

Road towards Lean Six Sigma in Service Industry: A Multi-Factor Integrated Framework

Alexandros Psychogios, Loukas K Tsironis

| | |
|------------------|---|
| Journal: | <i>Business Process Management Journal</i> |
| Manuscript ID | BPMJ-08-2015-0118.R2 |
| Manuscript Type: | Original Article |
| Keywords: | Operations management, Business excellence, Lean Six Sigma, Critical success factors, Multiple Case-studies, Service Industry |
| | |

SCHOLARONE™
Manuscripts

Review

Road towards Lean Six Sigma in Service Industry:

A Multi-Factor Integrated Framework

Abstract

Purpose - This study adopted a multiple case-study approach, of three companies, in order to identify the factors affecting Lean Six Sigma (L6 σ) implementation in service industry.

Design/methodology/approach – Secondary data were collected through companies' documents, written procedures and quality assurance policies. Primary data were collected through a number of in-depth interviews with managers and quality experts.

Findings - The analysis of qualitative data gathered through in-depth interviews with managers in all three cases resulted in the emergence of variety of CSFs regarding L6 σ implementation in service industry. As it can be seen the great majority of the factors have been identified in all three cases. Moreover the analysis shows that there are two categories of factors emerged.

Originality/value – This study has four major contributions. Firstly, it provides an intergraded multifactor framework regarding the implementation of L6 σ in service industry. In particular, this study contributes with three more particular factors that influence the implementation of L6 σ in services, namely *top-management active involvement*, *HR support activities*, and *practices & systems*. Secondly, it focuses on the responses of managers, who play the critical role in the adoption of L6 σ . Thirdly,

1
2
3
4
5 supports and expands current literature on the key success factors of L6 σ application.
6
7 Finally, it provides future ideas to explore and develop more the suggested L6 σ
8
9 framework.
10

11
12
13
14 **Key words:** *Lean Six Sigma, Critical Success Factors, Systems Approach, Multiple*
15
16 *Case-studies, Service Industry*
17

18
19
20 **Article Classification:** Research paper
21

22 **Introduction**

23
24
25 It has been argued that traditional management tools cannot cope effectively with
26
27 current business complexities (Itkin, 2008; Chee, 2008). Therefore, a lot of companies
28
29 continuously attempt to develop and implement new management ideas (Saravanan,
30
31 2006; Chang, 2006). A question that emerges is what are the special conditions that
32
33 affect the adoption of such practices in different than manufacturing organisations and
34
35 industries. A prime example of such practices is *Lean Six Sigma* (L6 σ) which is a
36
37 synthesis of Six Sigma (6 σ) and Lean Management (LM). L6 σ targets to maximize
38
39 shareholder value by achieving fast improvements in customer satisfaction, quality cost,
40
41 and speed of the process (Sunhilde & Simona, 2007; Hill et al. 2011).
42
43
44

45
46 By implementing this methodology, companies could improve business
47
48 environment and therefore performance. It is an approach that is focused on quality and
49
50 continuous improvement, based on the participation of all employees (Lubowe & Blitz,
51
52 2008). L6 σ has been applied in manufacturing industry and in some cases in services
53
54 and get good results, increasing efficiency of procedures and improving product quality
55
56 (Bowen & Youngdahl, 1998; Engelund et al. 2009).
57
58
59
60

1
2
3
4
5 L6 σ can be considered as another evolution of management tools in order to
6
7 face increased competition and market shifts (Caldwell, 2006a). However, the main
8
9 challenge for L6 σ are the special factors that influence its application in companies.
10
11 These factors seem to be related to both success and failure of quality management
12
13 systems (Moosa & Sajid, 2010). In other words, it has been widely argued that the
14
15 application of operations management techniques is not only based on technical factors,
16
17 but it is mainly associated with organisational-oriented factors like culture, climate,
18
19 working environment, policies and procedures (Hope & Mühlemman, 2001; Noronha,
20
21 2003; Ayoob, et al. 2003; Psychogios & Wilkinson, 2007).
22
23
24

25
26 Nevertheless, the emphasis on the exploration of the factors above seem to be
27
28 neglected from the current literature. In other words, there is a need to investigate the
29
30 factors that are critical for the success or failure of such an initiative. These factors are
31
32 known as critical success factors (CSFs) that are important in order to achieve effective
33
34 levels of quality management (Saraph et al. 1989), organizational goals (Hardaker &
35
36 Ward, 1987; Fishman, 1998; Hayes, 2000; Henderson & Evans, 2000), and
37
38 organizational performance (Guimaraes et al. 1996; Dwyer et al. 2000).
39
40

41
42 There are several studies that investigate CSFs of quality initiatives.
43
44 Traditionally the most of these studies concern total quality management (TQM)
45
46 programs (Yusof & Aspinwall, 1999), lean production (Achanga et al. 2006), and Six
47
48 Sigma (Antony & Banuelas, 2002). There are also some studies referring to L6 σ
49
50 (McManus, 2008; Ferguson, 2007; Lane 2008; Carreira, 2005; Arnheiter & Maleyeff,
51
52 2005), but it seems that main emphasis is on manufacturing industry. The service
53
54 industry, which traditionally is a more challenging organisational 'space', seems to be
55
56 neglected for the application of such concept (Psychogios et al. 2012). In this respect the
57
58
59
60

1
2
3
4
5 purpose of this paper is to explore and comprehend the CSFs related to the application
6
7 of L6 σ .
8

9
10 Moreover, since it is well documented that LM and 6 σ approaches are
11 complementary under a quality management philosophy tool (Antony et al. 2003;
12 Nāslud, 2008; Burgess, 2010; Vince, 2008; Shan et al. 2008) a more holistic approach
13 like this of systems science seems to be more capable of embedding philosophical and
14 cultural aspects of lean with the rigorous scientific approach of six sigma through a
15 unified hard / soft systems philosophy. In this respect, Pepper & Spedding (2010)
16 suggest that LM and 6 σ should be combined through the integrated management of
17 quality, a scientific approach and an ‘all-one-team’ approach “which optimises systems
18 as a whole and focuses on the right strategies in the correct places”. They conclude that
19 any such model should be: strategic and process focused; balanced between the two
20 philosophies to harness the recognised advantages of both; balanced between
21 complexity and sustainability; and structured around the type of problem experienced.
22 In similar vein, more recent scientific evidence revealed that while practitioner guides
23 prescribe brief implementation models they do not describe how they should be adapted
24 to particular organizational contexts (Orme et al. 2013). The existing approaches for
25 frameworking L6 σ methodology do not provide evidence towards soft systems thinking
26 (Orme et al. 2013). Therefore in this study is built on this argument, considering
27 systems approach as very useful one in understanding a complex process such as L6 σ .
28 In this respect, we argue that the factors influencing the application of L6 σ in service
29 industry cannot be seen and understood isolated to each other, but as a whole under the
30 formulation of a multifactor framework.
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55

56 The article is structured in six sections. The first section briefly introduces the
57 concept of L6 σ . The second section reviews the current literature related to L6 σ
58
59
60

1
2
3
4
5 application while the third one presents study's research rationale. The fourth section
6
7 explains the research methodology applied while the fifth one analyses the main
8
9 findings. Finally, the paper is completed with a concluding section.
10

11 12 13 **Lean Six Sigma**

14
15
16 As a synthesis of 6σ and LM, $L6\sigma$ incorporates principles and concepts from both of
17
18 them. 6σ suggests that there is a direct correlation between the defects appearing in
19
20 products and customer satisfaction. 6σ based its success on the use of statistical methods
21
22 for identifying defects and improving processes and at the same time responding to the
23
24 voices of customers (Sharma & Chetiya, 2009; Fazzari & Levitt, 2008). Also 6σ is a
25
26 methodology that improves business processes based on understanding, controlling
27
28 variation and reduces cost of poor quality (Bendell, 2006; De Mast, 2006; Kanji, 2008;
29
30 Harry, 1998; Chang-Tseh, 2007).
31
32

33
34 In addition, LM provides a set of standard solutions to common problems and
35
36 optimizes processes across the entire value chain, but lacks organizational structure,
37
38 analytical tools and quality control (De Koning et al. 2008). The most challenging
39
40 issues that organizations face are excess and waste of processes and their results. The
41
42 waste constitutes mainly of resources, time, manpower and capital. In today's business
43
44 environments companies need to reduce costs in order to offer cheaper and better
45
46 quality services. The reduction in costs can be achieved if the organization attacks
47
48 systematically on waste (Ferguson, 2007; Lane, 2008). According to LM rhetoric, the
49
50 improvement in quality can be achieved by the limitation of every aspect that does not
51
52 add value within the organization (Cooper, 2008).
53
54

55
56 Although 6σ and LM have different backgrounds, they have similar goals.
57
58 Nevertheless several of the businesses today have adopted one of the two approaches
59
60

1
2
3
4
5 they found that competitiveness can be improved up to a point (Carreira, 2005). Beyond
6
7 the positive results that can be achieved, Lean cannot bring a process under statistical
8
9 control, while 6σ alone cannot dramatically improve the speed of the production process
10
11 and reduce invested capital (Carreira, 2005). Therefore, a combination between the two
12
13 methods is required (Arnheiter & Maleyeff, 2005). The combination may result on the
14
15 reduction of process variation and elimination of waste (Furterer & Elshennawy, 2005;
16
17 Jing, 2009; Antony et al. 2003). In this respect, $L6\sigma$ concept emerged as a balanced
18
19 approach between the two concepts, attempting to create a synergy between their
20
21 functionalities (Arnheiter & Maleyeff, 2005; Ferguson, 2007) and create extra value to
22
23 organizations. $L6\sigma$ integrates 6σ and LM processes, where LM aims on cycle time and
24
25 waste elimination while 6σ seeks to eliminate defects and reduce variation (Lubowe &
26
27 Blitz, 2008).
28
29
30
31

