumar *et al.* (2011), Pepper and Spedding (2010)
24. Poor execution	Chakravorty (2009), Nwabueze (2012), Pinto *et al.* (2008)
25. Threat of redundancy	Bamber and Dale (2000), Gurumurthy and Kodali (2011), Martinez-Jurado and Moyano-Fuentes (2012)
26. Time consuming	Panizzolo *et al.* (2012), Percin and Kahraman (2010)
27. Lack of estimation of implementation cost	Aboelmaged (2011), Kumar *et al.* (2008b)
28. Weak infrastructure	Arumugam *et al.* (2013), Snee (2010)
29. Replicating another organisation's Lean/Six Sigma strategy	Al Amin and Karim (2013), Antony *et al.* (2012a), Bhasin (2012a, b)
30. Lack of a performance measurement system	Karim and Arif-Uz-Zaman (2013), Kumar *et al.* (2007)
31. Lack of understanding of how to get started	Kumar *et al.* (2009a, 2011)
32. Lack of application of statistical theory	Thomas *et al.* (2009)
33. Weak linking to suppliers	Bamber and Dale (2000)
34. Misalignment between the project aim, the main goals of the company and the customer demand	Ho *et al.* (2008)

Table III.

success (Antony, 2006; Laureani and Antony, 2012; Pepper and Spedding, 2010; Snee, 2010) and it is a guarantee of the best return for organisations. Leaders should take into account the different types of projects and choose the right people and the right tools for the project. The most appropriate project is the one with the most potential benefits for the bottom line (Antony *et al.*, 2012a; Snee, 2010).

(4) A weak link between the CI projects and the strategic objectives of the organisation has been allocated the fourth place in this paper. Antony *et al.* (2012a) argued that it is important to select projects that align with the organisation's strategic goals.

(5) Lack of resources, such as technical, human and financial resources, is one of the major problems that most organisations in different countries (Aboelmaged, 2011; Pinto *et al.*, 2008) and different sectors are facing (Antony and Desai, 2009).

4.2 Countries' evolution

(1) Developing countries: a survey on Six Sigma barriers in developing countries conducted by Aboelmaged (2011) in the United Arab Emirates, including the manufacturing and service sectors, showed that the most common failure factors were related to a lack of knowledge about Six Sigma and a lack of selection and prioritisation of Six Sigma projects. Likewise, the second factor was related to a lack of resources, such as financial and managerial resources. Moreover, there were some issues related to a lack of management support and others related to culture and resistance to change.

Moreover, a case study performed in Thailand by Nonthaleerak and Hendry (2008) showed that Six Sigma deployment fails as a result of issues related to implementation processes, such as a lack of project selection criteria, lack of knowledge on the selection of tools and lack of improvement sustainability. Furthermore, internal resistance and a lack of resources were identified as the most common failure factors in the Indian manufacturing sector (Antony and Desai, 2009). In Singapore, the major problem was the sustainability of Six Sigma projects, which was considered to be a complex process. Companies are forced to hire part-time employees due to the lack of resources, which makes sustainability much more difficult to achieve (Chakrabarty and Chuan, 2009).

(2) Developed countries: the key failure factor for the quality improvement initiative in developed countries is a lack of resources. This factor has appeared in Australia, the UK (Burcher *et al.*, 2010), Brazil (Pinto *et al.*, 2008) and the Danish public sector (Pedersen and Huniche, 2011). However, a lack of resources, such as technical, human and financial resources, leads LSS projects to fail. The second failure factor is the lack of management support and experience and the lack of training (Burcher *et al.*, 2010; Pedersen and Huniche, 2011; Pinto *et al.*, 2008).

