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Building a Sustainable Lean Culture

A Holistic Lean Leadership Model

By

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Abstract

Surprisingly, a high failure rate of lean initiatives in delivering promised business results calls into question the practicality and fruitfulness of lean as a change methodology. Many lean experts and scholars have tried to reveal the determining factors that affect the chance of success or failure of a lean initiative under different labels such as inhibitors, barriers, obstacles, or key success factors. One prominent concept, which is directly or implicitly mentioned in many of these studies, is profound role of 'leadership'. This study pursues two objectives in two phases, mainly through conduct of a survey among lean practitioners in different industries. The research objectives are: to investigate the role of leadership in achieving favorable business results, and to formulate a holistic lean leadership model. This model is based on practical and realistic leadership experiences of two iconic lean companies, and also verified, and modified as appropriate, according to the findings of the survey. Ingraining the culture of respect for people, commitment to (leadership) self-development, establishing (lean) overarching and supporting structures, and reinforcing lean in day-to-day management activities, are 4 main layers of the model that enable a leader to reach to the ideal state of a lean organization, which is kaizen (continuous improvement).

Keywords: *lean leadership, lean management, lean culture, sustainable lean, lean thinking, lean manufacturing*

Introduction

As a business grows, inevitably the whole system, including the organizational structure, functional interactions, the nature and range of products, customer relationships, and its other components, become more complex and difficult to manage. This complexity in most cases diminishes its flexibility to change and decreases the performance eventually down to a level which threatens its viability. Competent and smart business leaders recognize the need for improvement or change initiatives early on the path. Nevertheless, substantiated by the available facts, in most cases this vital need is ignored until a severe crisis emerges (Womack, Jones, and Roos, 1990; Pyzdek, 2003). Over the decades, different approaches and methodologies for change have been developed and deployed. Although each of these methodologies has gained success to some extent, they are either limited to isolated improvement projects at particular points of time, or are ambiguous when it comes to application and implementation.

Lean is one of the most reputable change methodologies (A. Taylor, M. Taylor, and McSweeney, 2013) that originated in manufacturing- known as lean manufacturing then- but later evolved to a continuous improvement process affecting all aspects of a business system (Holm, 2010). Today, this is generally referred to as lean thinking, which, as a comprehensive and continuous change strategy, touches every aspect and every function of a business. Not only does it transform the way any function works within a system but also it affects all the intangible elements of a business system, such as the organizational culture, interrelationships between different functions within the system as well as external relationships with other stakeholders like customers, suppliers and shareholders. Therefore, unlike other change methodologies, lean is not just a collection of disconnected improvement projects.

Lean, by its definition, is a continuous improvement process rather than a series of isolated change events. In addition, what gives lean an edge over some other methodologies, e.g. TQM, is that it is not confined by just some principles and vague recommendations. Lean provides a clear practical roadmap for change and is equipped with a comprehensive tool box for execution.

Nonetheless, lean has not been as successful as expected in delivering the promised results (Emiliani and Stec, 2005; Dombrowski and Mielke, 2013; Poksinska et al., 2013).

Problem definition

Lean's pioneer, Toyota, and some of its successors like Wiremold, have reaped astonishing benefits by using lean as their change strategy. These were not one-of-a-kind results, because they have been able to repeat their success frequently in their several attempts and they also have been successful in sustaining the benefits over a long period. However, in striking contrast to a few amazing success stories, the majority of the attempts for lean transformation either fail remarkably or at least fail to live up to the initial expectations (Emiliani and Stec, 2005; Dombrowski and Mielke, 2013; Poksinska, Swartling, and Drotz, 2013). In fact, an extensive survey done by Industry Week in 2007 reported that only 2% of the lean programs lived up to the expected results (Liker and Franze, 2011). Lean principles and tools might sound simple, but in practice most organizations either fail at the initial implementation or fail to sustain the benefits over time. This high failure rate (Emiliani and Stec, 2005; Bhasin, 2012) along those few mind-blowing results, bring this question to the foreground: "why does lean work invariably and significantly for a few companies but fail for a lot of them?"

Many authors believe that successful implementation of lean entails change in the organizational culture and giving enough attention to the 'respect for people' principle of lean (Halling and Wijk, 2013; Dombrowski and Mielke, 2014; Bhasin, 2011; Liker and Balle, 2013). This enormous emphasis on culture and people development either have implicitly brought the important role of leadership to the foreground or were explicitly followed by it.

Nevertheless, delving in the lean literature, one term is pervasive in many books, research papers, experts' speeches, and articles: 'Leadership'. Whether 'lack of leadership' listed as key failure factor or 'effective leadership' listed as key success factor, there is consensus on the role of leadership as an imperative in any lean turnaround (Aij, Visse, and Widdershoven, 2015; Dombrowski and Mielke, 2013; Mann, 2009; Ahmed, 2013; Bodek, 2008; Holm, 2010; Jadhav, Mantha and Rane, 2014; Goodridge et al., 2015). The experienced hurdles and challenges of so many companies on their lean journey, coupled with this omnipresent emphasis on leadership's role, triggered the need to investigate the role of leadership in successful lean turnaround.

As from the shareholder or business owner's point of view, the ultimate goal of any improvement or change initiative is an enhanced bottom line. To the author's knowledge, the existence of any direct association between leadership's role and achieved business results from lean thus far has

never been investigated. Thus the research question of this thesis is: “Is lean leadership the driving factor towards a successful lean transformation that delivers outstanding business results?”

If the answer to the above question turns out to be affirmative, it leads to the next problem, which is the necessity of a comprehensive and practical lean leadership model. Leaders, who are about to embark on their lean journey or are already struggling with the challenges of lean implementation, often feel lost, confused, or even skeptical. This is because leading in a lean way is significantly different from, and in many occasions even in complete contrast with, conventional leadership methods, to which they are accustomed. So, a holistic and practical leadership model is necessary for leaders in order to guide them and pave their way.

Research objectives

This study pursues the realization of two main research objectives:

1- Investigating the role of leadership as the driving factor which allows lean to deliver superior business results.
2- Devising a holistic lean leadership model incorporating all practical aspects of leading a lean organization.

In the following chapters, first, in order to define the context, the available literature is reviewed extensively in chapter one. Chapter two describes the methodology that is used for achieving the above objectives. Chapter three addresses the first objective and uses the findings of a survey for validating the role of leadership in delivering desirable business results. In chapter four, findings from the literature alongside the results of the survey are used for developing a lean leadership model. Finally, in chapter five conclusions are drawn from the results of the study and the limitations and opportunities for future work are discussed.

Chapter 1- Literature review

In the following sections, the literature on lean and lean leadership will be discussed on three levels. At the first level, in section 1-1, the history and origins of lean will be discussed. In section 2-1, lean principles and components of lean will be reviewed. Finally, at the last level, in section 3-3, definitions of leadership in the literature and available scarce resources on the more narrowly-focused subject of 'lean leadership' will be discussed.

1-1- Lean's origins and history

Toyota entered the U.S. market in 1957 but it wasn't until the early 1980s that the Americans started to feel the threat of their Japanese competitors who now had entered the U.S. market and were seriously competing with them with lower prices and better quality. In particular, Toyota was taking away the lead from American giant auto manufacturers (Iuga and Kifor, 2013). This strong appearance of Japanese competitors in the U.S. market made many academics and industry researchers curious about the Japanese and in particular Toyota's mysterious production system. Although John Krafick (1988), a researcher in the International Motor Vehicle Program (IMVP), was the first to use the word "lean" in his master's thesis for MIT's Sloan School of Management to refer to the Toyota Production System (TPS) (Womack et al., 1990; Samuel et al., 2015; Parkes, 2015; Ballard and Tommelein, 2012; Halling and Wijk, 2013; Holm, 2010; Poksinska et al., 2013), the publication of the book "The machine that changed the world" by Womack, Jones, and Roos (1990) was a landmark in the history of lean as it officially and extensively introduced lean manufacturing (also known as lean production system) to the academic community as well as the industry (Parkes, 2015; Miina, 2012; Bhasin, 2011; Found et al.,2009; Poksinska et al., 2013).

Although lean manufacturing- which later evolved into lean thinking, lean philosophy, or lean management system (Begam et al., 2013)- is coded and documented based on the TPS, many of its principles and tools (e.g. JIT and flow), had not been originally new concepts in late 90s (Womack et al., 1990; Čiarnienė and Vienažindienė, 2012). In fact, Japanese lean pioneers (e.g. Eiji Toyoda and Taichi Ohno) built on the innovations of their predecessors like FredericK Taylor and Henry Ford (Womack et al., 1990; Parkes, 2015; Čiarnienė and Vienažindienė, 2012; Emiliani and Stec, 2005; Schwagerman and Ulmer, 2013). For instance, development of Just in time (JIT) as one of the pillars of lean can be traced back to 1799, when Eli Whitney signed a contract with

the U.S. Army for the manufacture of 10,000 muskets at an incredibly low price and introduced the concept of interchangeable parts for the first time to the American industry (Iuga and Kifor, 2013; Woodbury, 1960). Standardized work and time study were first introduced and conceptualized by Frederick W. Taylor, father of 'scientific management' also known as 'Taylorism', at the end of 1980s (Iuga and Kifor, 2013; Parkes, 2012; Emiliani, 1998). Motion study and process mapping were introduced shortly after by Frank Gilbereth and later lay the foundation for value stream mapping (VSM) in lean (Iuga and Kifor, 2013). Flow, as one of the main principles of lean, was originally innovated by Henry Ford in 1913 (Womack et al., 1990; Parkes, 2015; Schwagerman and Ulmer, 2013) with the production of the famous T-model in just 93 minutes. Although collective efforts of these pioneers like Ford and Taylor enhanced productivity and earned competitive advantage for a while (Emiliani, 1998), it did not keep the Japanese from stealing their thunder.

By the time World War II ended in 1945, Toyota was a small auto manufacturer that was struggling for its very existence (Womack et al., 1990; Iuga and Kifor, 2013; Parkes, 2015). Imitating the American mass production system was not an option on the table due to several reasons, including scarce financial resources, very small market, and shortage and high price of land for production and storage (Parkes, 2015; Ballard and Tommelein, 2012). After spending a whole year meticulously studying Ford's production system in 1929, Kiichiro Toyoda, son of the founder of Toyota, resolved to find ways to tailor the American mass production system to Japan's unique culture, tiny market, production constraints, and post-war economic realities. He was also inspired by the instructions of quality wizards like Ishikawa, Edwards W. Deming (1950) and Joseph M. Juran (1954) (Iuga and Kifor, 2013; Parkes, 2015; Ballard and Tommelein, 2012; Schwagerman and Ulmer, 2013). Statistical Quality Control, the Plan-Do-Check-Act (PDCA) cycle, and Pareto charts later became inseparable parts of Japan's quality movement. The result of his endeavor with great contributions from a number of Toyota's genius engineers (e.g., Eiji Toyoda, and Taiichi Ohno) was the TPS, from which lean is derived.

One of the main pioneers of TPS was the legendary Taiichi Ohno, who invented the kanban system in 1947 for the first time and conceptualized JIT in the 1950s (i.e., in collaboration with Eiji Toyoda) (Womack et al., 1990; Parkes, 2015; Womack and Jones, 1996).

Kaizen has its origins in the 1950s, however it was Masaaki Imai who formally conceptualized it as one of the main building blocks of lean (J. Singh and H. Singh, 2009).