32 The implementation of $L6\sigma$ in a company should not be considered as the sum
33
34 of many individual improvement projects, but complementing and simultaneous
35
36 implementing approaches of LM and 6σ . $L6\sigma$ organization is the one where $L6\sigma$
37
38 philosophy expanded in all business operations and units, establishes a culture and
39
40 environment of creativity and innovation (Lubowe & Blitz, 2008). In this respect, it is
41
42 critical to explore the special conditions that facilitate or/an inhibit $L6\sigma$ application.
43
44
45

46 **$L6\sigma$ Implementation Factors**

47
48

49 CSFs are those key aspects of activity that produce very satisfactory results critical for
50
51 an organization to achieve its goals (Bullen & Rockart, 1981). CSFs can be considered
52
53 as major starting points for the $L6\sigma$ implementation process. According to the literature,
54
55 CSFs seem to be the key aspects of accomplishing companies' visions to improve
56
57
58
59
60

1
2
3
4
5 customer satisfaction and delivery of quality outcomes. Thus, the purpose in this section
6
7 is to discuss the CSFs that affect the L6 σ implementation.
8

9
10 Exploring the literature we can distinguish several CSFs that influence L6 σ . In
11 particular, literature emphasizes on the integration of L6 σ with business strategy
12 (Lubowe & Blitz, 2008; Fornari & Maszle, 2004; Antony et al. 2007; Kamensky, 2008),
13 customer satisfaction (Antony et al. 2003; Antony et al. 2007; Andel, 2007; Lubowe &
14 Blitz, 2008), committed leadership (Laosirihongthong et al. 2006; Maleyeff, 2007;
15 Stuenkel & Faulkner, 2009; Carleysmith et al. 2009; Ladhar, 2007) and quality-driven
16 organizational culture (Furterer & Elshennawy, 2005; Maleyeff, 2007; Lubowe & Blitz,
17 2008; De Koning et al. 2006; De Koning et al. 2008; O'Rourke, 2005). At the same
18 time, L6 σ literature focuses on aspects like training (Anthony et al. 2003; Ladhar,
19 2007; Caldwell, 2006a; Antony et al. 2004; Delgado et al. 2010) and teamwork
20 (Neuhaus & Guarraia, 2007). Finally, it gives special attention to project management
21 issues (Antony et al. 2004; Laosirihongthong et al. 2006; Ladhar, 2007; Breyfogle,
22 2008), and the importance of technical systems (Kamensky, 2008). It is important
23 though to examine in more details the most important CSFs as indicated in many
24 studies.
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42

43 One of the most critical factors widely investigated is leadership. In the
44 methodology of 6 σ , leadership holds a decisive role for its success (Antony &
45 Fergusson, 2004; Laosirihongthong et al. 2006; Carleysmith et al 2009). Also, the
46 effectiveness of LM needs to be supported by strong leadership that binds workers to
47 form multifunctional and self-working groups, which can apply the tools and techniques
48 of eliminating waste (Al-Najem et al. 2012). The emergence of leaders' role is included
49 as key evidence in various early studies of L6 σ (Antony et al. 2003; Lubowe & Blitz,
50 2008) as well. Many authors (Shah et al. 2008; Marhevko, 2008; Byrne et al. 2007;
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 Kumar et al. 2006; Johnson, 2006; Caldwell, 2006b; Furterer & Elshennawy, 2005;
6
7 Thompsen, 2005) agree that L6 σ is a methodology that demands dynamic decisions,
8
9 total participation of all employees, total confidence in the process towards the target
10
11 and loyalty to the process. In this respect, active leadership is critical since it is the one
12
13 that does not hesitate to take the subversive decisions and inspire the employees in order
14
15 to be more efficient, consistent, committed, and satisfied, in order to meet the principles
16
17 of L6 σ (Antony et al. 2003; Lubowe & Blitz, 2008). Byrne et al. (2007) argue that
18
19 leaders must be driven by a vision based on market demands and in their own abilities.
20
21 They also add the fact that leadership should aim to a constant innovation and to be
22
23 committed to operational change that leads to success. According to other authors,
24
25 leadership helps in changing the attitude of the personnel, empowerment readiness, and
26
27 improvement of production processes and in business efficiency but also, focus on
28
29 customers in order to achieve innovation and economic performance (Byrne et al. 2007,
30
31 Thompsen 2005).
32
33
34
35

36
37 Beyond leadership, organisational culture is another critical factor that impacts
38
39 the application of L6 σ . It is perhaps the most difficult component needed to be changed
40
41 in a company which wants to integrate successfully L6 σ (Tata & Prasad, 1998; Hope &
42
43 Muhlemann, 2001; Noronha, 2003; Ayoob et al. 2003). This is the reason why various
44
45 authors have emphasized that aspect for the application of quality management
46
47 initiatives (Psychogios & Wilkinson, 2007). The cultural obstacle is mainly related to
48
49 employee resistance who fear any change and future variations in their day-to-day
50
51 practices.
52
53

54
55 L6 σ literature has recorded specific causes of L6 σ -oriented change failure. Three
56
57 potential pitfalls may prevent proper culture change, the misinterpretation of
58
59 standardization, the devaluation of the role of diversity and how to use the released
60

1
2
3
4
5 capacity (Johnstone et al. 2011). For Johnstone et al. (2011), the failure of recognition
6
7 of the importance of unwritten rules and tacit assumptions, which characterize their way
8
9 of acting and performing, is one of the main factors for the failure of culture change that
10
11 L6 σ requires. Byrne et al. (2007), suggest that specific cultures can inhibit L6 σ
12
13 application due to the lack of the appropriate procedures, appropriate discipline and
14
15 entrepreneurial philosophy, that encourages significant innovations on an ongoing basis.
16
17 According to Hilton & Sohal (2012) the types of culture which have a positive effect on
18
19 L6 σ are: group culture (participation, teamwork, facility leaders, people and
20
21 obligations), development culture (creativity, flexibility, entrepreneurial leaders,
22
23 innovation and new resources) and rational culture (efficiency, focus on target
24
25 achievements leaders, orientation to the objectives and competition).
26
27
28

29
30 Another vital factor for L6 σ initiative is innovation. Innovation is the use of
31
32 knowledge in producing and delivering new products or services that consumers require
33
34 (Hoerl & Gardner, 2010). However, a question raised from researchers is whether the
35
36 L6 σ helps or restricts the innovation philosophy and *vice versa* (Johnstone et al. 2011;
37
38 Polk, 2011; Carleysmith et al. 2009; Scheeres, 2009; Fowler, 2008; Lubowe & Blitz,
39
40 2008; García-Porres et al. 2008; Byrne et al. 2007). L6 σ grows through formal
41
42 procedures, roles and ways of thinking limits the freedom for creativity and
43
44 consequently the possibility to express some form of innovation. At the same time, an
45
46 innovation culture may be proved antithetical on the application of strict procedures and
47
48 tools that L6 σ requires. However, there are research evidence supporting that L6 σ
49
50 creates a beneficial environment in terms of creativity and innovation (Carleysmith et
51
52 al. 2009; Johnstone et al. 2011; De Koning, 2008; Fowler, 2008). Other authors (Byrne
53
54 et al. 2007; Lubowe & Blitz, 2008; García-Porres et al. 2008; Polk, 2011; Scheeres,
55
56 2009), investigated and analysed the ways that L6 σ organisations can achieve
57
58
59
60

1
2
3
4
5 innovation and excellent financial performance. Their findings suggest that L6σ
6
7 organisations succeeded to have an integrated culture of innovation according to four
8
9 attributes they developed: a) the innovative vision that is based on customer insights, b)
10
11 a group of leaders who are committed to continuous innovation, c) the alignment across
12
13 the entire range of business and d) organizational skills that have made innovation an
14
15 everyday routine.
16
17

18
19 In conclusion, there are both institutional and contextual factors. Also, these
20
21 factors could be categorized into generic that applied in all types of organizations and
22
23 sectors, as well as in organisational-specific (corporate culture, national mentality and
24
25 working habits, particular PMS, quality system) and in industry-specific (services or
26
27 manufacturing) (Psychogios et al. 2012). However, the major issue with the majority of
28
29 the above studies is that they mainly developed in manufacturing. However, L6σ
30
31 methodology is not a standardized procedure so it can be used in various sectors and
32
33 various industries (Pande et al. 2000; Cross, 2007; Dreachslin, 2007). Nevertheless, it
34
35 seems that service industry is still neglected from the research agenda of many scholars.
36
37 This industry set a clear challenge for every quality initiative.
38
39
40

41 42 **L6σ application in Service Industry**

43
44
45 Recent literature shown that there is an increased interest is implementing L6σ in the
46
47 service industry (Naslund, 2008; Byrne et al. 2007; Brett & Queen, 2005). However,
48
49 there is a limited number of studies that attempt to identify the critical success factors
50
51 that affect L6σ in services (Psychogios et al. 2012; Psychogios & Tsironis, 2012).
52

53
54 For example, Vavra (2007) argues that L6σ can be successful in services when it
55
56 lasts for a long time, which also depends on the level of its maturity. According to
57
58 Hilton & Sohal (2012), a successful L6σ project in service organisations deploys in five
59
60

1
2
3
4
5 stages, the launch, the early success, the scale replication, the institutionalization and the
6
7 culture transformation. Another way of evaluating L6 σ success in services is related to
8
9 four parameters, like total quality, process efficiency, responsiveness and cost (De
10
11 Koning et al. 2008, Shah et al. 2008). In similar vein, the successful implementation of
12
13 L6 σ in services depends on the level of competences and roles of the individuals that
14
15 run L6 σ project (i.e. black belts) (Mehta, 2007, Hilton & Sohal 2012).
16
17