4.3 Industries' nature

(1) Services: data collection and data analysis are the most common failure factors in the service sector, as pointed out by Antony (2004), Antony *et al.* (2007) and Chakrabarty and Chuan (2009). Data collection is a significant problem facing service organisations, as data are not always ready for analysis, leading to more time, extra costs and a large amount of effort (Chakrabarty and Chuan, 2009). Antony (2004) and Antony *et al.* (2007) argued that there are two problems in the service sector: managerial problems, such as resistance to change and a weak quality improvement strategy, and technical problems, such as a lack of data and data analysis. Psychogios *et al.* (2012) stated that a lack of awareness is a big challenge for quality improvement programmes, e.g. a lack of awareness of the benefits of and the need for quality improvement

programmes, lack of strategic plans and goals and some issues related to workers' attitude and habits. In addition, the lack of knowledge about customers' needs, changes in customers' needs and expectations and the fast growth of customers' expectations constitutes a major challenge for the software industry (Antony and Fergusson, 2004). Authors have argued that it is important to link the improvement project to customers, ensure that the organisation can truly understand the voice of the customers and make sure that there are plans and strategies to meet customers' requirements.

(2) Health care: many problems lead quality programmes to fail in the health-care sector and have been cited in this research by a significant number of authors. Resistance to culture change is one of the serious problems facing health-care organisations (Bhasin, 2012a, b). The organisational culture determines which methodology is most appropriate for an organisation. Bhasin (2012a, b) argued that most CI projects fail due to a lack of change in culture. Hence, organisations should change their culture completely to guarantee successful LSS deployment. Nonetheless, large investments in training represent another problem for quality improvement programmes in health care (Antony *et al.*, 2007; Taner *et al.*, 2007) as well as a lack of management support, poor statistical competence and some issues related to project selection. Antony *et al.* (2007) believed that a lack of communication is one of the major problems facing health-care organisations and leading to failure. Antony *et al.* (2007) suggested establishing clear and effective channels for communication at all organisational levels to ensure the engagement of all the team members in the improvement projects. These communication channels will help health-care organisations to solve problems related to the lack of communication. However, there are also problems related to data and data analysis. Although a great deal of data could be available in the health-care sector, the majority of these data are not ready for analysis, which mean poor analysis of data, wasted time and high costs. Moreover, it is difficult to measure patients' satisfaction due to the busy and noisy environment in hospitals (Antony *et al.*, 2007).

(3) Higher education: first of all, authors have argued that there is a shortage of publications on quality improvement in higher education. The search of four databases resulted in one paper that met the research criteria. This paper was published in 2012 by Antony *et al.* More research is needed to address the current gaps in the literature. Antony *et al.* (2012a) pointed out many challenges in the higher education sector. One of the challenges is replicating another organisation's quality improvement strategy, e.g. some terminologies appeared in the higher education sector but were originally taken from the manufacturing industry. This problem relates not only to terminology, but also to tools and techniques, which were taken from the manufacturing and service sectors as well. Furthermore, as in any other industry, the lack of awareness about the benefits of deploying quality improvement programmes has been cited as a barrier to successful deployment and leads managers to set unclear strategies for the new improvement. Other challenges are related to the culture and the resistance to culture change. It is not easy to change the culture in any organisation as it takes years to do so. Changing the culture of an organisation means changing workers' habits, attitude and mentality to build a culture of confidence and trust. Last but not least, there are challenges

related to customers and the complexity of understanding customers' voices and different types of customers.

(4) Manufacturing: the analysis of papers published on Lean and Six Sigma failure factors in the manufacturing sector has resulted in some common factors, such as the unavailability of data. Poor data for analysis is one of the barriers to LSS project success in the manufacturing sector as well (Ho *et al.*, 2008). Another problem is the lack of alignment of the project aim with the organisation's strategy and customers' requirements (Ho *et al.*, 2008). Moreover, many companies have failed due to a lack of knowledge in selecting an appropriate strategy, which leads to wasted money and time (managers' time, workers' time and production time) (Al Amin and Karim, 2013). Many case studies have pointed out the replication of another organisation's strategies as a failure factor for Lean/Six Sigma projects. In fact, not all organisations are the same, even if they are located in the same sector or manufacture the same products (Al Amin and Karim, 2013).