1-2- Lean DNA

The five principles of 1- specify value, 2- identify value stream, 3- flow, 4- pull, and 5- perfection, delineate the main body of lean (Womack and Jones, 1996). Towards operationalization of these principles, Womack and Jones (1996) proposed a four-step action plan: 1. getting started, 2. creating an organization to channel your stream, 3. installing business systems to encourage lean thinking, and 4. completing the transformation. They also, for the very first time, formally originated the term "lean thinking" and "lean enterprise" and introduced lean as a comprehensive management system rather than a production toolbox. However, the mainstream perception of lean is still the toolbox view (Emiliani, 2005; Gelei et al., 2015).

Liker (2004) formulated the Toyota's management principles by a pyramid model called 4P (Figure 1-1):

Philosophy: long-term thinking as opposed to short-term financial goals.

Process: the right waste-free processes will produce the right results.

People and partners: realization of 'respect for people' component of lean.

Problem solving: continually solving root problems drives organizational learning

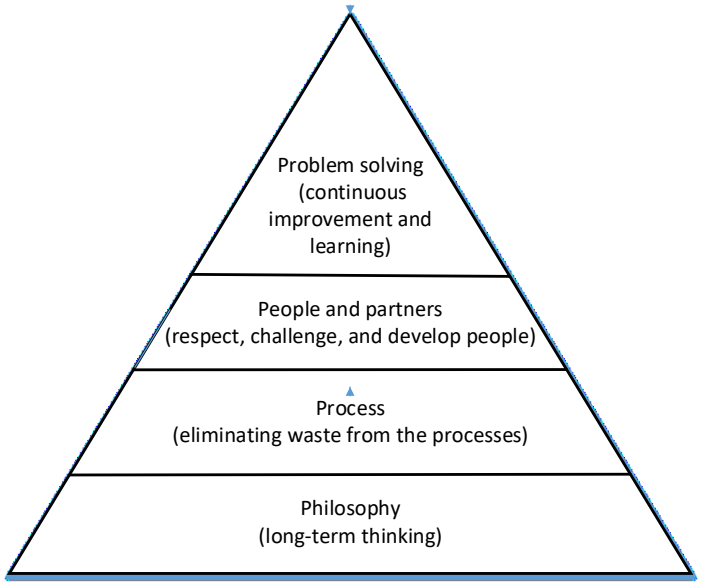

Figure 1. 4P model (Liker, 2004)

Lean transformation occurs in three ways: 1. Cultural transformation, 2. Major operational change initiatives, and 3. Continuous improvements (Jordan and Michel, 2001). They suggest a four-step iterative lean change initiative model: 1- develop and refine project plan, 2- assess benefits: align with strategic goals, evaluate leanness, 3- assess costs and risks: customer life cycle, development and operations, long-term liabilities, 4- improvement: increase benefits, reduce costs, and mitigate risks.

Murman et al. (2002) believe in an enterprise-wide approach to lean and define a lean enterprise as "an integrated entity that efficiently creates value for its multiple stakeholders by employing lean principles and practices". They recommend deployment of a three-phase value-creation framework on all above-mentioned three levels of enterprise, which consists of 1. Value identification, 2. Value proposition, and 3. Value delivery.

Miina (2012) proposed an empirical lean implementation model in the form of a 5-step closed loop: 1. lean knowledge acquisition, 2. lean house development, 3. lean house communication and training, 4. lean implementation process planning, and 5. lean implementation process execution (Figure 2).

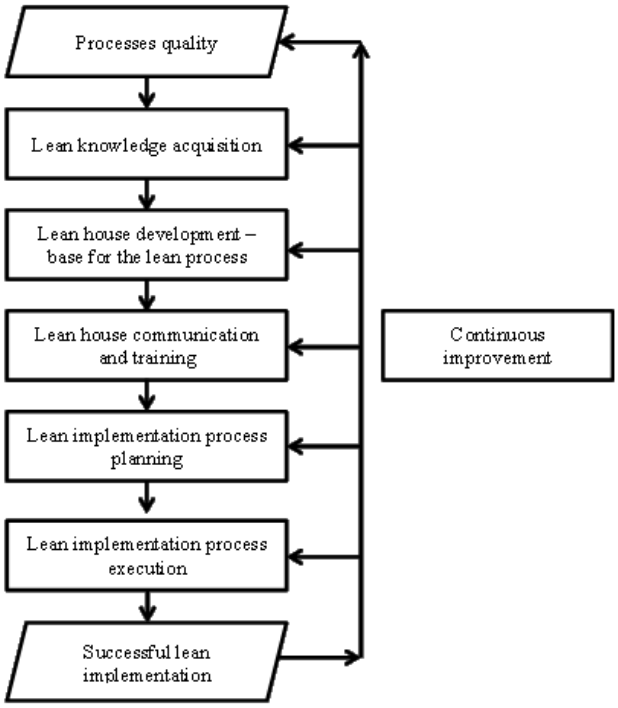

Figure 2. Lean implementation process (Miina, 2012)

1-3- Lean and leadership

Leadership

Some of the key requirements for change are leadership, empathy, and solid communications (Johnson, 1993). Therefore, lean as a change strategy or as proactive-to-change management system, is not an exception. Verification or rejection of this statement requires having a clear definition of "leadership".

Despite its seemingly simple and easy-to-grasp definition, leadership is a fuzzy concept that can be defined and interpreted in quite a variety of ways. In fact, the overlooked difference between management and leadership has led to inadvertent but detrimental confusion between management and leadership in a considerable part of the literature.

Bennis (1989) highlights the fuzziness of the leadership concept: "it's hard to define, but you know it when you see it." Actually most of the definitions are restricted by the limits of Bennis's (1989) statement: "you know it when you see it" (Kirby, 2015). One of them is Maxwell's (1998) definition of leadership: "leadership is influence- nothing more, nothing less".

Acknowledging the shortcoming of the existing definitions, Bennis (2003) defines leadership as: "leadership is a function of knowing yourself, having a vision that is well communicated, building trust among colleagues, and taking effective action to realize your own leadership potential."

Winston and Patterson (2006) studied a large corps of leadership's definitions- 160 articles and books- and have identified more than 90 variables as pieces of leadership as a whole picture and concluded that each definition captures one or more aspect of leadership's vast concept.

Rost (1993) reviewed 450 books and articles and finally distinguished leadership from management. In his words: "management is an authority relationship between at least one manager and one subordinate who coordinate their activities to produce and sell particular goods and/or services". Quite differently he defines leadership as follows: "leadership is an influence relationship among leaders and followers who intend real changes that reflect their mutual purposes."

People often mistakenly associate the word "leadership" to any activity related to persons in high positions in hierarchical structure of organizations (Barker, 2002). Barker (2003) believes that management and leadership diverge due to their approach to change. While management strives for stability, "leadership is a process of transformative change where the ethics of individuals are integrated into the mores of a community as a means of evolutionary social development".

In their quest for a comprehensive definition for leadership, Winston and Patterson (2006) defined a leader as follows: "A leader is one or more people who selects, equips, trains, and influences one or more follower(s) who have diverse gifts, abilities and skills and focuses the follower(s) to the organizations' missions and objectives causing the follower(s) to willingly and enthusiastically expand spiritual, emotional, and physical energy in a concerted coordinated effort to achieve the organizational mission and objective."

Emiliani (2007) suggests a new definition for leadership: "beliefs, behaviors, and competencies that demonstrate respect for people, improve business conditions, minimize or eliminates organizational politics, ensure effective utilization of resources, and eliminate confusion and rework." He elaborates on how leaders affect the way their followers do their daily job rather than their personal attributes. This definition has two distinct elements that makes it more compatible with the lean paradigm: 1- elimination of waste as one of the leadership's responsibilities, and 2- emphasis on respect for people (Emiliani, 2007).

Dombrowski and Mielke (2013) suggest a new definition for lean leadership: "Lean leadership is a methodical system for the sustainable implementation and continuous improvement of Lean Production System (LPS). It describes the cooperation of employees and leaders in their mutual striving for perfection. This includes the customer focus of all processes as well as the long-term development of employees and leaders."

Some common characteristics of the last three definitions lead them to be harmonized with the lean philosophy: 1- acknowledgement of leaders' determining influence on and interactions with other people, including their followers, as important elements of leadership, and 2- differentiation between leadership and management by implying the transformational nature of leadership as opposed to coercive nature of management. However, since Emiliani's definition also encompasses lean's main tenet, waste elimination, and although all can serve as the basis for the sake of this study, Emiliani's has an edge over the former.

Lean leadership

Some surveys report success rates as low as 2% for lean attempts (Liker and Franze, 2011). This low success rate is largely attributed to failure in sustaining results in the long-run rather than initial implementation. Scrutinizing this phenomenon, the underlying reason may be explained by Liker's 4P model that describes Toyota's management system by a four-layer pyramid (Dombrowski and Mielke, 2014). Overemphasis on process and ignorance of the other three layers (i.e. philosophy, people, and problem solving) are what feed this trend. Simply put, if lean benefits are to be sustainable, lean tools need to be applied in an environment that encourages and espouses respect for people, a process-oriented mindset, and a continuous improvement culture (Bhasin, 2011). Mann (2009) believes that implementation of lean tools accounts for at most 20% of the lean transformation.

Thus, the question is: "who has the power and authority to engrain the culture of continuous improvement? To convert the management-by-objective mindset to a lean mindset? To create the culture of respect for people?" Pondering these questions deeper, they might be distilled to: "who has enough power, influence and authority to change people? To keep them on track? To reinforce lean principles?"

Based on Winston and Patterson's (2006) definition of leadership, it has all the required qualifications to assume responsibility for actualization of the often-ignored parts of lean. The

leader is in a position to influence and change his/her followers and keep them on track by constantly challenging and coaching them and clearly defining and promulgating the organization's values, vision, and goals. In this sense, lean leadership is what guarantees sustainable implementation and continuous success of lean (Dombrowski and Mielke, 2013).

Mann (2009) perfectly describes leadership's role in lean: "There is a missing link in lean. This missing link is the set of leadership behaviors and structures that make up a lean management system. Lean management bridges a critical divide: the gap between lean tools and lean thinking."

What brought leadership into foreground are findings of a number of researchers, who have tried to identify the barriers and inhibitors of lean implementation. The natural resistance to change, the anxiety and time that it takes from management to be actively involved in the process, motivate workforce, and lead them by example are obstacles for lean implementation (Begam et al., 2013).

Based on the findings of an empirical data, the two factors of leadership and customer focus have been proven as important factors for successful lean implementation in the Malaysian automotive industry (Habidin and Yusof, 2013)

Using Constant Comparative Method (Boeije, 2002) and a model for change proposed by Robertson et al. (1993), Halling and Wijk (2013) identified 8 barriers to lean implementation shared by both manufacturing and healthcare: 1- unknowledgeable lean consultants, 2- leadership, 3- time, 4- no vision, 5- no common view of lean, 6- organizational silos, 7- insufficient communication, and 8- reactive culture.

According to Mann (2009), implementing lean tools accounts for just 20% of a successful lean transformation and the remaining 80% is achieved through change of leaders' behaviors, mindset, and practices. Halling and Renstro (2014) consider lack of lean leadership as the missing link between lean toolbox and lean thinking. In fact, "lack of sufficiently-self-developed leaders" is one of the reasons for the low rate of true lean success (Koenigsaecker, 2005). If lean is to succeed, the senior leadership needs to "push up" his/her "personal learning curve", be an active member of the initial VSM team, and gain personal experience by actively participating in kaizens (Koenigsaecker, 2005).

Reviewing the literature, top management resistance, lack of top/senior management focus leadership, lack of top/senior management involvement (commitment and support), lack of

communication between management and workers, lack of empowerment of employees, and lack of cooperation and mutual trust between management and employees are among the experienced barriers to lean in manufacturing (Jadhav et al., 2014).