18
19 On the other hand, what seems to lack from service organisations is a systematic
20
21 approach of business change and improvement (Naslund, 2008). These companies fail
22
23 to properly implement L6 σ either due to the lack of appropriate leadership, or to the
24
25 incorrect selection of candidates for leadership positions that can take an inactive role
26
27 and involvement (Brett & Queen, 2005). Moreover, successful implementation of L6 σ
28
29 in services requires its integration with continuous improvement philosophy (Pojasek,
30
31 2003), which means that a shallow confrontation with the project cannot result in its
32
33 success (Malik & Blumenfeld, 2012).
34
35

36
37 Gibbons (2006) emphasizes on improvement of the overall equipment
38
39 effectiveness using L6 σ . Mazzola et al. (2007) focuses on the ways in which Lean and
40
41 6 σ can drive process improvement actions. Pojasek (2003) examines the initiatives that
42
43 need to be taken for a successful L6 σ implementation. Pusporini et al. (2012) explain
44
45 how the use of L6 σ achieves maximum competitiveness of new service delivery. Vavra
46
47 (2007) & Naslund (2008) indicate that the proper implementation of L6 σ increases
48
49 operational readiness for change. In similar vein, Leduc et al. (2010) involved the
50
51 operational learning as a factor that can lead to business change and thus the
52
53 achievement of objectives of L6 σ . Arumugam et al. (2012) pointed out that the
54
55 observation function as a tool with a very important contribution to the success of L6 σ
56
57 projects.
58
59
60

1
2
3
4
5 Kondić & Maglić (2008) argues that the most critical factor for the success of
6
7 L6 σ in services is customer satisfaction. Manville et al. (2012) rank as the most
8
9 important CSFs the enthusiasm, the support and commitment of senior management, the
10
11 connection of L6 σ to business strategy, its connection with the client, understanding the
12
13 techniques and tools, the selection and the priority programs, and finally, training and
14
15 education. Timans et al. (2012) agree with the above criteria, but go further by adding
16
17 the personal experience of the upper management team members with L6 σ projects, the
18
19 development of leadership skills. They also emphasize some factors that prevent the
20
21 success such as the internal resistance, the unavailability of resources, changing
22
23 business objectives and lack of leadership.
24
25
26

27
28 An important conclusion from the above literature is that there is a generic
29
30 agreement that the success of every L6 σ initiative depends on specific CSFs in service
31
32 industry as it is depicted in figure 1. The great majority of scholars agree that there is a
33
34 group of factors while others focuses on single ones. Also, CSFs of L6 σ application in
35
36 service industry could be classified in facilitators or inhibitors. The former influence
37
38 positively the process while the latter are considered as barriers to L6 σ successful
39
40 implementation (Psychogios & Tsironis, 2012; Psychogios et al. 2012). Moreover, all of
41
42 the studies above recognize the importance of the CSFs in L6 σ and some conclude that
43
44 these factors play a much more significant role in comparison to previous quality
45
46 initiatives like TQM and JIT (Naslund, 2008).
47
48

49
50 Insert here figure 1
51

52 **Rationale of the study**

53
54
55 Literature suggests that CSFs like leadership, strategic orientation, teamwork, technical
56
57 approaches (metrics-systems), and training affect L6 σ application in the service
58
59
60

1
2
3
4
5 industry. The previous list is complemented by the appropriate organizational culture
6
7 which emphasizes on quality improvement and customer satisfaction. However, the in-
8
9 depth exploration of the interrelationship of the CSFs seems to be neglected by the
10
11 literature. What is missing is a holistic framework which integrates and interrelates the
12
13 CSFs that can contribute to our understanding regarding the implementation of L6 σ .
14
15 Since the majority of the above factors have emerged mainly in studies conducted in
16
17 manufacturing industry, service industry seems to be a more complex and challenging
18
19 business field for L6 σ application. Therefore, it seems that L6 σ research needs to turn
20
21 their attention towards service organisations (De Koning et al. 2008; Su et al. 2006).
22
23

24
25 At the same time, the entire lean program and six sigma can be organized and
26
27 implemented within the basic structure of the Systems Approach (Pojasek, 2003). The
28
29 Systems Approach offers an ideal way to coordinate lean and six sigma. Neither lean
30
31 nor six sigma has a simplified means for determining continuous improvement and
32
33 tracking it. They may track costs, but not performance. By contrast, the Systems
34
35 Approach, L6 σ can cope effectively and efficiently with current business demands.
36
37 (Itkin, 2008; Chee, 2008; Pojasek, 2003). According to (Clegg & Orme, 2012) L6 σ is a
38
39 holistic soft systems methodology (SSM), which is the most suitable approach for
40
41 improving human activity systems, rather than hard systems thinking which is more
42
43 suitable for mechanistic or physical systems. However a clear concise model has not yet
44
45 been produced (Pepper & Spedding, 2010). Thus, the current challenge is to produce a
46
47 unified model of lean management and six sigma improvement that is systematic,
48
49 systemic and holistic which can be used to optimize systems as a whole (Clegg & Orme,
50
51 2012). The risk of not applying systems approach to L6 σ improvement initiatives is that
52
53 different levels (or pitches) of thinking (e.g. philosophy, methodology and tools) and
54
55
56
57
58
59
60

1
2
3
4
5 their potential overlap will go unrecognized; and thus their potential impact on
6 organizational performance will be reduced (Clegg & Orme, 2012).
7
8

9
10 In this respect, the present study attempts to expand our understanding regarding
11 the factors influencing the application of L6 σ in services by adopting a system view. In
12 particular, by analyzing research evidence gathered in three distinctive companies that
13 applied L6 σ , attempts to argue in favor of a multi-factor framework that can be critical
14 in its application.
15
16
17
18
19

20 21 **Research Methodology** 22

23
24 This study followed a multiple case-study approach as the most appropriate considering
25 the exploratory nature of the study (Voss et al. 2002; Nonthaleerak & Hendry, 2008;
26 Christy & Wood, 1999; Goodman, 1999). Qualitative research is particularly well-
27 suited to service industry investigations (Gilmore & Carson, 1996; Psychogios &
28 Priporas, 2007) and useful in case-driven research approaches (Ellram et al. 2004). This
29 is even more important when the phenomenon and the context under investigation are
30 not easily separated (Yin, 2003a, 2003b). A multiple case-study approach can also
31 provide more in-depth evidence in understanding complex relationships related to
32 operations and supply chain management (Ellram, 1996), which are associated with the
33 concept of L6 σ . Furthermore, through this research approach someone can identify
34 links between theory and method (Dubois & Araujo, 2007). In addition, an empirically
35 valid theory can be supported mainly by multiple case-studies (Eisenhardt & Graebner,
36 2007) that can explore and explain better social phenomena that cannot be identified
37 easily through other methods (Eisenhardt, 1989a 1989b). In a similar vein, Flyvbjerg
38 (2006) argues that through a case study approach we can explore things that cannot
39 easily identified with other methods. Also, an in-depth multiple case-study approach can
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 increase the ability of organisational actors to take better decisions and improve
6 performance (Rendtorff, 2015). Finally, through a multiple case-study approach
7 comparisons of events and data across cases can be developed (Voss et al. 2002;
8 Nonthaleerak & Hendry, 2008).
9

10
11
12
13
14 Furthermore, the qualitative approach it is more suitable for capturing complex
15 relationships (Delgado et al. 2010), for exploring the impact of different factors on
16 quality management tools, like L6 σ (Psychogios & Priporas, 2007). Finally, managers
17 are more likely to participate in a qualitative process of investigation (Coldwell, 2007).
18 Therefore, since the aim of the study was to explore an integrated framework of CSFs
19 that potentially affect the adoption of L6s in services, a qualitative approach was more
20 appropriate.
21
22
23
24
25
26
27
28

29
30 In particular, three companies operating in service industry have been identified
31 as critical cases where L6 σ has been applied. Company A (CA) operates in
32 telecommunication industry, Company B (CB) operates in airline industry and
33 Company C (CC) operates in Insurance industry. Primary data were collected by
34 conducting face-to-face in-depth interviews with managers that involved in the L6 σ
35 application process. The interview questionnaire was a semi-structured one with open-
36 ended questions. The semi-structured interview can provide explanations of why things
37 happened (Creswell, 2003). In addition, the open-ended questions allowed participants
38 to develop their own views (Denscombe, 2003) on issues related to inter-organisational
39 relationships and dependence between the L6 σ and other management practises used
40 by the companies. The interview guide employed covered a variety of different issues
41 such as key service performance aspects and how they are measured and dependencies
42 among operations and quality targets of the companies.
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 A purposive sampling approach was used in order to select the interviewees
6
7 (Patton, 1990). The sample within the cases was based on the position that respondents
8
9 held in the organization and their functional involvement in the implementation process.
10
11 Managers that involved in the L6 σ application process were selected from a variety of
12
13 business areas like administration, quality assurance, human resources, sales, marketing,
14
15 operations, and IT. Also, some of the managers interviewed were experts in 6 σ (Black
16
17 Belts and Green Belts). In total 47 interviews were conducted, 15 in Company A
18
19 (telecommunication) 18 in Company B (airline) and 14 in Company C (insurance).
20
21

22
23 Interviews conducted in an open manner guaranteeing that the participants
24
25 would freely respond the issues under investigation. All interviews conducted in English
26
27 language as the all of the participants are using English as their day-to-day working
28
29 language. The interviews began with questions developed to collect information
30
31 regarding interviewees' involvement in the process of L6 σ , in order to ensure that the
32
33 participants shared a sufficient understanding of the process under investigation. The
34
35 interviews recorded after permission taken and they transcribed shortly after occurred
36
37 attempting to increase reliability (Eisenhardt, 1989b).
38
39