Nonetheless, changing the organisational culture and making CI a way of life have not been accomplished in many manufacturing organisations. Changing the employee and management attitude towards work is not that easy, especially in traditional manufacturing (Bamber and Dale, 2000).

A lack of understanding greatly affects organisations in the manufacturing sector, e.g. the lack of top management understanding of how to implement quality improvement initiatives and the lack of understanding about the adoption of Lean/Six Sigma tools and techniques in a specific environment (Gurumurthy and Kodali, 2011; Karim and Arif-Uz-Zaman, 2013). As well as the lack of understanding of how to start and what should be carried out first (Nwabueze, 2012), there is a lack of understanding about the change that will happen after implementing a quality improvement programme (Gurumurthy and Kodali, 2011).

There are some issues related to employees, such as poor education (Bamber and Dale, 2000; Gurumurthy and Kodali, 2011; Karim and Arif-Uz-Zaman, 2013) and poor knowledge about the concept of quality improvement programmes (Bamber and Dale, 2000).

Likewise, there are some issues related to top management, for instance a lack of investment in employee training and claiming that training is a waste of money and workers' time (Nwabueze, 2012; Worley and Doolen, 2006) as it takes employees away from their work for a period of time. Regarding the lack of senior managers' understanding and education (Bamber and Dale, 2000), according to Karim and Arif-Uz-Zaman (2013), many organisations have failed to obtain any benefits from Lean implementation due to the unclear understanding of managers of Lean performance and how to measure the performance.

The last factor is the lack of rewards and respect for employees' effort and their role in the successful deployment of the new programme (Worley and Doolen, 2006). Authors have argued that it is important to link LSS to the human resource reward system to reward LSS team members for their efforts and support during the implementation of successful LSS projects.

4.4 Organisations' size

(1) Large organisations: a survey conducted by Pinto *et al.* (2008) in 1,000 large organisations in Brazil showed that the most common reason for quality

improvement programmes' failure is a shortage of financial resources, especially for the large investment needed for training. Moreover, most organisations fail due to problems related to execution and this supports the view of Snee (2010) that CI initiatives fail due to poor deployment.

(2) SMEs: a lack or resources, such as financial resources and physical resources, has been cited as a key failure factor for LSS deployment in a large number of SMEs, as in large companies (Antony, 2008; Antony *et al.*, 2005; Kumar *et al.*, 2009a, b). Other factors that have also been cited as critical for LSS failure in SMEs are a lack of understanding of how to commence LSS deployment (Kumar *et al.*, 2009a, 2011) and poor organisational capability (Kumar *et al.*, 2009a, b; Zhang *et al.*, 2012). Therefore, managers should make sure that all the necessary resources are available before they start the deployment of any LSS project in their organisation (Kumar *et al.*, 2009a; Pepper and Spedding, 2010). In SMEs, there is no appearance of problems related to management support, as SMEs are more agile. Hence, management activities, such as support and commitment, are much easier than in large organisations. On the other hand, training and education are harder in SMEs than in large organisations (Antony, 2008).

Although many reasons behind the failure of Lean, Six Sigma and LSS in organisations have been discussed in this paper, Laureani and Antony (2012) argued that organisations can ensure success if they direct their effort and focus towards the critical success factors. The concept and the idea of identifying CSFs for managers was popularised by Rockart (1979) to determine the information that managers need. Rungasamy *et al.* (2002) defined CSFs as "those factors essential to the success of any program or technique, in the sense that, if objectives associated with the factors are not achieved, the application of the technique will perhaps fail catastrophically". In terms of LSS, this definition means that there are some factors that should be met during the implementation of LSS; otherwise, the implementation could easily fail.