Ahmed (2013) attributed failure of a majority of lean efforts to six major reasons including distinction between management by objectives (MBO) and lean management.

Organizational culture is an incorporeal entity with critical tangible impacts and its shaping or reshaping is one of the primary roles of leadership. Consequently, the highly determining role of leadership in successful lean turnaround is implied indirectly by some authors by highlighting the culture as an imperative in a triumphant lean transformation. According to Testani and Ramaknishnan (2011) a successful lean transformation demands an organizational culture transformation and transformational leadership is critical to transform a business into "adaptive operating culture."

Bhasin (2011) investigated the correlation between different performance indices with defined cultural criteria and asserted that the main challenge for leaders in lean organizations is fostering "a culture that is conductive to lean".

Shook (2010) argues that the Toyota leaders' way for achieving sustainable benefits out of process improvements is indeed culture transformation. Often-ignored human aspect of lean, which is signified by organization's culture, plays a vital role in success of a lean turnaround (Bhasin, 2012).

Lean leadership's how-to

While no holistic model, framework, or road map could be detected in the literature, some attempts have been made for elucidating leadership's contributing or inhibiting attributes, attitudes, behaviors, or roles in a lean transformation. Shook (2010) believes that changing behaviors and attitudes through lean techniques, such as andon, in fact precedes the change of culture, not the other way around.

Senior leaders contribute to lean's success in five ways: "1- developing and implementing structures and processes for anticipating and responding to the difficulties of a lean initiative; 2- transforming commitments to change into actual change, supporting and sustaining new behaviors and practices; 3- converting process improvements from project mode to ongoing process; 4-

establishing and maintaining new, process-focused measures alongside conventional measures; and 5- cultivating sustainable lean culture of continuous improvement (Mann, 2009).

Emiliani (1998) defines the lean behaviors as: "behaviors that add or create value. It is the minimization of waste associated with arbitrary or contradictory thoughts and actions that leads to defensive behavior, ineffective relationships, poor co-operations, and negative attitudes." He also coined the term 'fat behavior' as opposed to 'lean behavior'. Emiliani (1998) believes that one of the major negative outcomes of fat behaviors of leaders is 'loss of employee commitment' and inevitably diminishing participation level.

Bodek (2008) associates failure of lean undertakings with the difference between leading and managing. He lists a number of key differences between leaders and managers including: independent thinking vs. providing solutions, eliminating waste, showing respect, encouraging as many ideas as possible from workers, cultivating a multi-skilled workforce by job rotating, instilling the mindset that two steps forwards and one step backward is ok, and encouraging the sharing of mistakes. While micro-management is a positive contributor to lean transformation in short run, in the long term micro-management impedes the progress and sustainability of lean efforts (Gelei et al., 2015).

Toyota seeks managers with high capacity for improvement rather than experienced managers in hope for quick results. Furthermore, there is a balance between the time that the executive spends on the shop-floor and in the office (Marksberry and Hughes, 2011).

Lean leadership is delineated by five basic principles: 1- continuous improvement culture, 2- self-development, 3- qualification, 4- gemba (genchi genbutsu), and 5- hoshin kanri (Dombrowski and Mielke, 2013).

Dombrowski and Mielke (2014) have listed 15 practical leadership guidelines under these five principles: Improvement culture: 1- continuous improvement demands leader's continuity, 2- leaders have to promote the CIP, but may not intervene directly in the problem-solving, 3- errors will always occur- their consequences should be avoided; self-development: 4- self-awareness is the first step toward (self-)improvement, 5- after a promotion, the status quo has to be internalized, 6- lean leadership requires different abilities and behaviors; qualification: 7- leaders have to make themselves in their actual job superfluous, 8- all employees need to be developed individually, 9- learning has to take place in short cycles; gemba: 10- decisions are based on facts, 11- the gemba

is the place of action and learning, 12- leading at the gemba only works with a small leader-to-employee ratio; hoshin kanri: 13- long-term goals are never abandoned in favor of short-term goals, 14- the target system is also used to assess the employee development, and 15- in the striving for perfection the formulation of precise intermediate goals is indispensable.

Pokinska et al. (2013) studied and reported managerial and leadership practices according to four managerial processes proposed by Yukl (1997): 1- lean leaders are more visible in the gemba and interact more effectively with employees, 2- lean leaders spend more time for face to face meetings with employees and also use visual tools as a mean for facilitating information flow, 3- lean leaders focus on cultivating employee's problem solving competencies and gradually involve them in decision making process, and 4- lean leaders encourage desired lean behaviors by instilling values in the employees, sharing objectives, and serving as a role model and coach.

Aij et al. (2014) have reported three common leadership characteristics that are critical to successful lean implementation in the context of healthcare practice: 1. going to the gemba, 2- empowerment and trust, and 3. modesty and openness.

A relentless PDCA cycle- comprised of standards, visualizing and reporting abnormalities, and kaizen- is the first responsibility of lean leaders and managers (Liker and Balle, 2013).

There is a trivial difference between the skills and competencies required from leaders for the lean transformation at the outset and then for sustaining the benefits (Found et al., 2009).

Effective and frequent communication is a positive leadership behavior. Pamfilie et al. (2012), affirmed that "in a successful lean Six Sigma project the leader is an efficient communicator which plays a prominent role in employee's support and motivation". In their effort to develop an ideal lean leadership profile, Gelei et al. (2015) have also recognized communication as a contributor leadership attribute.

Given the complexity and fuzziness of recommended leadership behaviors and practices, iconic lean companies, such as Toyota and Wiremold, may serve as practical exemplars to be used by leaders. As an archetype of extraordinary successful lean transformation, Wiremold is one of the most written-and-spoken-about lean companies. Emiliani et al. (2007) recount Art Byrne's steps beginning from announcing a new strategy and rigorously refining it in iterative cycles. They further try to establish the leader's role in operationalizing lean through kaizen, by explaining Art

Byrne's active involvement in selecting initial kaizen opportunities, conducting initial kaizen training, selecting kaizen team leaders, and identifying cross-functional team members.

Based on his valuable hands-on experience in Wiremold, Byrne (2012) set the lean practitioners straight about the way to go about lean: "you will have to understand and commit to three management principles that will serve as the foundation on which your transformation will be built: 1- lean is the strategy, 2- lead from the top, 3- transform the people." He also suggest four principles to be stick to by leaders in implementing lean: 1. work to takt time, 2. create one-piece flow, 3. establish standard work, and 4. connect your customer to your shop floor through a pull system.

Testani and Ramaknishnan (2011) proposed the lean transformational leadership model (LTL) (Figure 3). This model describes the gravitational pull that transformational leadership behaviors and transactional leadership behaviors impose on dynamics of the interaction within and between different levels of enterprise (levels of a living (open) system). They believe transformational leadership behaviors pull the organizations culture toward a more adaptive and lean culture.

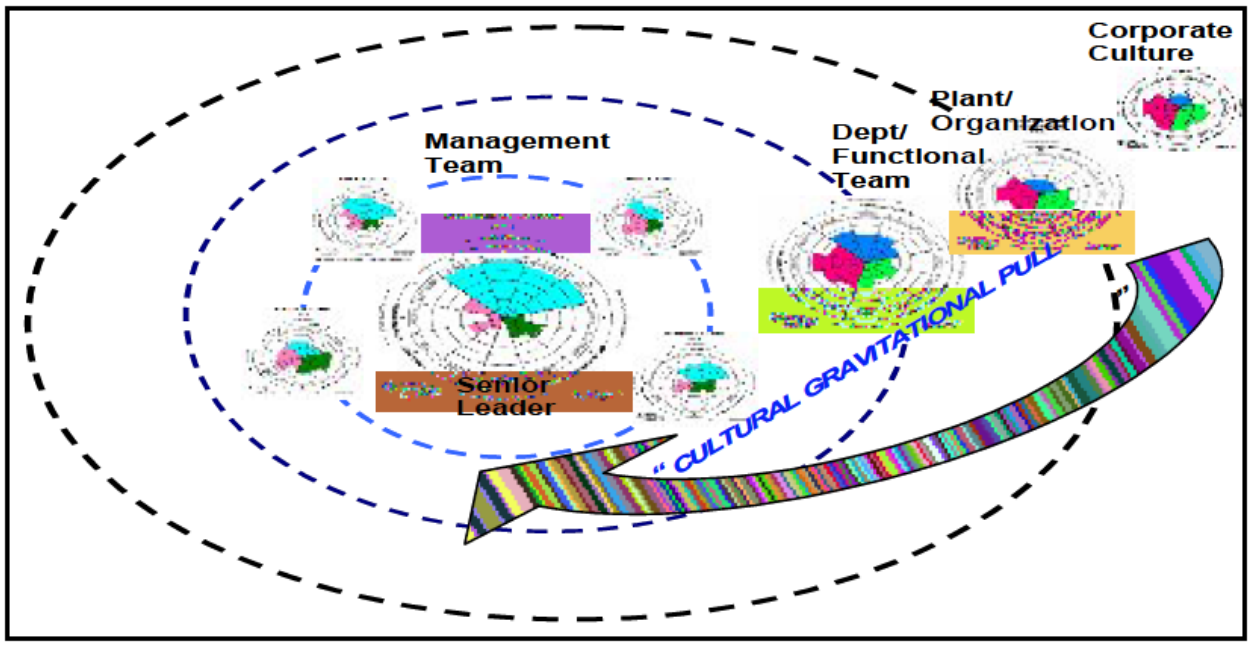

Figure 3. Lean transformational leadership model (Testani and Ramakrishnan, 2011)

Dibia et al. (2014) incorporated leadership in their 'lean "leadership People Process Outcome" (LPPO) implementation model' (Figure 4). This model distances lean implementation from toolbox approach and brings it closer to lean thinking by incorporating 'people' and 'leadership' in the lean implementation.

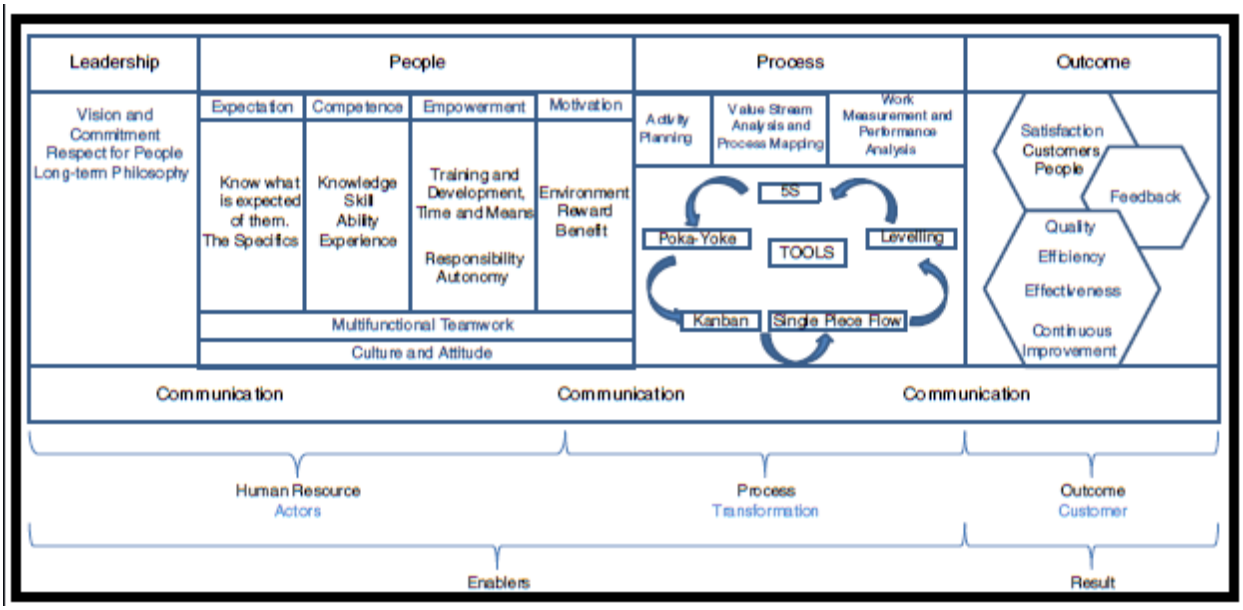

Figure 4- Lean "Leadership People Process Outcome" implementation model. (Dibia et al., 2014)

Despite the efforts that have been made in describing and articulating the desired behaviors and expected attitudes of leaders in lean organizations, a disturbingly low rate of success signals leaders' unwillingness or incapability in doing their job. Most leaders are "lost" in the lean journey and there are a number of common errors among leaders that hampers their success including tool-box view, batch-and-queue mindset and business metrics, lack of direct participation, disintegrated improvements, short-term business horizon, and shareholder focus rather than customer focus, (Emiliani, 2005).