40
41 Company's documentation related to quality programs, such as procedures and
42
43 quality management policies were used as secondary data. The analysis of the
44
45 secondary data contributed to the design of the interview questionnaire. Also, secondary
46
47 information helped to triangulate data and to increase overall validity (Marshall &
48
49 Rossman, 1999).
50

51
52 Within-case analysis was conducted manually, in parallel with data collection, to
53
54 understand the main types of L6 σ (inter)dependencies. Following the work of Miles &
55
56 Huberman (1994), the data were pulled together in a database and categorised in terms
57
58 of source type (interview transcripts and documents). The data was coded to facilitate
59
60

1
2
3
4
5 analysis, in accordance with practice (Krippendorff, 1980; Dubois & Gadde, 2002).
6
7 Open coding procedures were used (Strauss & Corbin, 1990). Through this method
8
9 emphasis was given in the identification of key-words related to the scope of the study.
10
11 These key-words and their interrelations were subsequently adjusted considering also
12
13 themes emerging from the data as well as additional theoretical insights from the L6σ
14
15 theory. Open codes were successively grouped into higher level categories using an
16
17 axial coding approach (Strauss & Corbin, 1990). Furthermore, searching for cross-case
18
19 patterns, the method followed was the construction of an array, in order to identify
20
21 similarities and differences per category case (Voss et al. 2002). Finally, key findings
22
23 were identified by using a pattern matching approach (Yin, 2003b) and then discussed
24
25 with reference to the existing L6σ literature.
26
27
28
29
30
31
32

33 Findings

34
35
36 The analysis of qualitative data gathered through in-depth interviews with managers in
37
38 all three cases resulted in the emergence of variety of CSFs regarding L6σ
39
40 implementation in service industry (Voss et al, 2002; Meredith, 1998). In particular, the
41
42 multiple case-studies deployed allowed comparison of events that provided more
43
44 generic conclusions (Nonhaleerak and Hendry, 2008). This approach also contributed
45
46 in the exploration of the impact of different contextual factors on operations
47
48 management tools and techniques (Delgado et al, 2010; Psychogios and Priporas, 2007;
49
50 Mangan, 1999). In addition, taking into consideration the nature of services, the analysis
51
52 of the qualitative data provided more robust results regarding the application of L6σ
53
54 (Gilmore and Carson, 1996).
55
56
57
58
59
60

1
2
3
4
5 Table 1 depicts in more detail the sources of the CSFs according to the case each
6
7 one emerged after the interviews with managers. As it can be seen the great majority of
8
9 the factors have been identified in all three cases. Moreover the analysis shows that
10
11 there are two categories of factors emerged.
12

13
14 Insert here table 1
15

16
17 It is important though to see in more details how these factors are supported with
18
19 evidence provided by the three cases investigated. *Top management involvement &*
20
21 *support* was identified as a factor that facilitates the process. This finding, presenting in
22
23 table 2, seems to be in line with findings from previous studies (Lubowe & Blitz, 2008;
24
25 Antony et al. 2003; Carleysmith et al. 2009).
26
27

28
29 Insert here table 2
30

31
32 Similarly, strong and committed leadership seems to be critical for L6 σ
33
34 implementation in service industry (see table 3). The leadership aspect can widely be
35
36 observed in all of interviewees' responses. Indicative of a committed leadership is the
37
38 fact that the majority of functions are coordinated by top executive officers in all cases
39
40 explored.
41
42

43
44 Insert here table 3
45

46
47 In addition, *Quality-driven organizational culture* (see table 4) seems to
48
49 facilitate the process of overcoming barriers for successful implementation, which is
50
51 aligned with the suggestion that quality management systems demand organizational
52
53 culture change (Furterer & Elshennawy, 2005; Maleyeff, 2007).
54

55
56 Insert here table 4
57
58
59
60

1
2
3
4
5 *Continues training* is also critical for L6 σ application, and especially this
6 training related to project management tools and development of soft skills (see table 5).
7
8 Previous studies seem to support similar arguments (Antony et al. 2003; Caldwell,
9 2006a; Ladhar, 2007).
10
11
12

13
14 Insert here table 5
15
16

17
18 Moreover, the emphasis on *teamwork in problem solving* (see table 6) and
19 collective decision-making process, seems to be substantial in L6 σ , at least for the two
20 out of the three cases explored. This again supports similar findings by Neuhaus &
21 Guarraia (2007).
22
23
24
25

26
27 Insert here table 6
28
29

30 *Direct link between L6 σ and customer satisfaction* (see table 7) is considered to
31 be the guiding principle for implementation of L6 σ . This is in line with literature
32 (Antony et al. 2003; Antony et al. 2007; Lubowe & Blitz; 2008). L6 σ projects need to
33 start with transfer of the Voice of the Customer (VoC) to the Voice of Processes (VoP)
34 and of course the synthesis between the VoC and the Voice of the Business (VoB)
35 (Psychogios, et al. 2012).
36
37
38
39
40
41
42

43
44 Insert here table 7
45
46

47 In addition, *strategic orientation of quality improvement initiatives* (see table 8)
48 has been proved as another important element of the successful application of L6 σ . The
49 interviewees' arguments show that a strong relation between the two facilitates the L6 σ
50 process, which seems to be also supported by the current literature (Lubowe & Blitz,
51 2008; Fornari & Maszle, 2004; Antony et al. 2007; Kamensky, 2008).
52
53
54
55
56
57

58
59 Insert here table 8
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Moreover, *supportive Technical systems* like appropriate *tools, techniques* as well as *supportive IT systems* (see table 9), have been considered as extremely substantial in the proper application of L6 σ , at least for the two industries investigated, namely telecommunication and airline. This finding seems to support similar findings by Kamensky (2008), that argues in favor of an appropriate infrastructure with technical approaches that can facilitate L6 σ .

Insert here table 9

Finally, *clear targets for L6 σ projects* (see table 10) is confirmed in the two out of three cases as important aspect of L6 σ implementation, which is also confirmed by the existing literature (Antony et al. 2004; Laosirihongthong et al. 2006; Ladhar, 2007; Breyfogle, 2008).

Insert here table 10

Nevertheless, this study identified two other factors that seem to be equally significant in L6 σ implementation. The first is referred to *prior implementation of other quality management initiatives*, (see table 11) such as ISO, EQA, etc. This provides the necessary experience for the employees regarding quality management. Also the documentation of all the processes, required by prior systems, such as ISO, seem to facilitate L6 σ . Therefore, it seems that this experience provides the appropriate knowledge and expertise for L6 σ application. It is interesting to mention that most of the interviewees suggested that it would have been better first to deploy L6 σ in the organization and then ISO standards, because in that case ISO standards implementation would have been more formal. In other words, prior deployment of quality management practices seems to facilitate L6 σ implementation.

Insert here table 11

1
2
3
4
5
6
7
8
9 Similarly, almost all interviewees from the two out of the three companies
10 agreed that *integration of L6 σ with the performance management system* (see table 12)
11 can facilitate the implementation process of the former. This integration motivates
12 managers and employees to increase the level of commitment and involvement. For
13 instance, a group of interviewees pointed out that the integration is necessary in order to
14 minimize subjective performance evaluation of individuals that leads to wrong results.
15
16
17
18
19
20
21

Insert here table 12

22
23
24
25 Several authors agreed that the management involvement and commitment are
26 important aspects in the service industry for L6 σ and any other quality practices
27 implementation (Abdullah et al., 2008; Worley & Doolen, 2006; Chakrabarty and Tan,
28 2007; Psychogios and Wilkinson, 2007; Cotte et al., 2008; Psychogios et al., 2009,
29 Appiotti and Bertels, 2010; Psychogios, 2010).
30
31
32
33
34
35
36

37 In sum, it can be argued that the factors briefly examined above can be
38 considered as major starting points for the L6 σ implementation process in service
39 industry. According to the literature, as well as the arguments and findings of this
40 study, these CSFs seem to be the key aspects of accomplishing service companies'
41 visions to improve customer satisfaction and delivery of quality outcomes. In
42 particular, these factors concentrate on both macro (overall organization change
43 towards continuous improvement), and micro (particular service quality
44 improvement and problem resolution on a project level) aspects of the
45 implementation process (Psychogios, et. al., 2012).
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Discussion and Conclusions

The present study addressed a series of CSFs for implementation of L6 σ in three service companies. Analysing current L6 σ literature and investigating the particular organizations, we can support the view that these factors can be seen as facilitators. Current research confirmed that the CSFs analysed in the previous section are not consist only a significant framework of L6 σ application, but also a good investigation tool in a potential application of such a system.

Moreover, an integrated framework can be emerged from the synthesis of these factors. Figure 2 presents the proposed L6 σ application framework for service organisations. This framework consists of three new components that are equally critical aspects that encompass the whole framework and concerns the totality of the L6 σ implementation is service organisation.

Insert here figure 2

The above multifactor framework needs three main aspects in order to be implemented successfully. In particular, every single continuous improvement paradigm requires strong leadership that is associated with commitment and support coming from the top of the organisation and applied accordingly to every single hierarchical level. Also, human resources (HR) support activities and practices & systems seem to be another two critical aspects. Every component consists of the CSFs revealed from the present study.