Snee (2010) pointed out that improvement programmes fail due to poor deployment. However, taking LSS's eight key characteristics into account is very important for LSS success. These characteristics are "1- creates bottom line results; 2- active senior management leadership; 3- uses a disciplined approach (DMAIC); 4- rapid project completion (three–six months); 5- clear definition of success; 6- infrastructure created (MBB, BB, GB); 7- focuses on customers and processes; and 8- sound statistical approach" (Snee, 2010).

In addition, authors have observed that there is a rich seam of publications in LSS benefits in different sectors. This is indeed true, but going to the opposite extreme, during this review there was lacking of studies reporting the failure of LSS implementation. There may be many reasons for this; businesses are presumably not keen to spend time and effort preparing studies for publication that only demonstrate failure, or it may be bias in selection of articles for publication by the various journals who only want to report successes. Authors argue that in some cases, companies do not willing to show their failures as showing failures could affect their reputation in the market so they could lose their costumers and decrease market share. The fact remains that this is a significant omission; publication of detailed analysis of failed implementations or projects would be of great benefit to those businesses contemplating LSS implementation in the future.

4.5 Future research

Authors believe that future research is needed to assess the criticality of some factors that appeared in a small number of cases explored in this research. These factors include weak linking of the LSS strategy to suppliers (Bamber and Dale, 2000), the lack of understanding of how to start (Kumar *et al.*, 2009a), the lack of application of statistical theory (Thomas *et al.*, 2009) and so on. Future research is also needed to identify the critical failure factors for LSS deployment in relation to countries' evolution (devolved and developing countries), industry (public, service, health care, higher education and manufacturing) and organisations' size (SMEs and large organisations). Furthermore, there is a shortage of publications on quality improvement, especially in the LSS area in higher education. Searching four databases resulted in one paper that met the research criteria, which was published in 2012 by Antony *et al.* Authors believe that organisations need a guide to the successful implementation of LSS in each sector, especially for organisations that want to start LSS from scratch. Finally, there is a significant need for a measurement system for LSS performance as most organisations' failure is due to the lack of a Lean/Six Sigma maturity model. More research is needed to address the current gaps in the literature.

5. Conclusion

Although LSS has been used in organisations as a quality improvement initiative for many years and many academics are interested in conducting research on LSS, there is a lack of academic research targeting LSS critical failure factors. Hence, the purpose of this research was to explore the factors that lead LSS projects to fail in different sectors, such as manufacturing, services, higher education, etc. The research undertook a systematic literature review of four well-known academic databases using inclusion and exclusion criteria. Searching the databases resulted in 65 academic papers on Lean, Six Sigma and LSS that met the research criteria. Analysing these papers resulted in 34 critical failure factors of LSS deployment in organisations. Organisations' CEOs and managers should pay attention to the critical success factors and should be aware of the most common failure factors that lead other organisations in the same industry to fail in their LSS projects. They also need to understand their organisation's readiness and capability before starting any LSS project. When organisations start the project, managers should support the LSS teams as their support and commitment is one of the top critical success factors for LSS projects. However, a lack of management support definitely leads the whole project to fail.

It is clear from the results in this paper that a lack of resources is a massive challenge for organisations, regardless of the evolution of the country or the size of the organisation. A shortage of financial resources is undoubtedly one of the main barriers to LSS success in a massive number of organisations.

Authors believe that LSS is still in its early stages, especially in higher education, and it will be one of the world-class quality improvement programmes in the coming years, particularly in western countries.

Moreover, the huge gap in the literature that needs to be addressed in future research has been discussed in this paper, e.g. to identify the CFFs of LSS deployment for countries at different stages of evolution (developed and developing), different industries (public, service, manufacturing, etc.) and different organisation sizes (SMEs and large organisations). Like any other study, this research has its limitations: one limitation could be that the number of databases searched was restricted to four. This

research could be more valuable if supported by a survey of a number of companies to determine more critical failure factors of LSS. The author will address these limitations in future research.

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