The missing link in competency models, which renders many of them ineffective despite the substantial investments, is the underestimation of beliefs entrenched in the organizational culture and leaders' mind-set (Emiliani, 2003).

Self-development and lean leadership tools

As the lean way of operating the business takes a completely different mindset, culture, and set of skill and competencies, naturally leaders needs to change their own mentality and develop their leadership skills if they are to coach and develop their subordinates. Therefore, self-development is one of the main elements of leadership's new role in the lean context (Dombrowski and Mielke, 2013; Emiliani, 2013; Liker and Convis, 2012). Emiliani (2013) uses music as a framework to help leaders appreciate lean leadership by comparing the similarities of learning to play a musical instrument with learning how to exercise lean properly. Emiliani notes precise timing and

synchronization, signified by takt time and beats in lean and music respectively, as the most evident similarity between them. Emiliani (2013) asserts that just as it takes several years and lots of practice and perseverance for a musician to master playing a musical instrument, senior managers and leaders need to recognize the need for long-term and persistent commitment to self-development and learning if they are to succeed in lean implementation.

Found et al (2009) have confirmed the necessity of the double-loop learning cycle explain at all levels of management for a sustainable lean implementation. Their study demonstrated a prolonged learning curve for middle managers if an organization is to continue reaping benefits from lean. Liker and Convis (2012) have formulated a lean leadership development model based on Toyota's systematic way of leadership development. At the center of the model, there are Toyota's core values: 1- spirit of challenge, 2- kaizen mind, 3- genchi genbutsu (go and see), 4- teamwork, and 5- respect for people. Four iterative phases of leadership development, which are repeated at every level as a typical leader moves up the leadership ladder are: 1- commit to self-development, 2- coach and develop others, 3- support daily kaizen, and 4- create vision and align goals (hoshin kanri).

According to Koenigsaecker (2005) four levels of change and learning are required for a successful lean transformation: 1- Jishukin/RCI (rapid continuous improvement), learning about basic lean tools and applying new lean principles, under sensei's tutelage, 2- learning supporting leadership or management practices, 3- actually believing the key principles of lean, and 4- key changes in leadership behavior.

Implementing lean in its entirety is significantly more difficult to be understood and practiced than it may sound (Emiliani, 2013). Ergo, the creation of new tools or adaptation of already existing tools that can help leaders to perform their newly emergent roles seems necessary. Schwagerman and Ulmer (2013) elaborated on the role of A3 report as a leadership or management process for ingraining the continuous improvement culture in the organization. They assert that frequent and consistent application of the A3 method, which is founded on PDCA and continuous improvement mentality, gradually instills the culture of continuous improvement in both leaders and employees.

Emiliani (2008) put forth the idea of standardized work for executive leadership. Despite mainstream perception which considers leadership as a significantly volatile and purely knowledge-based activity, he argues that only a small fraction of the executives' day-to-day work

is notably varied. Emiliani (2008) believes that standardized work for leaders can reduce inconsistencies in decision-making and also bad decisions which are the root causes of variability and errors.

Jordan and Michel (2001) suggest use of balanced scorecard (Kaplan and Norton, 1996) upon approval and acceptance of a set of strategic goals. Based on this balanced scorecard any strategic goals have to be assessed from four different perspectives: 1. Customary financial goals, 2. Goals relating to customers' viewpoint, 3. goals relating to efficient and effective operations, and 4. goals relating to preparing for the future through learning and growth. However, Jordan and Michel added two more perspectives: 1. goals relating to globalization, and 2. goals relating to innovation. They also draw attention on the significance of having a balanced performance measurement system corresponding to these strategic goals.

Lean leadership/management system vs. other management/leadership paradigms

There are divergences as well as convergences between lean leadership/management principles and practices and other managerial or leadership paradigms. What gives lead leaders an edge over others are some unconventional counterintuitive properties of true lean leaders. For example, lean project management becomes more efficient and powerful than traditional project management as the complexity and uncertainty of the project grows (Ballard and Tommelein, 2012).

Ljungblom (2012) conducted a comparative study between 'developmental leadership' and 'lean leadership' and concluded that the similarities are significantly more than the differences. However, while lean leadership behaviors are intended to serve the overriding purpose of continuous improvement through waste elimination, a developmental leadership model merely seeks to get the leaders to own up to their behaviors and to pursue self-development.

'Shared leadership' and 'authentic leadership' are two complementary concepts that fit well into the lean paradigm. "Team leadership is central for lean" and in order to operationalize this team leadership, authentic leaders have to be the reported-to authorities (Holm, 2010).

1-4- Literature review summary

Table 1 summarizes the explored available literature on lean leadership. Referring to ‘lean leadership’s how-to’ section of the table, attempts have been made to articulate responsibilities of leadership in lean implementation and also for describing characteristics and attributes of lean leaders. Some authors have devised guidelines or to-do lists for successfully leading a lean transformation. Besides, according to the Table 1, imperative of leadership is well-established explicitly and implicitly by scholars, which suggests the necessity of a comprehensive leadership model at leaders’ disposal throughout their lean journey.

		Literature source			
Significance of lean leadership	Implicitly	Shook (2010): Toyota leaders' way for achieving sustainable benefits out of lean is culture transformation.	Bhasin (2011): main challenge for lean leaders is fostering "a culture that is conductive to lean".	Bhasin (2012): sustainable lean requires an environment that encourages respect for people, process-oriented mindset, and continuous improvement.	Dombrowski and Mielke (2014): ignorance of lean philosophy, people, and problem solving, are responsible for lean's high failure rate.
	Explicitly	Koenigsaecker (2005): "lack of sufficiently-self-developed leaders" is one of the reasons for low rate of true lean success.	Mann (2009): lean management fills "a critical gap between lean tools and lean thinking".	Halling and Wijk (2013): leadership is one of the barriers to lean implementation in manufacturing and healthcare.	Dombrowski and Mielke (2013): lean leadership guarantees sustainability by coaching people and defining the values, vision, and goals.
		Ahmed (2013): failure of lean efforts is partly due to lack of distinction between management by objectives (MBO) and lean management.	Begam et al. (2013): the anxiety and time that it takes from management to be actively involved in the process is one of the obstacles for lean.	Jadhav et al. (2014): lack of management involvement, and lack of communication, cooperation and mutual trust are among the barriers to lean.	Hibidin and Yusof (2013): leadership and customer focus are two key success factors of Lean-Six-Sigma programs in Malaysian automotive industry
Lean leadership's how-to		Shook (2010): changing behaviors and attitudes through lean techniques, such as andon, precedes the change of culture, not the other way around.	Mann (2009): senior leaders contribute to lean by: 1- structures for responding to the difficulties, 2- supporting new practices; 3- ongoing improvements; 4- process-focused metrics, and 5- CI culture	Emiliani (1998): lean behaviors minimize the "waste associated with arbitrary or contradictory actions." 'Fat behavior' lead to 'loss of employee commitment' and diminishing participation level.	Bodek (2008): key differences between leaders and managers include: independent thinking, showing respect, encouraging ideas, and no-fear-of-mistake mindset.
		Gelei et al. (2015): while micro-management is a positive contributor to Lean transformation in short run, in long term micro-management impedes the progress and sustainability of lean efforts.	Marksberry and Hughes (2011): Toyota seeks managers with high capacity for improvement rather than experienced manager and there is a balance between executives' time on the shop-floor and in the office.	Dombrowski and Mielke, (2013):Lean leadership's five basic principles: 1- continuous improvement culture, 2- self-development, 3- qualification, 4- genchi genbutsu, and 5- hoshin kanri	Dombrowski and Mielke (2014): 15 lean leadership guidelines such as leader's continuity, not intervening directly in problem solving, self-awareness, developing each employees individually, and genchi genbutsu
		Pokinska et al. (2013): lean leaders 1- are more visible in the gemba, 2- spend more time for face-to-face meetings and use visual tools, 3- develop and empower employees, and 4- serve as a role model and coach.	Aij et al. (2014): three critical-to-lean leadership characteristics in healthcare: 1. going to the gemba, 2- empowerment and trust, and 3. modesty and openness.	Liker and Balle (2013): a PDCA cycle- comprised of standards, visualizing and reporting abnormalities, and kaizen- is the first responsibility of lean leaders.	Found et al (2009): there is a trivial difference between the skills and competencies required from leaders for the lean transformation in the first place and then for sustaining the benefits
		According to Pamfilie et al. (2012), effective and frequent communication is a positive leadership behavior.	In their effort to develop an ideal lean leadership profile, Gelei et al. (2015) recognized communication as a contributor leadership attribute.	Emiliani (2005): lean leaders' errors: tool-box view, batch-and-queue mindset, lack of participation, disintegrated improvements, short-term horizon, and shareholder focus	Emiliani (2003): the missing link in competency models is underestimation of beliefs entrenched in the organizational culture and leaders' mind-set.
Self-development & leadership tools	self-development	Emiliani (2013): music may serve as a framework to help leaders appreciate lean leadership by comparing the similarities of learning to play a musical instrument with learning how to exercise lean properly	Found et al (2009): a double-loop learning cycle for managers is necessary for a sustainable lean implementation.	Liker and Convis (2012) formulated a lean leadership development model comprising four phases: 1- commit to self-development, 2- develop others, 3- support daily kaizen, and 4- create vision and align goals	
	Leadership	Emiliani (2008): Standardized work for leaders can reduce inconsistencies in decision-making and also bad decisions.	Jordan and Michel (2001): any strategic lean goal has to be assessed from 6 perspectives according to balanced scorecard: 1- financial, 2- customers' viewpoint, 3- efficient operations, 4. future, 5. globalization, and 6. innovation.	Schwagerman and Ulmer (2013): Frequent and consistent application of the A3 method, gradually instills the culture of continuous improvement in both leaders and employees.	

	Leadership model	Testani and Ramaknishnan (2011): Lean Transformational Leadership model (LTL). They believe transformational leadership behaviors pull the organizations culture toward a more adaptive and lean culture.	Dibia et al. (2014): Lean "leadership People Process Outcome" (LPPO) implementation model'. This incorporates 'people' and 'leadership' in the lean implementation.	
Lean vs. other paradigms		Ballard and Tommelein, (2012): Lean project management becomes more efficient than traditional one as the complexity and uncertainty grows.	Ljungblom (2012): While lean leadership behaviors are intended to serve the overriding purpose of continuous improvement, developmental leadership model seeks for getting the leaders own up their behaviors and self-develop.	Holm (2010): 'Shared leadership' and 'authentic leadership' are two complementary concepts that fit well into lean paradigm.