The *active involvement of top management* plays a significant role as a prerequisite for the implementation of L6 σ and can be considered as a major issue of the suggested framework. This involvement starts with the commitment of the management towards the need of applying such a concept for achieving competitive advantage. The

1
2
3
4
5 commitment occurs when managers have realized that it is imperative that the operation
6
7 of the business in an innovative way and that the chosen approach is one of the best
8
9 options. The sense of imperativeness depends on the current position in terms of the
10
11 customer requirements, stakeholder expectations, the strategic positioning, and the
12
13 economic performance.
14

15
16 It is also critical these factors to be framed by the additional *HR support*
17
18 *activities*. Clear definition of roles and responsibilities is needed. The implementation
19
20 of every improvement initiative requires the existence of a group that will lead the
21
22 effort. While all employees need to understand the vision of L6 σ and eventually to be
23
24 able to apply some of the techniques of the process to improve their work, managers
25
26 need lead this effort. The goal of the leading team is to support every effort and
27
28 individual. They are responsible of the proper training of the team members and other
29
30 workers and to empower the efficient collaboration among employees on specific
31
32 abilities and skills of decision making processes. Additionally, teams will have to set
33
34 clear goals, take responsibility, manage crises and to have effective partnerships with
35
36 other groups. The L6 σ needs teamwork, with many capabilities for effective
37
38 collaboration and problem solving (George et al. 2004).
39
40
41
42

43 Furthermore, this aspect is related to the resources based view (RBV) of the
44
45 organization. The role of the HR on the firm success has been documented as very
46
47 important (Newbert, 2007). Employees, regardless of their position in the hierarchy,
48
49 have certain skills. The reason that the right choice of the human resources is considered
50
51 vital for the successful implementation of business change is the fact that policy and
52
53 strategy of HRM is at the heart of organizational system. The management must realize
54
55 that need to use all the experience and skills of employees, along with specialized tools
56
57 and systems, aligning them with organizational vision, goals and business strategies
58
59
60

1
2
3
4
5 (Pekka-Economou & Lykogianni, 2005). The task of management is to strengthen the
6
7 core values and capabilities (core competences) of workers in order to achieve the
8
9 perfection of the organizational system (Dahlgaard & Dahlgaard-Park, 2006).
10
11 Employees, strategically placed in key positions, will contribute in this way greatly to
12
13 the successful transition to the new situation. Through cooperation and participation,
14
15 while providing continuous education and training, respectfulness of their efforts and
16
17 ultimately empowering them to make decisions that will make their work easier, but
18
19 also the objectives of management, provided all the guarantees for employee
20
21 satisfaction (Pekka -Economou & Lykogianni, 2005). Satisfying this in turn leads
22
23 employees to become a driving force for the company that is trying to change the
24
25 structures and to implement a new methodology.
26
27
28

29
30 The third aspect concerns *practices and systems*. It is a set of supporting actions,
31
32 tools and computerised systems. Practices and systems existence are essential for
33
34 assuring L6 σ promises. The correct selection and use of practices and systems is a vital
35
36 factor of any successful L6 σ implementation plan. This factor includes simple and
37
38 complex tools that can cover all functions of the project. Before any implementation the
39
40 availability of resources within the company, the usage and scope of each practice and
41
42 systems and project's characteristics should be considered carefully.
43
44

45
46 In a recent study a structural equation model (SEM) developed in order to
47
48 support this framework with more robust quantitative evidence gathered from a large
49
50 number of companies (Tsironis, 2014). Although this study is an ongoing one, the
51
52 model showed the relationships among factors which their existence is necessary for the
53
54 acceptance and survival of L6 σ initiatives. This framework can be seen as the
55
56 managerial basis for visualizing in every organization the meaning of L6 σ as
57
58 organizational change process.
59
60

1
2
3
4
5 Beyond the above arguments, the main limitation of the study is the fact that in
6
7 all three cases only managers and top-administrators were approached. Frontline
8
9 employees who are also directly involved in L6 σ approach, may offer a more clear view
10
11 on issues related to the impact of critical factors on L6 σ application. Therefore, it is
12
13 critical for future studies to investigate first-line employees that always play an equally
14
15 substantial role in the application of integrated quality management initiatives like L6 σ
16
17 (Psychogios et al. 2009).
18
19

20
21 Moreover, it would be critical for future research to clarify the CSFs identified
22
23 by this study. In other words, more combined methodologies need to be applied
24
25 targeting to widely explore the influence of the factors on L6 σ application as well as to
26
27 investigate in depth the hidden agenda of its implementation. Also, further research
28
29 should emphasise the exploration of the application of the above framework in other
30
31 than service industry. Furthermore, it is critical to understand that beyond the generic
32
33 factors, there are specific ones applied in specific contexts that need to be taken into
34
35 account. Finally, a critical point for a future research would be the quantification of each
36
37 one of the three components suggested. This would enhance a wider survey that could
38
39 provide rich evidence towards the support of such a model.
40
41
42

43 Beyond the above suggestions we can strongly argue that this study has four
44
45 major advantages. Firstly, it expands our understanding regarding the implementation of
46
47 L6 σ in three different service industries, in which the application of management
48
49 models is more complex and problematic. Secondly, it focuses on the responses of
50
51 managers, who always play the most significant role in the adoption of such techniques.
52
53 Thirdly, supports current literature on the key factors of L6 σ application. Finally, it
54
55 contributes to our understanding of L6 σ process in services, by proposing a multifactor
56
57 framework.
58
59
60

1
2
3
4
5 This framework of L6 σ application in service industry can be used in facilitating
6
7 two main issues: first, it can facilitate managers of service industries to understand the
8
9 aspects of L6 σ method in their organisations. Second, it can guide managers in
10
11 recognising the key factors that potentially will influence the effective implementation
12
13 and therefore the success of L6 σ in service organisations, where by default the
14
15 application of such practices is much more challenging in comparison to manufacturing.
16
17 Though the framework needs to be treated as a dynamic one rather than as a static and
18
19 future research can contribute in recognising the nature of the dynamic factors in service
20
21 industry.
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

References

- Andel, T. (2007). Lean & Six Sigma Traps to Avoid. *Material Handlin Management*, 62(3), pp. 23-28.
- Abdullah, M. M., Uli, J. & Tari, J. J. (2008). The influence of soft factors on quality improvement and performance: Perceptions from managers. *The TQM Journal*, 20(5), pp. 436-452.
- Achanga, P., Shehab, E., Roy, R., & Nelder, G. (2006). Critical success factors for lean implementation within SMEs. *Journal of Manufacturing Technology Management*, 17(4), pp. 460-471.
- Al-Najem, M., Dhakal, H., & Bennett (2012). The role of culture & leadership in lean transformation: a review & assessment model. *International Journal of Lean Thinking*, 3 (1). pp. 119-138.
- Antony J., & Banuelas R. (2002). Key Ingredients for the effective implementation of Six Sigma program. *Measuring Business Excellence*, 6(4), p.p. 20-27.
- Antony, J. & Fergusson, K. (2004). Six-Sigma in the software industry: Results from a pilot study. *Managerial Auditing Journal*, 19(8), pp. 1025–1030.
- Antony, J., Escamilla, J.L., & Caine, P. (2003). Lean Sigma. *Manufacturing Engineer*, 82(2), pp. 40-42.
- Antony, J., Foutris, F., Banuelas, R., & Thomas, A. (2004). Using Six Sigma. *Manufacturing Engineer*, 83(1), pp. 10-12.
- Antony, J., Kumar, M., & Cho, B.R. (2007). Six Sigma in Service Organizations: Benefits, challenges, difficulties, common myths & success factors. *International Journal of Quality & Reliability Management*, 24(2), pp. 294-311.
- Appiotti, M. & Bertels, T. (2010). Achieving competitive advantage through Lean thinking. *Journal of financial transformation*, 101-104.
- Arnheiter, E., & Maleyeff, J. (2005). The integration of lean management & Six Sigma. *The TQM Magazine*, 17(1), 5-18.
- Arumugam, V., Antony, J., & Douglas, A. (2012). Observation: a Lean tool for improving the effectiveness of Lean Six Sigma. *The TQM Journal*, 24(3), pp. 275 - 287.
- Ayoob, A., Deshmukh G. S., & Gupta D. A, (2003). Critical Success Factors of TQM. *Production Planning & Control*, 14(1), pp.3-14.

- 1
2
3
4
5 Bendell, T. (2006). A Review & Comparison of Six Sigma & the Lean Organisations.
6 *The TQM Magazine*, 18(3), p.255-262.
- 7
8 Bowen, D.E. & Youngdahl, W.E. (1998). Lean Service: In Defense of a Production-
9 Line Approach. *International Journal of Service Industry Management*, 9(3),
10 pp.207 – 225.
- 11
12 Brett, C., & Queen, P. (2005). Streamlining Enterprise Records Management with Lean
13 Six Sigma. *Information Management Journal*, 39(6), pp. 58-62.
- 14
15 Breyfogle III, F. (2008). Better Fostering Innovation: 9 Steps That Improve Lean Six
16 Sigma. *Business Performance Management*, 6(3), pp. 16-20.
- 17
18 Bullen, C.V., & Rockart, J.F. (1981). *A Primer on Critical Success Factors*. Center for
19 Information Systems Research Working Paper No. 69, 1981.
- 20
21 Burgess, D. (2010). Lean Six Sigma: Red hot relevance. *Quality*. 49(6), p. 42-45.
- 22
23 Byrne, G., Lubowe, D., & Blitz, A. (2007). Using a Lean Six Sigma approach to drive
24 innovation. *Strategy & Leadership*, 35(2), pp. 5-10.
- 25
26 Caldwell, C. (2006a). Lean-Six Sigma tools for rapid cycle cost reduction. *Healthcare*
27 *Financial Management*. 60(10), pp. 96-98.
- 28
29 Caldwell, C. (2006b). A high quality of care. *IEEE Engineering Management Review*,
30 34(1), pp. 15-21.
- 31
32 Carleysmith, S.W., Dufton, A.M., & Altria, K.D. (2009). Implementing Lean Sigma in
33 pharmaceutical research & development: a review by practitioners. *R&D*
34 *Management*. 39(1), pp. 95-106.
- 35
36 Carreira, B. (2005). *Lean Manufacturing that works*. New York, NY: Amacom.
- 37
38 Chakrabarty, A. & Tan, K. C. (2007). The current state of six sigma application in
39 services. *Managing Service Quality*, 17(2), 194-208.
- 40
41 Chang, H. (2006). An Empirical Evaluation of Performance Measurement Systems for
42 Total Quality Management. *Total Quality Management & Business Excellence*,
43 17(8), pp. 1093-1109.
- 44
45 Chang-Tseh, H. (2007). Information technology & Six Sigma implementation. *Journal*
46 *of Computer Information Systems*, 47(4), pp. 1-10.
- 47
48 Chee, C. S. (2008). Measuring success. *Enterprise Innovation*, 4(1), pp. 16-17.
- 49
50 Christy, R., & Wood, M. (1999). Researching Possibilities in Marketing. *Qualitative*
51 *Market Research: An International Journal*, 2(3), pp189-197.
- 52
53
54
55
56
57
58
59
60