Table 1-Summary of literature review

Nonetheless, so far, no holistic, practical, and repeatable lean leadership model has been proposed in the literature. The only lean leadership models identified in the literature are the Lean Transformational Leadership Model (LTL) (Testani and Ramaknishnan, 2011) and lean "Leadership People Process Outcome" (LPPO) implementation model (Dibia, Dhakal and Onuh, 2014). However, both models lack the practicality and comprehensiveness that leaders need to more confidently set about the lean transformation. Their focus is leadership style in terms of leadership behaviors that shape the nature and dynamics of leadership-employee interactions. While, these models cover 'respect for people' aspect of lean to a large extent, they still fall short when it comes to various other areas of leadership's effects. In fact, leadership is an extremely complex and multi-faceted role and its different dimensions interact with one another. Neglecting any of the leadership's potential effects or responsibilities, renders the model a far cry from a comprehensive practical roadmap for lean leaders.

As lean leadership is the "missing link" in lean transformations (Mann, 2009), this gap points to a critical need by leaders for a practical and holistic leadership model, the fulfilment of which may unlock the door to successful and sustainable lean transformation. Therefore, the development of such a leadership model is the central objective of this research study.

In addition, Table 1 also suggests critical gaps in the literature in terms of lean leadership tools. While ample literature on technical and manufacturing-related lean tools is available, when it comes to leadership, a critical gap can clearly be identified. If the leaders are to be efficient and effective in their role, they also need to be equipped with appropriate lean tools. Filling this gap provides considerable opportunities for future research.

Chapter 2- Methodology

This research project pursues two main objectives: 1- investigating the role of leadership as the driving factor for successful lean implementation that delivers outstanding business results, and 2- proposing a holistic, implementable, and repeatable practical lean leadership model.

These objectives are achieved through findings of an expansive literature review complemented by results of a survey conducted among a number of lean-practicing organizations.

The first objective is reformulated through eight hypotheses. In this study, two variables represent 'leadership' and four variables represent 'business results'. Each of the eight hypotheses tests the existence of a statistically significant correlation between one of the 'leadership' variables and one of the 'business results' variables. Chi-square test, Cramer's V, Kruskal-Wallis H test, and Kendall's tau-b are the statistical methods that are used for hypothesis testing as appropriate. The data, used for hypothesis testing, is collected through the survey.

Achievement of the second objective entails two main steps:

1- Literature review and development of a preliminary model: lean leadership practices and enablers are identified through an extensive literature review. The findings lay the groundwork for devising a preliminary lean leadership model.
2- Revising and validating the lean leadership model: Each element of the preliminary model is validated through findings of the survey. Each element is represented by one or more variables and each variable is represented by a question of the survey. A series of hypotheses are tested for existence of a statistically significant correlation between each of the proposed elements and the respective organization's lean initiative's level of success. The same statistical methods as above are deployed for hypothesis testing as appropriate based on the type of the variables being tested. The elements which are approved to be correlated to the lean initiative's level of success are kept at the model and the rest are discarded.

Figure 5 demonstrates schematically the methodology that is pursued in a simple diagram.

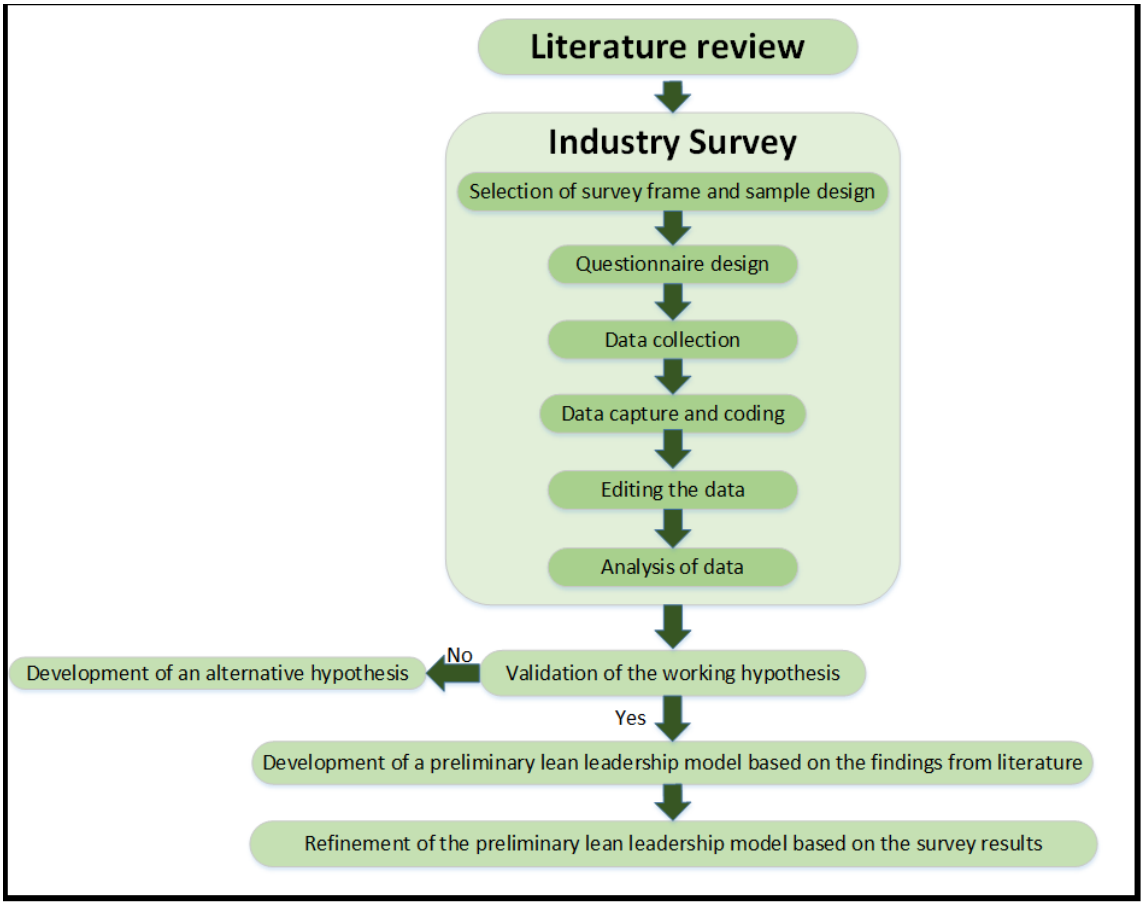

Figure 5. Methodology

2-1- Probing data from literature

Since the preliminary lean leadership model is created based on the lean leadership practices mentioned in the literature, and the survey questions regarding the leadership practices are also formulated on the basis of the leadership practices and enablers mentioned in the literature, a broad literature review is integral to this study's methodology. Four database searching engines are mainly used for the purpose of searching the literature: Aerospace, Google Scholar, IEEE Xplore, and Engineering Village. The key words used are: lean leadership, lean management, lean culture, barriers to lean, lean failure, lean success.

As the result of the searches, initially 86 papers and articles were quickly reviewed; out of which 49 are shortlisted as the most relevant and informative. Besides the shortlisted papers, 15 books are identified as containing relevant information and were used along the papers as references for this literature review.

2-2- Survey design and sampling procedure

A survey was conducted in order to serve two main purposes:

1- To verify or reject existence of a statistically significant correlation between superior business metrics and role of leadership in a lean initiative. The data required for doing such analysis was collected through this survey (Appendix II).
2- To verify or reject determining role of each of the lean leadership practices, extracted from the literature and incorporated in the preliminary lean leadership model, a series of statistical hypotheses needed to be tested. Each of these hypotheses is designed to verify or reject existence of a statistically significant correlation between a variable representing one the elements of the preliminary model and the lean initiative's level of success. The data required for conducting the tests was also collected through this survey.

One part of the questions in the survey questionnaire is related to business results, which serve the first purpose. However, the majority of the questions serve the second purpose and are based on the key leadership practices extracted from the available literature and reputed books that tell the story of real-life successful lean turnarounds.

In the course of iterative modifications, the number of questions in the survey was minimized to an extent that did not jeopardize the reliability and usefulness of the data to be collected. Since the targeted respondents of the survey are mainly people in leadership and management positions, to make it less time-consuming to be filled out and consequently more appealing to respondents with, most likely, busy schedules, most of the questions were designed in a multi-choice format. However, to acquire a better and deeper understanding of the potential enablers or impediments to lean implementation, a number of open-ended questions were added as complementary questions.

Overall, the questions of the survey are designed to probe deep into leadership practices, resulting business performance, and other possible contributors in the realm of leadership.

In order to make the survey more accessible and more respondent-friendly, and easier to be filled out, it was built online through the website www.surveymonkey.com. This online survey application also allows easier and faster collection and organization of the data.

The population under study in this research project consists of companies that have already embarked on their lean journey for enough time to allow them obtain at least some business results

that can be reflected on. So, regardless of size, field of activity, and nationality, any company that had already started lean and got some tangible business results was targeted. To reach out to such companies, mainly 2 strategies were used: 1- Posting the survey link on lean-related forums and groups on the Internet including the links below, and 2- Sending the online survey link to 24 lean or continuous improvement professionals and practitioners through LinkedIn's Inmail feature.

Lean Enterprise Institute's (LEI) lean forum: (https://www.lean.org/FuseTalk/Forum/)

LinkedIn group 'TPS Principles and Practice' (https://www.linkedin.com/groups/4669590)

LinkedIn group 'Operational Excellence' (https://www.linkedin.com/groups/129331)

LinkedIn group 'Lean Six Sigma' (https://www.linkedin.com/groups/37987)

LinkedIn group 'lean forum' (https://www.linkedin.com/groups/1841145)

LinkedIn group 'Continuous Improvement, Six Sigma, and Lean group' (https://www.linkedin.com/groups/52933)

LinkedIn group 'Value Stream Mapping' (https://www.linkedin.com/groups/982747)

LinkedIn group 'Lean Business System' (https://www.linkedin.com/groups/1801885)

LinkedIn group 'Lean Human Resources' (https://www.linkedin.com/groups/3260967)

LinkedIn group 'Lean Sig Sigma Worldwide' (https://www.linkedin.com/groups/3786766)

LinkedIn group 'Gemba Academy' (https://www.linkedin.com/groups/50264)

2-3- Phase I: testing the working hypothesis

2-3-1- Variable definition

The main research question is: "is leadership the driving factor toward a successful lean transformation that delivers outstanding business results?" In this regard, the first step would be to formulate it in the form of a statistical hypothesis to be tested for validation or rejection. This question and any derived hypothesis encompass two main elements of 'leadership' and 'business results and validating or rejecting the working hypothesis involves investigating the correlation of these two distinct elements. Each of the two elements needed to be broken down into clearly

defined and measurable variables and each of the variables had to be represented by a question in the survey questionnaire.

Business results

Since a combination of financial/business measures can reflect the overall success of an organization in business terms, four variables have been considered as indicators of bottom line business results: 1- annual change in gross sales on average during the implementation of lean, 2- annual change in gross profit on average during the implementation of lean, 3- annual change in market share on average during the implementation of lean, 4- annual change in company's value/size on average during the implementation of lean.

Leadership

Leadership as a driving force behind lean is inherently a qualitative fuzzy variable that needs to be clearly defined and quantified for the sake of statistical analysis. Therefore, it has been examined from two different perspectives, each represented by one variable:

Position of the initiator of the lean transformation: This aspect of leadership's role in lean transformation is represented by a multi-chotomous nominal variable defined by three categories: 1- leadership, 2- business improvement manager/lead, and 3- other. This variable is represented by question number 7 of the survey questionnaire (Appendix II), which is originally in the form of an open-ended question, however, for the sake of analysis the responses were later converted to a multi-chotomous nominal variable by categorizing the responses according to the above-mentioned groups (Appendix IV-table 4-1).

A total of 45 legitimate answers were recorded for this question, which generated a response rate of 91.8%.

Leadership's level of direct involvement: Leadership's involvement is repeatedly mentioned in the literature as a determining factor in success of lean (Mann, 2009; Began et al, 2013; Habidin and Yusof, 2013; Halling and Wijk, 2013; Halling and Renstro, 2014; Koenigsaecker, 2005). However, its exclusive impact on achieving superior business results has never been studied. Thus, one of the leadership factors chosen to be studied is 'the leadership's level of direct involvement. This variable is represented by an ordinal rank variables defined on a 5-point scale. In question number 27 of the survey questionnaire (Appendix II), the respondents were asked to rank the 'level

of leadership's direct involvement' in the lean initiative on a 1-to-5 scale where '1' is for 'no involvement', and '5' is for 'very high level of involvement.'

Responded by all but one of the participants, the response rate for this question was 97.5%.

2-3-2- Formulation of the statistical hypotheses

The main null hypothesis of this study is "the business results achieved from a lean initiative are independent (have no correlation) with the role of leadership in the initiative." And so the alternative hypothesis is "the business results achieved from a lean initiative depend (have a statistically significant correlation) with the role of leadership in the initiative. However, the two main components of this hypothesis, 'leadership' and 'business results', need to be clearly defined and represented by measurable variables in order for the hypothesis to be testable. So, it is reformulated as eight hypotheses which are organized in two groups:

1- Hypotheses regarding the correlation between 'role of leadership as the initiator' and 'the business results':

   Hypothesis 1: it investigates the existence of a statistically significant correlation between 'annual change in gross sales on average' and 'position of the initiator'.

   Null hypothesis H_0: 'annual change in gross sales on average' is statistically independent from 'position of the initiator of lean' (there is no statistically significant correlation between 'annual change in gross sales on average' and 'position of the initiator of lean'.

   Alternative hypothesis H_1: 'annual change in gross sales on average' is statistically dependent to 'position of the initiator of lean' (there is no statistically significant correlation between 'annual change in gross sales on average' and 'position of the initiator of lean'.

   Hypothesis 2: it investigates the existence of a statistically significant correlation between 'annual change in gross profit on average' and 'position of the initiator'.

   Null hypothesis H_0: 'annual change in gross profit on average' is statistically independent from 'position of the initiator of lean' (there is no statistically significant correlation between 'annual change in gross profit on average' and 'position of the initiator of lean'.

   Alternative hypothesis H_1: 'annual change in gross profit on average' is statistically dependent to 'position of the initiator of lean' (there is no statistically significant

correlation between ‘annual change in gross profit on average’ and ‘position of the initiator of lean’.

Hypothesis 3: it investigates the existence of a statistically significant correlation between ‘annual change in market share on average’ and ‘position of the initiator’.

Null hypothesis H_0: ‘annual change in market share on average’ is statistically independent from ‘position of the initiator of lean’ (there is no statistically significant correlation between ‘annual change in market share on average’ and ‘position of the initiator of lean’.

Alternative hypothesis H_1: ‘annual change in market share on average’ is statistically dependent to ‘position of the initiator of lean’ (there is no statistically significant correlation between ‘annual change in market share on average’ and ‘position of the initiator of lean’.

Hypothesis 4: it investigates the existence of a statistically significant correlation between ‘annual change in company’s value on average’ and ‘position of the initiator’.

Null hypothesis H_0: ‘annual change in company’s value on average’ is statistically independent from ‘position of the initiator of lean’ (there is no statistically significant correlation between ‘annual change in company’s value on average’ and ‘position of the initiator of lean’.

Alternative hypothesis H_1: ‘annual change in company’s value on average’ is statistically dependent to ‘position of the initiator of lean’ (there is no statistically significant correlation between ‘annual change in company’s value on average’ and ‘position of the initiator of lean’.

2- Hypotheses regarding the correlation between ‘leadership’s level of direct involvement in the initiative’ and ‘the business results’

Hypothesis 5: it investigates the existence of a statistically significant correlation between ‘annual change in gross sales on average’ and ‘leadership’s level of direct involvement in the initiative’.

Null hypothesis H_0: ‘annual change in gross sales on average’ is statistically independent from ‘leadership’s level of direct involvement in the initiative’ (there is no statistically significant correlation between ‘annual change in gross sales on average’ and ‘leadership’s level of direct involvement in the initiative’.

Alternative hypothesis H_1: 'annual change in gross sales on average' is statistically dependent to 'leadership's level of direct involvement in the initiative' (there is no statistically significant correlation between 'annual change in gross sales on average' and 'leadership's level of direct involvement in the initiative'.

Hypothesis 6: it investigates the existence of a statistically significant correlation between 'annual change in gross profit on average' and 'leadership's level of direct involvement in the initiative'.

Null hypothesis H_0: 'annual change in gross profit on average' is statistically independent from 'leadership's level of direct involvement in the initiative' (there is no statistically significant correlation between 'annual change in gross profit on average' and 'leadership's level of direct involvement in the initiative'.

Alternative hypothesis H_1: 'annual change in gross profit on average' is statistically dependent to 'leadership's level of direct involvement in the initiative' (there is no statistically significant correlation between 'annual change in gross profit on average' and 'leadership's level of direct involvement in the initiative'.

Hypothesis 7: it investigates the existence of a statistically significant correlation between 'annual change in market share on average' and 'leadership's level of direct involvement in the initiative'.

Null hypothesis H_0: 'annual change in market share on average' is statistically independent from 'leadership's level of direct involvement in the initiative' (there is no statistically significant correlation between 'annual change in market share on average' and 'leadership's level of direct involvement in the initiative'.

Alternative hypothesis H_1: 'annual change in gross sales on average' is statistically dependent to 'leadership's level of direct involvement in the initiative' (there is no statistically significant correlation between 'annual change in market share on average' and 'leadership's level of direct involvement in the initiative'.

Hypothesis 8: it investigates the existence of a statistically significant correlation between 'annual change in company's value on average' and 'leadership's level of direct involvement in the initiative'.

Null hypothesis H_0: 'annual change in company's value on average' is statistically independent from 'leadership's level of direct involvement in the initiative' (there is no

statistically significant correlation between ‘annual change in company’s value on average’ and ‘leadership’s level of direct involvement in the initiative’.

Alternative hypothesis H_1: ‘annual change in company’s value on average’ is statistically dependent to ‘leadership’s level of direct involvement in the initiative’ (there is no statistically significant correlation between ‘annual change in company’s value on average’ and ‘leadership’s level of direct involvement in the initiative’.

All of the eight hypotheses are tested in the same order as mentioned above in section 3-1 of chapter 3, using the data collected from the survey.

2-3-3- Statistical analysis

The effect of leadership as the driving factor on each of these business metrics and the correlation between leadership factors and these metrics are the subject of interest of the first phase of this study. In the following sections, the central research question is approached in four different ways:

1- **Kruskal-Wallis one-way test of variance (H test):** Construction of a series of hypotheses to determine if there are statistically significant differences between two or more independent samples (each sample representing one of the response categories of the independent variable) in relation to a continuous dependent variable (any of the business metrics). This method has been used in subsequent sections for analysis of the association of each leadership factor (‘position of the initiator’ and ‘leadership’s level of direct involvement’) with each of four business metrics.

Null hypothesis H_0: assumes that the samples are from identical populations.

Alternative hypothesis H_1: assumes that the samples come from different populations.

Acceptance of the alternative hypothesis supports the proposed idea that leadership has a profound impact on the bottom line results and is probably the driving factor for a successful lean transformation that delivers superior business results.

The Kruskal-Wallis test is the non-parametric counterpart of the one-way ANOVA test. The test assesses whether c independent samples are from the same population or from populations with continuous distribution and the same median for the variable being tested. The variable being

tested must be at least of ordinal type. The test procedure starts by assigning natural ordered ranks to the sample values, from the smallest to the largest. Tied ranks are substituted by their average.

Let R_i denote the sum of ranks for sample i, with n_i cases and N denote the total number of observations across all samples. Under the null hypothesis, we expect that each R_i will exhibit a small deviation from the average of all R_i, $\bar{R}$. The test statistic is:

$$KW = \frac{12}{N\,(N+1)} \sum_{I=1}^{c} n_i\,(R_i - \bar{R})^2 \qquad (1)$$

which, under the null hypothesis, has an asymptotic chi-square distribution with df = c – 1 degrees of freedom (when the number of observations in each group exceeds 5) (Marques de Sa, 2007). So, using the table of critical values for chi-square distribution (Appendix I), the null hypothesis will be rejected or accepted.

When there are tied ranks, a correction is inserted in the formula, dividing the KW value by:

$$1 - \left(\sum_{i=1}^{g}(t_i^3 - t_i)\right)/\,(N^3 - N) \qquad (2)$$

Where t_i is the number of ties in group i of g tied groups, and N is the total number of cases in the c samples (sum of the n_i) (Marques de Sa, 2007). In this study all the above-mentioned calculations and analysis are done using SPSS statistical software.

For the Kruskal-Wallis H test the degree of freedom equals (c-1), with c being the number of categories of the grouping variable.

2- **Chi-square test:** The Chi-square statistic is a non-parametric (distribution free) test designed to analyze group differences when the dependent variable is measured at a nominal level.

In order to explain Chi-square test, first the concept of 'contingency table' is defined. Suppose the independent variable has r categories (i= 1,2,…, r), each represented by one row of a table; and the dependent variable, of which correlation with the independent variable is being tested, assumes c possible values, each represented by one column of a table (j= 1,2,…, c). If each cell of the table contains the number of observations in the sample that belongs to respective categories of the dependent and the independent variables, then the table is called a contingency table.

The formula for calculating Chi-Square value for each cell is:

$$\chi_{ij}^2 = \frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad (3)$$

And the final chi-square statistic is:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \chi_{ij}^2 \quad (4)$$

Where:

O_{ij} = Observed value of each cell (the actual count of cases in each cell of the table)

E_{ij} = Expected value of each cell

In the Chi-square statistic, the "expected" values represent an estimate of how the cases would be distributed in different categories of the dependent variable if there were no effect by the independent variable. Expected values must reflect both the incidence of cases in each category and the unbiased distribution of cases if there is no effect by the other variable. This means the statistic cannot just count the total N and divide by number of categories of the independent variable for the expected number in each cell (McHugh, 2013).

$$E_{ij} = \frac{M_r \times M_c}{n} \quad (5)$$

Where M_r = represents the row marginal for that cell, M_c = represents the column marginal for that cell, and n = represents the total sample size.

For the chi-square test the degree of freedom equals the product of (r-1) and (c-1), with r being the number of rows and c being the number of columns.

3- **Cramer's V (phi) Coefficient φ_c**: this method will be used for measuring the magnitude of association or the effect size of 'position of the initiator' as one of the leadership factors on each of the four business metrics.

Cramer's V coefficient is designed for assessing the association between two multi-chotomous variables. This coefficient is stemmed from Chi-square statistic.