- 1
2
3
4
5 Clegg, B., & Orme R. (2012). Systems of Systems: Pure, & Applied to Lean Six
6 Sigma. In A. V. Gheorghe (Ed.), *System of Systems* (p.p. 57-76). Rijeka: In-Tech.
7
8
9 Coldwell, D. A. L. (2007). Is Research that is Both Causally Adequate & Adequate on
10 the Level of Meaning Possible or Necessary in Business Research? A Critical
11 Analysis of some Methodological Alternatives. *Electronic Journal of Business*
12 *Research Methods*, 5(1), p.47-58.
13
14
15 Cooper, R. (2008). Maximizing productivity in product innovation. *Research*
16 *Technology Management*, 51(2), pp. 47-58.
17
18
19 Cotte, P., Farber, A., Merchant, A., Pararikas, P. & Sirkin, H. L. (2008). Getting more
20 from Lean. BCG Publication,
21 <<http://www.bcg.co.jp/documents/file15326.pdf>>[Retrieved October 22, 2015]
22
23
24 Creswell, J. W. (2003). *Educational research*. Thousand Oaks, CA: Sage.
25
26 Cross, C. (2007). Business in Special Forces. *Industrial Engineer*, 39(10), pp. 26-30.
27
28 Dahlgard, J. J., & Dahlgard-Park, S. M. (2006). Lean Production, Six Sigma Quality,
29 TQM & Company Culture. *The TQM Magazine*, 18(3), p.263-281.
30
31 De Koning, H., Does, R.J.M.M., & Bisgaard, S. (2008). Lean Six Sigma in financial
32 services. *International Journal of Six Sigma & Competitive Advantage*, 4(1), pp.
33 1-17.
34
35 De Koning, H., Verver, J.P.S., Heuvel, van den J., Bisgaard, S., & Does, R.J.M.M.
36 (2006) Lean six sigma in healthcare. *Journal of Healthcare Quality*, 28(2), pp. 4-
37 11.
38
39
40 De Mast, J. (2006). Six Sigma & Competitive Advantage. *Total Quality Management*,
41 17(4), p.455-464.
42
43
44 Delgado, C., Ferreira, M., & Branco, C.M. (2010). The implementation of lean Six
45 Sigma in financial services organizations. *Journal of Manufacturing Technology*
46 *Management*, 21(4), pp. 512–523.
47
48
49 Denscombe, M. (2003). *The Good Research Guide for Small-scale Social Research*
50 *Projects*. Maidenhead, UK: Open University Press.
51
52 Dreachslin, J. (2007). Applying Six Sigma & DMAIC to Diversity Initiatives. *Journal*
53 *of Healthcare Management*, 52(6), pp. 361-367.
54
55
56 Dubois, A. & Araujo, L. (2007). Case research in purchasing & supply management:
57 Opportunities & challenges. *Journal of Purchasing & Supply Management*, 13(3),
58 pp. 170-181.
59
60

- 1
2
3
4
5 Dubois, A., & Gadde, L. E. (2002). Systematic combining: An abductive approach to
6 case research. *Journal of Business Research*, 55(7), pp. 553-560.
7
8
9 Dwyer, S., Richard, O. C., & Chadwick, K. (2003). Gender diversity in management &
10 firm performance: The influence of growth orientation & organizational culture.
11 *Journal of Business Research*, 56, p.p. 1009-1019.
12
13 Eisenhardt, K. M. (1989a). Agency theory: An assessment & review. *Academy of*
14 *Management review*, 14(1), pp. 57-74.
15
16 Eisenhardt, K. M. (1989b). Building Theories from Case Study Research. *The Academy*
17 *of Management Review*, 14(4), pp. 532-550 .
18
19 Eisenhardt, M.K., & Graebner E.M. (2007). Theory building from cases: Opportunities
20 & challenges. *Academy of Management Journal*, 50, pp. 25-32.
21
22 Ellram, L.M. (1996). The use of case study method in logistics research. *Journal of*
23 *Business Logistics*, 17(2), pp. 93-138.
24
25 Ellram, L.M., Tate, W.L., & Billington, C. (2004). Understanding & managing the
26 services supply chain. *Journal of Supply Chain Management*, 40 No. 4, pp. 17-32.
27
28 Engelund, E.H., Breum, G., & Friis, A. (2009). Optimisation of large-scale food
29 production using lean manufacturing principles. *Journal of Foodservice*, 20(1),
30 pp.4-14.
31
32 Fazzari, A. J., & Levitt, K. (2008). Human Resources as a Strategic Partner: Sitting at
33 the Table with Six Sigma. *Human Resource Development Quarterly*, 19(2), p.171-
34 180.
35
36 Ferguson, D. (2007). Lean & six sigma: The same or different? *Management Services*,
37 51(3), 12-13.
38
39 Fishman, A. (1998). Critical success factors, key to attaining goals. *Inside Tuscon*
40 *Business*, 8(17), 10-12.
41
42 Flyvbjerg, B. (2006). "Five Misunderstandings About Case-Study Research. *Qualitative*
43 *Inquiry*, 12, pp. 219-245.
44
45 Fornari, A., & Maszle, G. (2004). Lean Six Sigma leads Xerox. Retrieved from:
46 [http://www.xerox.com/downloads/usa/en/n/nr_SixSigmaForumMag_2004_Aug.p](http://www.xerox.com/downloads/usa/en/n/nr_SixSigmaForumMag_2004_Aug.pdf)
47 [df](http://www.xerox.com/downloads/usa/en/n/nr_SixSigmaForumMag_2004_Aug.pdf).
48
49 Fowler, N.E. (2008). *Lessons learned through deploying an unconventional design for*
50 *lean six sigma deployment program*. 66th Annual Technical Conference of the
51 Society of Plastics Engineers, 3, pp. 1539-1543.
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5 Furterer, S., & Elshennawy, A. K. (2005). Implementation of TQM & Lean Six Sigma
6 Tools in Local Government: a Framework & a Case Study. *Total Quality*
7 *Management & Business Excellence*, 16(10), pp. 1179-1191.
8
9
10 García-Porres, J., Ortiz-Posadas, M.R., & Pimentel-Aguilar, A.B. (2008). *Lean Six*
11 *Sigma applied to a process innovation in a Mexican health Institute's Imaging*
12 *Department*. 30th Annual International Conference of the IEEE Engineering in
13 *Medicine & Biology Society*, pp. 5125-5128.
14
15
16 George, M., Rowlands, D., & Kastle, B. (2004). *What is Lean Six Sigma?* New York,
17 NY: McGraw-Hill.
18
19
20 Gibbons, P. (2006). Improving overall equipment efficiency using a lean Six Sigma
21 approach. *International Journal of Six Sigma & Competitive Advantage*, 2(2), pp.
22 207-32.
23
24
25 Gilmore, A., & Carson, D. (1996). Integrative qualitative methods in a services context.
26 *Marketing Intelligence & Planning*, 14(6), 21-26
27
28 Goodman, R. (1999). The Strengths & Difficulties Questionnaire: A research note.
29 *Journal of Child Psychology & Psychiatry*, 38(5), 581-586.
30
31
32 Guimaraes, T, Yoon Y., & Clevenson, A. (1996). Factors important to expert system
33 success: a field test. *Information & Management* 30(3), 119–130.
34
35
36 Hardaker, M., & Ward, B. K. (1987). How to make a team work. *Harvard Business*
37 *Review*, 65(6), 112 - 119.
38
39 Harry, M.J. (1998). Six sigma: a breakthrough strategy for profitability. *Quality*
40 *Progress*, 31(5), pp.60-4.
41
42 Hayes, B.J. (2000). Assessing for lean six sigma implementation & success. *Six Sigma*
43 *Advantage*, Retrieved from: <http://software.isixsigma.com>.
44
45
46 Henderson, K.M., & Evans, J.R. (2000). Successful implementation of Six Sigma:
47 benchmarking General Electric Company. *Benchmarking: An International*
48 *Journal*, 7(4), pp.260 – 282.
49
50
51 Hill, A.V., Weiyong, Z., & Gilbreath, H.G. (2011). Discipline your Lean Sigma
52 programs. *Industrial Engineer*, 46(6), p.48-52.
53
54
55 Hilton, R.J., & Sohal, A. (2012). A conceptual model for the successful deployment of
56 Lean Six Sigma. *International Journal of Quality & Reliability Management*,
57 29(1), pp. 54-70.
58
59
60

- 1
2
3
4
5 Hoerl, R.W., & Gardner, M.M. (2010). Lean Six Sigma, creativity, & innovation.
6 *International Journal of Lean Six Sigma*, 1(1), pp.30 - 38.
7
8 Hope, C., & Muhlemann, A. (2001). The Impact of Culture on Best Practice Production/
9 Operations Management. *International Journal of Management Reviews*, 3(3), pp.
10 199-217.
11
12 Itkin, D. (2008). The effect of business ownership change on occupational employment
13 & wages. *Monthly Labour Review*, 131(9), pp. 3-23.
14
15 Jing, G.G. (2009). A Lean Six Sigma BREAKTHROUGH. *Quality Progress*, 42(5), 24-
16 31.
17
18 Johnson, P. (2006). *Leadership for lean six sigma*. IIE/ASQ Lean and Quality
19 Conference and Expo 2006, pp. 26.
20
21 Johnstone, C., Pairaudeau, G., & Pettersson, J. (2011). Creativity, innovation & lean
22 sigma: a controversial combination? *Drug Discovery Today*, 16(1/2), pp. 50-57.
23
24 Kamensky, J. (2008). Is Lean Six Sigma Cool? *PA Times*, 31(4), p. 9.
25
26 Kanji, G. K. (2008) Reality check of Six Sigma for Business Excellence. *Total Quality*
27 *Management*, 19(6), p. 575-582.
28
29 Kondić, Ž., & Maglić, L. (2008). Improvements at quality management system using
30 methodology lean six sigma. *Tehnicki Vjesnik*, 15(2), pp. 41-47.
31
32 Krippendorff, K. (1980). *Content analysis. An introduction to its methodology*.
33 Newbury Park, CA: Sage.
34
35 Kumar, M., Antony, J., Singh, R. K., Tiwari, M. K., & Perry, D. (2006). Implementing
36 the Lean Sigma framework in an Indian SME: a case study. *Production Planning*
37 *& Control*, 17(4), pp. 407-423.
38
39 Ladhar, H. (2007). Effective Lean Six Sigma Deployment in a Global EMS
40 Environment. *Circuits Assembly*, 18(3), pp. 40-45.
41
42 Lane, G. (2008), Lean made your way. *Industrial Engineer*, 40(2), 34-38.
43
44 Laosirihongthong, T., Rahman, S., & Saykhun, K (2006). Critical Success Factors of
45 Six-Sigma Implementation: An Analytic Hierarchy Process based study.
46 *International Journal of Innovation & Technology Management*, 3(3), pp. 303-
47 319.
48
49 Leduc, A., Hadley, G., & Ratzlaff, M. (2010). *Immersive learning using Lean Six Sigma*
50 *methodology in the Manufacturing Engineering Technology capstone course*.
51 117th Annual ASEE Conference & Exposition, pp.18.
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5 Lubowe, D., & Blitz, A. (2008). Driving Operational Innovation Using Lean Six Sigma.
6 *Business Performance Management*, 6(3), pp. 10-15.
- 7
8 Maleyeff, J. (2007). *Improving Service Delivery in Government with Lean Six Sigma*.
9 IBM Center for The Business of Government.
- 10
11 Malik, A., & Blumenfeld, S. (2012). Six Sigma, quality management systems & the
12 development of organisational learning capability: Evidence from four business
13 process outsourcing organisations in India. *International Journal of Quality &*
14 *Reliability Management*, 29(1), pp. 71 - 91.
- 15
16 Mangan, S. (1999). Qualitative research methods in cross-national settings.
17 *International Journal of Social Research Methodology*, 2(2), pp. 109-124.
- 18
19 Manville, G., Greatbanks, R., Krishnasamy, R., & Parker, D. (2012). Critical success
20 factors for Lean Six Sigma programmes: a view from middle management.
21 *International Journal of Quality & Reliability Management*, 29(1), pp. 7-20.
- 22
23 Marhevko, J.D. (2008). *Kick Starting a Successful Lean Six Sigma System*. Quality
24 Texas Foundation.
- 25
26 Marshall, C., & Rossman, G.B. (1999). *Designing Qualitative Research*, 3rd ed.
27 Thousand Oaks, CA: Sage.
- 28
29 Mazzola, M., Gentili, E., & Aggogeri, F. (2007). SCOR, lean & Six Sigma integration
30 for a complete industrial improvement. *International Journal of Manufacturing*
31 *Research*, 2(2), pp. 188-97.
- 32
33 McManus, K. (2008). So long Six Sigma? *Industrial Engineer*, 40(10), 18.
- 34
35 Mehta, M. (2007). *Blending lean & six-sigma to create a synergistic model for*
36 *production & business processes*. IIE Annual Conference & Expo 2007, pp. 37.
- 37
38 Meredith, J. (1998). Building operations management theory through case and field
39 research. *Journal of Operations Management*, 16(4), p. 441-454.
- 40
41 Miles, M.B., & Huberman, A.M. (1994). *Qualitative Data Analysis: An Expanded*
42 *Sourcebook*, 2nd ed. Newbury Park, CA: Sage.
- 43
44 Moosa, K., & Sajid, A. (2010). Critical analysis of six sigma implementation. *Total*
45 *Quality Management & Business Excellence*, 21(7), 745-759.
- 46
47 Näsland, D. (2008). Lean, Six Sigma & Lean Sigma: Fads or Real Process
48 Improvement Methods? *Business Process Management Journal*, 14(3), p.269-
49 287.
- 50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5 Neuhaus, K., & Guarraia, P. (2007). Want More From Lean Six Sigma. *Harvard*
6 *Management Update*, 12(12), pp. 3-5.
- 7
8 Newbert, S. L. (2007). Empirical research on the resource-based view of the firm: an
9 assessment & suggestions for future research. *Strategic Management Journal*,
10 28(2), p.p. 121–146.
- 11
12 Nonthaleerak, P., & Hendry, L. (2008). Exploring the Six Sigma phenomenon using
13 multiple case study evidence. *International Journal of Operations & Production*
14 *Management*, 28(3), pp. 279-303.
- 15
16 Noronha, C. (2003). National Culture & Total Quality Management: Empirical
17 Assessment of a Theoretical Model. *The TQM Magazine*, 15(5), pp. 351-356.
- 18
19 O'Rourke, P. (2005). *A Multiple-case Analysis of Lean Six Sigma Deployment &*
20 *Implementation Strategies*. Unpublished M. Ed. Dissertation. Air University.
- 21
22 Orme, R., Clegg, B.T., Rees, C., & Titchen, M. (2013). *A Systems Approach to*
23 *customizing Lean Six Sigma Implementations*. Proceedings of the 24th Annual
24 Conference of the Production & Operations, Management Society.
- 25
26 Pande, P.S., Neuman R. P., & Cavanagh, R.R. (2000). *The Six Sigma Way: How GE,*
27 *Motorola, & Other Companies are honing their performance*. New York, NY:
28 McGraw-Hill.
- 29
30 Patton, M.Q. (1990). *Qualitative Evaluation & Research Methods*, 2nd ed. Newbury
31 Park, CA: Sage Publications.
- 32
33 Pekka-Economou, V., & Lykogianni, V. (2005). *The Human Factor as a Source of*
34 *Competitive Advantage in the New Globalized Markets*. 37th World Congress
35 Proceedings of the International Institute of Sociology Research Committee,
36 Stockholm, Sweden.
- 37
38 Pepper, M.P.J., & Spedding, T.A. (2010). The evolution of Lean Six Sigma.
39 *International Journal of Quality & Reliability Management*. 27(2), p.p. 138-155.
- 40
41 Pojasek, P. (2003). Lean, Six Sigma, & the systems approach: management initiatives
42 for process improvement. *Environmental Quality Management*, 13(2), pp. 85-92.
- 43
44 Polk, J.D. (2011). Lean Six Sigma, innovation, & the change acceleration process can
45 work together. *Physician executive*, 37(1), pp. 38-42.
- 46
47 Psychogios, A. (2010). A four-fold Regional Specific Approach to TQM: The Case of
48 South Eastern Europe. *International Journal of Quality & Reliability*
49 *Management*, 27(9), 1036-1053
- 50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5
6
7 Psychogios, A. G. & Priporas, C. V. (2007). Understanding total quality management in
8 context: Qualitative research on managers' awareness of TQM aspects in the
9 Greek service industry. *The Qualitative Report*, 12(1), pp 40-66.
- 10
11 Psychogios, A.G., & Tsironis, L.K. (2012). Towards an integrated framework for Lean
12 Six Sigma application: Lessons from the airline industry. *Total Quality
13 Management & Business Excellence*, 23(4), pp. 397-415.
- 14
15 Psychogios, A.G., Atanasovski, J., & Tsironis, L.K. (2012). Lean Six Sigma in a service
16 context: A multi-factor application approach in the telecommunications industry.
17 *International Journal of Quality & Reliability Management*, 29(1), pp. 122-139.
- 18
19 Psychogios, G. A., & Wilkinson A. (2007). Exploring TQM awareness in the Greek
20 national business context: between conservatism & reformism cultural
21 determinants of TQM. *The International Journal of Human Resource
22 Management*, 18(6), pp. 1042 – 1062
- 23
24 Psychogios, G. A., Wilkinson A., & Szamosi, L. (2009). Getting to the Heart of the
25 Debate: 'Hard' Versus 'Soft' Side Effects of TQM on Middle Manager Autonomy.
26 *Total Quality Management & Business Excellence*, 20(4), pp. 445-466.
- 27
28 Pusporini, P., Abhary, K., & Luong L. (2012b). Environmental Performance as Key
29 Performance Indicators in the Lean Six-Sigma Methodology. *Advanced Materials
30 Research*, 488 - 489, pp.1082-1086.
- 31
32 Rendtorff, D. J. (2015). Case Studies, Ethics, Philosophy, & Liberal Learning for the
33 Management Profession. *Journal of Management Education*, 39(1), pp. 36–55.
- 34
35 Saraph, J. V., Benson, G., & Schroeder, R. G., (1989). An instrument for measuring the
36 critical factors of quality management. *Decision Sciences*, 20, p.p. 810-829.
- 37
38 Saravanan, R. (2006). Development & validation of an instrument for measuring Total
39 Quality Service. *Total Quality Management & Business Excellence*, 17(6), p.p.
40 733-749.
- 41
42 Scheeres, J. (2009). *How lean six sigma fosters innovation in healthcare*. IIE Annual
43 Conference & Expo.
- 44
45 Shah, R., Chandrasekaran, A., & Linderman, K. (2008). In pursuit of implementation
46 patterns: the context of Lean & Six Sigma. *International Journal of Production
47 Research*, 46(23), pp. 6679–6699.
- 48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5 Sharma, S., & Chetiya, A. R. (2009) Simplifying the Six Sigma Toolbox through
6 Application of Shainin DOE Techniques. *The Journal of Decision Makers*, 34(1),
7 p.13-29.
8
9
- 10 Strauss, A., & Corbin J. (1990). *Basics of Qualitative Research: Grounded Theory*
11 *Procedures & Techniques*. Newbury Park, CA: Sage.
12
- 13 Stuenkel, K., & Faulkner, T. (2009). A Community Hospital's Journey into Lean Six
14 Sigma. *Frontiers of Health Services Management*, 26(1), pp. 5-13.
15
- 16 Su, C.T., Chiang, T.L., & Chang, C.M. (2006). Improving service quality by
17 capitalising on an integrated Lean Six Sigma methodology. *International Journal*
18 *of Six Sigma & Competitive Advantage*, 2(1), p.p. 1-22.
19
- 20 Sunhilde, C., & Simona, T. (2007) Lean Six Sigma & Innovations. *Fascicle of*
21 *Management & Technological Engineering*, 6(16), p. 2525-2530.
22
- 23 Tata, J., & Prasad, S. (1998). Cultural & Structural Constrains of Total Quality
24 Management Implementation. *Total Quality Management*, 9(8), p.p. 703-710.
25
- 26 Thompsen, J.A. (2005). *Gaining Greater Benefit from Lean Six Sigma & Leadership*
27 *Initiatives Within the Military*. 2005 IEEE International Engineering Management
28 Conference, pp. 846-850.
29
- 30 Timans, W., Antony, J., Ahaus, K., & Van Solingen, R. (2012). Implementation of Lean
31 Six Sigma in small- & medium-sized manufacturing enterprises in the
32 Netherlands. *Journal of the Operational Research Society*, 63(3), pp. 339–353.
33
- 34 Tsironis L., (2014). *Towards the development of a Lean Six Sigma application*
35 *framework, working paper, #BEL: 318-21, Business Excellence Laboratory*
36 (BEL), University of Macedonia.
37
- 38 Vavra, B. (2007). Tie Lean, Six Sigma strategies to plant worker's knowledge. *Plant*
39 *Engineering*, 61(3), p. 18.
40
- 41 Vince, G. (2008). Lean Six. *Management Services*, 52(1), 22-23.
42
- 43 Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations
44 management. *International Journal of Operations & Production Management*,
45 22(2), p. 195-219.
46
- 47 Worley, M. J. & Doolen, L. T. (2006). The role of communication and management
48 support in a Lean manufacturing implementation. *Management Decision*, 44(2),
49 228-245.
50
- 51 Yin, R.K. (2003a). *Applications of Case Study Research*, 2nd ed. London, UK: Sage.
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Yin, R.K. (2003b). *Case Study Research: Design & Methods*, 3rd ed. London, UK: Sage.