Cramer's V has an advantage over χ^2 statistic in analyzing the relationship between categorical variables. While comparing the obtained value for $\chi 2$ statistic with the critical values of Chi-square

distribution table (Appendix I) leads to rejection or acceptance of the under-study independency hypothesis, it does not demonstrate the strength (size) of the association. Hence, in analyzing and interpreting the nature of relationship between two categorical variables, Cramer's V coefficient can be uses as a complementary method by providing extra details and insight.

$$\boldsymbol{\varphi_c} = \sqrt{\frac{\boldsymbol{\chi^2}}{\boldsymbol{n} \times [\boldsymbol{min}\,(\boldsymbol{r},\boldsymbol{c}) - \mathbf{1}]}} \qquad (6)$$

Where r is the number of rows (number of response categories of independent variable) and c is the number of columns (number of response categories of dependent variable) (Chen and Popovich, 2002)

Interpretation of Cramer's V depends on the number of rows and columns of the contingency table, which is represented by the degree of freedom. It needs to be noted that the degree of freedom used for interpreting the Cramer's V effect size is different from Chi-square's degree of freedom. For Cramer's V coefficient, degree of freedom equals the minimum value between (r-1) and (c-1) (Gravetter and Wallnau, 2007)

4- **Hypothesis testing using Kendall's tau-b coefficient**: this method will be used for measuring the magnitude as well as the direction of association of the leadership's level of direct involvement in the lean endeavor as one of the leadership factors on each of the four business metrics.

Kendall's tau is a nonparametric measure of association that describes the relationship between two variables and is used frequently in the social science literature. It requires a random sample of data pairs (*X, Y*) measured on at least an ordinal scale and taken from any continuous bivariate distribution. It takes values that range between −1 and +1, with +1 indicating an absolute positive association between the variables, -1 indicating an absolute negative association, and zero indicating no association/relationship between the concerned variables (Gibbons, 1993)

Specifically, tau measures the association between X and Y as the proportion of concordant pairs minus the proportion of discordant pairs in the samples. Two bivariate observations, (X_i, Y_i) and (X_j, Y_j), are called concordant whenever the product $(X_i - X_j)(Y_i - Y_j)$ is positive, that is, when the difference between the X components in the pairs has the same sign as the difference between the Y components in the same pairs. A pair is called discordant when the same product is negative.

Kendall's tau can be calculated using the below formula where C denotes the number of concordant pairs and D denotes the number of discordant ones. Observations with a tie in either set are called neither concordant nor discordant and are not counted in calculating either C or D (Gibbons, 1993).

$$\tau = \frac{2\,(C-D)}{n\,(n-1)} \tag{7}$$

The above formula is the most generic form of Kendall's tau coefficient, called τ_a, which is used in the simple case of not having equal values and consequently equal ranks in the data set. Based on the way that equal ranks are treated, several other variations of τ, namely τ_b, and τ_c exist.

Since 'leadership's level of direct involvement' as one of the defined leadership factors is an ordinal variable that can take only 5 values on the discrete integer range of 1 to 5, naturally the number of ties in the data set are considerable. So, in order to deal with the situation, τ_b is selected and used as the appropriate measure of association.

$$\tau_b = \frac{2\,(C-D)}{\sqrt{(n^2-n-2t')(n^2-n-2u')}} \tag{8}$$

Where

$$t' = \frac{(\sum t^2 - \sum t)}{2} \tag{9}$$

for t the number of observations tied at any given value in the X set and the sums Σ are over all sets of t tied X values; u′ represents the same calculation for ties in the Y set (Gibbons, 1993).

The following statistic, Z_B, has the same distribution as the τ_b distribution, and is approximately equal to a standard normal distribution when the quantities are statistically independent. Therefore, it can be used for testing of hypothesis when the null hypothesis is the independency of two components (X and Y) of a set of bivariate data.

$$Z_B = \frac{C-D}{\sqrt{v}} \tag{10}$$

Where

$$v = (v_0 - v_t - v_u)/18 + v_1 + v_2 \quad (11)$$

$$v_0 = n(n-1)(2n+5) \quad (12)$$

$$v_t = \sum_i t_i\,(t_i - 1)\,(2t_i + 5) \quad (13)$$

$$v_u = \sum_j u_j\,(u_j - 1)\,(2u_j + 5) \quad (14)$$

$$v_1 = \sum_i t_i\,(t_i - 1) \sum_j u_j\,(u_j - 1)/\,(2\,n\,(n-1)) \quad (15)$$

$$v_2 = \sum_i t_i\,(t_i - 1)\,(t_i - 2) \sum_j u_j\,(u_j - 1)\,(u_j - 2) / (9\,n\,(n-1)\,(n-2)) \quad (16)$$

t_i = number of tied values in the i^{th} group of ties for the first variable

u_j = number of tied values in the j^{th} group of ties for the second variable

Thus, to test whether two variables are statistically dependent, one computes Z_B, and finds the cumulative probability for a standard normal distribution at $-|Z_B|$. For a 2-tailed test, multiply that number by two to obtain the p-value. If the p-value is below a given significance level, one rejects the null hypothesis (at that significance level) that the quantities are statistically independent.

The questions representing the business metrics are in the form of open-ended questions and the respondents were asked to provide the numeric values of the change in each of the business metrics (in the form of exact numbers, or in indexed, or percentage terms). So the collected data for business results were inherently in the form of continuous variable. While Kruskal-Wallis H test and Kendall's tau-b are applicable to continuous variables, application of Chi-square test of independency, and Cramer's V entailed further processing of the data and transforming them into the form of nominal variables (Appendix III).

2-4- Phase II: development of the lean leadership model

Through an extensive literature review, leadership-related practices were identified, particularly based on the leadership practices of Art Byrne, the CEO of Wiremold, one of the legendary lean companies. The preliminary lean leadership model was proposed based on the identified leadership practices. This preliminary model served as the foundation for the second step to be built upon.

In the second part of our analysis, correlations of a number of variables representing the identified leadership practices, with level of the lean initiative's success in achieving its goals, were studied. Similar to the first phase of the statistical analysis, all of the variables involved in this step are also either nominal or ordinal. Thus, the suggested statistical tools to test the aforementioned correlation are similarly the Chi-square, Cramer's V (phi) coefficient, Kruskal-Wallis H, and Kendal's tau-b tests.

Based on the results, the leadership practices that exhibit weak or no significant correlation with the success level were ruled out and the rest, which show significant correlation, were classified as enabler or inhibitor based on the sign (direction) of the association.

All of the mathematical calculations, drawing of tables and diagrams, as well as statistical tests and procedures are done by either SPSS or Microsoft Office Excel.

Chapter 3- Phase I: validating the working hypothesis

A total of 49 respondents participated in the survey; who were practicing lean in companies that operate in different business fields. Figure 6 shows the distribution of respondents based on the field of activity of their respective companies.

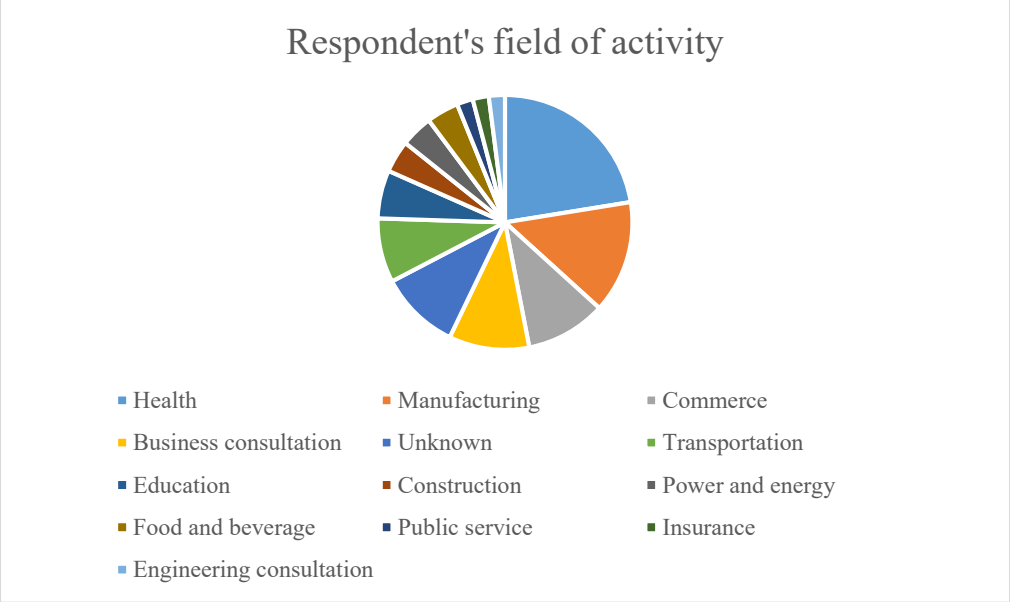

Figure 6. Pie chart for respondents' field of activity

In addition, Figure 7 below demonstrates the distribution of the respondents based on the level of their organizational position.

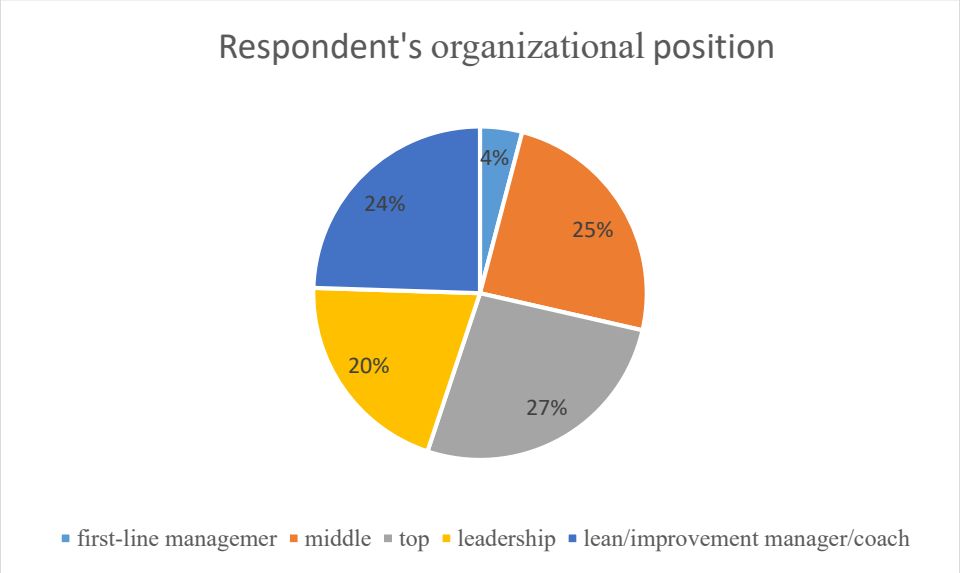

Figure 7. Pie chart for respondent's level of organizational position

3-1- Association between the leadership factors and business results

Verification of leadership as a driving force behind a successful lean transformation that delivers desirable business results is done in two parts. First, the correlation between the position of the initiator and experienced average annual change in the four selected business metrics is examined. Second, the impact of leadership's level of direct involvement in the transformation on the bottom-line business results is investigated.

The four business results related variables are represented in the survey questionnaire (Appendix II) by questions number 49, 50, 54, and 55 respectively. According to Kalton and Kasprzyk (1982) "receipts of various sources of income may have high nonresponse rate" so since these questions all related to financial information, as it was expected from the outset, more than 65% of the respondents (32 respondents) did not answer any of these questions (i.e. due to the confidentially concerns). Thereby, the response rates for questions 49 (gross sales), 50 (gross profit), 54 (market share), and 55 (company's value) are 34.7%, 32.7%, 22.4%, and 26.5% respectively.

In order to address this shortcoming, in the first step all the non-respondents who had provided contact information were approached for the second time and were offered a confidentiality agreement that guarantees protection of their financial information. Despite this confidentiality proposition, they were still reluctant to provide such information.