Yusof, S.M., & Aspinwall, E.M., (1999). Critical Success Factors for TQM in SMEs, *Total Quality Management*, 10(4&5), p.p. 803-809.

For Peer Review

Figure 1: CSFs influencing the Application of L6σ in Service Industry



Figure 2: Multifactor Model of L6σ Application in Service Industry



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1: Key Success Factors of L6 σ across Cases

| CSFs | Company A Telecommunicati on | Company B Airline | Company C Insuranc e |
|--|------------------------------------|----------------------|-------------------------------|
| <i>Management involvement & support</i> | V | V | V |
| <i>Committed leadership</i> | V | V | V |
| <i>Quality-driven culture</i> | V | V | |
| <i>Quality-driven training</i> | V | V | V |
| <i>Teamwork</i> | V | V | |
| <i>Link L6σ targets and customer satisfaction</i> | V | V | V |
| <i>Binding strategy with L6σ targets</i> | V | V | V |
| <i>Supportive technical systems</i> | V | V | |
| <i>Clear targets of L6σ projects</i> | V | N/A | V |
| <i>Prior experience in implementing similar quality initiatives</i> | V | V | V |
| <i>Link performance management system with L6σ</i> | V | N/A | V |

Table 2: Evidence towards top management involvement & support

| CSFs | Indicative Statements | Source of evidence |
|---|---|---|
| <i>Top-Management involvement & support</i> | <i>"During the application of L6σ the great majority of top-mangers had active participation in all phases"</i> | Quality assurance manager - black belt (CA) |
| | <i>"Top management involvement was critical during the phase of adoption of the concept"</i> | Operations manager - black belt (CB) |
| | <i>"Managers did care about results and since they realised that L6σ can bring those they show great support"</i> | Sales manager (CA) |
| | <i>Top-management was determined towards the targets of the method from the first moment"</i> | Marketing manager (CC) |

Table 3: Evidence towards Committed leadership

| CSFs | Indicative Statements | Source of evidence |
|-----------------------------|---|-------------------------------|
| <i>Committed leadership</i> | <i>"Managers show commitment towards the application of the tool and this was a great motivation for everybody"</i> | Chief operations manager (CB) |
| | <i>"Leaders' commitment supported people moral during the first difficult phase"</i> | HR manager (CA) |

Table 4: Evidence towards quality-driven culture

| CSFs | Indicative Statements | Source of evidence |
|------------------------|--|---|
| Quality-driven culture | <i>"The culture here drives recruitment and selection of the appropriate knowledgeable and experienced staff to support changes"</i> | Assistant quality assurance manager - green belt (CB) |
| | <i>"L6σ helped to change the culture and improve in terms of information flow and knowledge transfer"</i> | HR manager (CA) |

Table 5: Evidence towards quality-driven training

| CSFs | Indicative Statements | Source of evidence |
|-------------------------|--|---|
| Quality-driven training | <i>"Training is critical since can guide people to know who the customer is (internal and external)"</i> | Quality assurance manager - black belt (CA) |
| | <i>"It is critical to begin the project with training on tools techniques but also project management and process of change"</i> | Operations manager - black belt (CC) |

Table 6: Evidence towards teamwork

| CSFs | Indicative Statements | Source of evidence |
|----------|--|-------------------------------|
| Teamwork | <i>"Both regular and spontaneous meetings among people participated in L6σ application proved very important in binding the team together"</i> | Logistics officer (CB) |
| | <i>"Managers gave great consideration to teamwork as a critical aspect to deal with incidents"</i> | Chief operations officer (CB) |

Table 7: Evidence towards link L6 σ targets and customer satisfaction

| CSFs | Indicative Statements | Source of evidence |
|--|---|---|
| Link L6 σ targets and customer satisfaction | <i>"It was widely understood from the beginning that L6σ is applied in order to improve quality and therefore, deliver what customers want"</i> | Assistant quality assurance manager - green belt (CB) |
| | <i>"According to the vision of L6σ the customer is the decision maker"</i> | Logistics officer (CB) |
| | <i>"Customer demand triggers the whole organization L6σ helped to make this clear to the whole personnel"</i> | Marketing manager (CC) |

Table 8: Evidence towards binding strategy with L6 σ targets

| CSFs | Indicative Statements | Source of evidence |
|---|---|-------------------------------|
| Binding strategy with L6 σ targets | <i>"L6σ was linked to strategic goals for the coming years and their implementation".</i> | Operations officer (CA) |
| | <i>"The major strategic objective is to reduce cost and satisfy the customer. This was related to what L6σ attempted to do"</i> | Chief operations officer (CB) |

Table 9: Evidence towards supportive technical systems

| CSFs | Indicative Statements | Source of evidence |
|------------------------------|--|------------------------------|
| Supportive technical systems | <i>"L6σ requires specific integrated systems for performance, service quality and process management. Plus total involvement of employees"</i> | IT manager - black belt (CC) |
| | <i>"Appropriate systems facilitates and motivates employees to adjust their attitudes towards L6σ philosophy"</i> | HR manager (CC) |

Table 10: Evidence towards clear targets of L6σ projects

| CSFs | Indicative Statements | Source of evidence |
|-------------------------------|---|--------------------|
| Clear targets of L6σ projects | <i>"Project targets need to be selected around specific standards like financially measurable results, high proof of improvement, etc".</i> | HR manager (CB) |
| | <i>"The responsibility of defining the selection criteria belongs to the company and its people"</i> | IT manager (CA) |

Table 11: Evidence towards prior experience in implementing similar quality initiatives

| CSFs | Indicative Statements | Source of evidence |
|--|---|---|
| Prior experience in implementing similar quality initiatives | <i>"The application of systems like ISO9002 and similar, enhanced employees to understand what they need to do under the L6σ context"</i> | Operations manager - black belt (CC) |
| | <i>"TQM projects prepared people for similar changes."</i> | Assistant quality assurance manager - green belt (CB) |

Table 12: Evidence towards link performance management system with L6σ

| CSFs | Indicative Statements | Source of evidence |
|---|---|-----------------------------|
| Link performance management system with L6σ | <i>"One critical issue was that we have clearly linked L6σ to the established performance management system. This helped employees to understand better their individual targets"</i> | HR manager (CC) |
| | <i>"The combination of the new tool with the performance appraisal system proved to be critical for employees' acceptance and understanding of the new quality oriented targets."</i> | HR development manager (CA) |