Missing responses is one of the most common problems to surveys that imposes biasing effects on the results (Montaquila and Ponikowski, 1993). Compensation for item nonresponse, which this survey suffers from, is usually done by imputation (i.e. assigning values for missing responses) (Kalton and Kasprzyk, 1982). So, the second approach, which was considered to address the problem, was imputation. Toward this end, several commonly used imputation methods including deductive imputation, mean imputation overall, random imputation overall, mean imputation with classes, random imputation within classes, hot-deck imputation, flexible matching imputation, predicted regression imputation, and random regression imputation were studied in terms of their applicability to and suitability for these concerned variables with high nonresponse rates.

However, the results of the above study suggests that due to small sample size and considerably large proportion of nonresponses to responses (2 to 1 at the best) applying any of these methods probably generates larger bias and compromise reliability of the results. Therefore, in this thesis, the data are treated and analyzed as-is, while in making any inference and conclusion the low response rate should be considered as a reason for extra caution.

3-1-1 Correlation between 'position of the initiator' and the four business metrics

On the one hand, the position of the initiator is a multi-chotomous nominal variables which may take three different values (leadership, business improvement manager, and other). On the other hand, business results, characterized by four business metrics of gross sales, gross profit, market share, and company's value/size, are originally continuous scale variables (i.e. the associated questions are in the form of open-ended questions). So, one way of assessing the association between these two types of variables is Kruskal-Wallis H test for independency as described in chapter 2.

The Kruskal-Wallis H test only checks for validation or rejection of the null hypothesis (independency). Therefore, Cramer's V coefficient is used as a complementary tool for measuring the magnitude (effect size) of this correlation. Since Cramer's V coefficient can only be calculated for two sets of categorical (ordinal or nominal) variables, the collected data for business metrics are transformed into categorical data by splitting the range of observed data into a few subdivisions.

The association between the 'position of the initiator', as a nominal variable, and average annual change in 'gross sales', 'gross profit', 'market share', and 'company's value' as originally continuous variables, may be analyzed using Kruskal-Wallis H test, Chi-square test, and Cramer's V coefficient. However, in order for Chi-square test and Cramer's V to be applicable to these types of variables, the continuous data is converted to categorical data based on tables 3-1, 3-2, 3-3, and 3-4 of Appendix III. Accordingly, the contingency tables, based on which Chi-square and Cramer's V tests are done, may be find in Appendix VI.

Using the SPSS statistical software, three types of statistical tests are conducted in order to investigate the correlation between the four business metrics and 'position of the initiator'. The results are summarized in Table 2.

Variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
Gross sales	Kruskal-Wallis	1.051	1	0.305	3.84	0.05
	Chi-square	1.862	3	0.645	7.81	0.05
	Cramer's V	0.331	1			
Gross profit	Kruskal-Wallis	2.191	1	0.149	3.84	0.05
	Chi-square	3.277	3	0.351	7.81	0.05
	Cramer's V	0.453	1			

Market share	Kruskal-Wallis	1.103	1	0.325	3.84	0.05
	Chi-square	2.333	3	0.506	7.81	0.05
	Cramer's V	0.441	1			
Company's value	Kruskal-Wallis	0.517	1	0.472	3.84	0.05
	Chi-square	1.465	3	0.690	7.81	0.05
	Cramer's V	0.336	1			
*Df stands for 'degree of freedom' ** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test						

Table 2. Summary of the statistical correlation tests' results for 'position of the inititar' and the busienss metrics

Gross sales

'Average annual change in gross sales' is represented by question 49 of the survey questionnaire (Appendix II). A total of 17 responses to this question are cross-tabulated in Appendix VI- Table 6-1. The Chi-square and Cramer's V tests are done based on the contingency table (Appendix VI-Table 6-1), however for the Kruskal-Wallis test the contingency table is not needed. Since the total count for the 'Business improvement manager' row of the contingency table is zero, this category and its corresponding row is disregarded in the calculations and analysis of Chi-square and Cramer's V tests.

According to the values for the KW statistic and p-value (Table 2), since $1.051<3.84$ and $p= 0.305>0.05$, for N=17 at $\alpha= 0.05$ level of significance, there is no statistically significant difference between 'lean initiative's level of success' when the lean initiative is initiated by the leadership comparing with the other categories.

Based on the table of critical Chi-square values (Appendix I), for N=17 and for 3 degrees of freedom, at $\alpha= 0.05$ level of significant, the chi-square statistic should be greater than 7.81 for the null hypothesis (independency of the variables) to be rejected. So, since $1.862<7.81$ and $p=0.545> 0.05$, there is no statistically significant correlation between the 'position of the initiator' and 'average annual change of gross sales'

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V between 0.3 and 0.5 signals a medium effect. Thus, $\varphi_c =0.331$ suggests an effect of medium magnitude by the 'position of the initiator' on 'the lean initiative's success level'.

Gross profit

‘Average annual change in gross profit’ is represented by question 50 of the survey questionnaire (Appendix II). A total of 17 responses to this question are cross-tabulated in Appendix VI- Table 6-2.

Since the total count for the ‘Business improvement manager’ row of the contingency table is zero, this category and its corresponding row is disregarded in the calculations and analysis of Chi-square and Cramer’s V tests.

According to the values for the Kruskal-Wallis test statistic (KW=2.191<3.84) and p-value (p= 0.149), at α= 0.05 level of significant, there is no statistically significant difference between ‘gross profit’ of the companies in which a lean transformation was initiated by leadership and the other group.

Based on the table of critical Chi-square values (Appendix I), for N=16 and for 3 degrees of freedom, at α= 0.05 level of significant, the Chi-square statistic should be greater than 7.81 for the null hypothesis (independency of the variables) to be rejected. So, since 3.277<7.81, there is no statistically significant correlation between the ‘position of the initiator’ and ‘average annual change of gross profit’

According to Cohen (1988), for 1 degree of freedom, a value of Cramer’s V in the range of 0.30 to 0.50 signals a medium effect. Thus in accordance with the Kruskal-Wallis test and Chi-square test, φ_c =0.453 does not demonstrate an effect of large magnitude on the ‘average annual change in gross profit’ as a business outcome by ‘position of the initiator’.

Market share

‘Average annual change in market share’ is represented by question 54 of the survey questionnaire (Appendix II). A total of 11 responses to this question are cross-tabulated in Appendix VI- Table 6-3. Since the total count for the “Business improvement manager” row of the contingency table is zero, this category and its corresponding row is disregarded in the calculations and analysis.

According to the above values for the Kruskal-Wallis test statistic (KW=1.103<3.84) and p-value (p=0.325>0.05), there is no statistically significant difference between ‘market share’ of the companies that their lean transformation was initiated by leadership and the other group.

Based on the table of critical Chi-square values (Appendix I), for N=11 and for 3 degrees of freedom, at α= 0.05 level of significant, the chi-square statistic should be greater than 7.81 for the

null hypothesis (independency of the variables) to be rejected. So, since 2.333<7.81 and p=0.506>0.05, then, based on the Chi-square test, there is no statistically significant correlation between the 'position of the initiator' and 'average annual change in market share.'

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V in the range of 0.30 to 0.50 signals a medium effect. Thus in accordance with the Kruskal-Wallis and Chi-square tests, φ_c =0.441 does not demonstrate an effect of large magnitude on the 'average annual change in market share' by the 'position of the initiator'.

Company's value

'Average annual change in company's value/size' is represented by question 55 of the survey questionnaire (Appendix II). A total of 13 responses to this question are cross-tabulated in Appendix VI- Table 6-4. Since the total count for the "Business improvement manager" row of the contingency table is zero, this category and its corresponding row is disregarded in the calculations and analysis.

According to the values for the test statistic Kruskal-Wallis (KW=0.517<3.84) and p-value (0.472>0.05), for N=13 and at α=0.05 level of significance, there is no statistically significant difference between 'average annual change in value/size' of the companies that their lean transformation was initiated by leadership and the other group.

Based on the table of critical Chi-square values (Appendix I), for N=13 and for 3 degrees of freedom, at α= 0.05 level of significant, the chi-square statistic should be greater than 7.81 for the null hypothesis (independency of the variables) to be rejected. So, since 1.465<7.81 and p=690>0.05, then there is no statistically significant correlation between the 'position of the initiator' and 'average annual change in company's value.'

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V (φ_c =0.336) between 0.30 and 0.50 signals a medium effect. This is in accordance with the results of Kruskal-Wallis and Chi-square tests above.

3-1-2- Correlation between ‘leadership’s level of involvement’ and the four business metrics

Leadership’s level of direct involvement in the lean transformation is represented by question 27 of the survey questionnaire (Appendix II). Kendall’s tau-b coefficient is an appropriate parameter for measuring magnitude and also direction of the association between two ranked variables when tied ranks exist within the data (Chen and Popovich, 2002). So, along with Kruskal-Wallis H test for independency, the correlation of “leadership’s level of direct involvement” with each of the four business metrics is also evaluated by this coefficient.

Using the SPSS statistical software, the two types of statistical tests are conducted in order to investigate the correlation between the four business metrics and ‘leadership’s level of direct involvement’. The results are summarized in Table 3.

Variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
Gross sales	Kruskal-Wallis	11.315	4	0.003	9.49	0.05
	Kendall’s tau	0.633		0.001		0.05
Gross profit	Kruskal-Wallis	11.881	4	0.001	9.49	0.05
	Kendall’s tau	0.645		0.001		0.05
Market share	Kruskal-Wallis	4.972	3	0.116	7.81	0.05
	Kendall’s tau	0.511		0.040		0.05
Company’s value	Kruskal-Wallis	8.366	3	0.006	7.81	0.05
	Kendall’s tau	0.591		0.012		0.05

*Df stands for ‘degree of freedom’
** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test

Table 3. Summary of the statistical correlation tests' results for 'leadership's level of direct involvement' and the business metrics

Gross sales

According to the above values for the KW and p-value, at α= 0.01 level of significance, there is a statistically significant difference between 'gross sales' of the companies that their leaders are more involved in the lean transformation and the ones that their leaders are allegedly less involved in the transformation. As 'the leadership's level of direct involvement' increases, the mean rank of the corresponding group in terms of 'average annual change in gross sales' also increases.

Based on the above values of Kandall's tau-b coefficient and p-value, at α= 0.01 level of significance, there is a positive strong correlation between "leadership's level of involvement" and "average annual change in gross sales". This is in accordance with the result of Kruskal-Wallis test above.

Gross profit

According to the Table 3, since KW=11.315>9.49 and p=0.003<0.05, at α= 0.05 level of significance, there is a statistically significant difference between 'average annual change in gross profit' of the companies that their leaders are more involved in the lean transformation and the ones that their leaders are allegedly less involved in the transformation.

Based on the values of τ_b =0.633 and p=0.001<0.05, at α= 0.05 level of significance, there is a positive strong correlation between "leadership's level of involvement" and "average annual change gross profit". This is in accordance with the result of Kruskal-Wallis test above.

Market share

Since the total count for the group with 'the leadership's level of involvement' equals to '4' is zero, this category is disregarded in the calculations and analysis. So the interpretation of the results are based on 3 degrees of freedom.

According to Table 3, since KW=4.972<7.81 and p=0.116, so at α=0.05 level of significance, there is no statistically significant difference between the growth of 'market share' of the companies that their leaders are more involved in the lean transformation and the ones in which their leaders are supposedly less involved. However, one noteworthy observation is that, according to the information provided by SPSS (Table 4), the mean ranks for the two groups with higher levels of involvement (3 and 5) are considerably higher than that of the two groups with lower levels of involvement (1 and 2). Therefore, care must be taken in interpreting the results.

Ranks

	Leadership's direct-involvement	N	Mean Rank
average annual change in market share	1	1	3.00
	2	4	4.00
	3	1	8.00
	5	6	8.50
	Total	12	

Table 4. SPSS output for Kruskal-Wallis correlation test between 'annual change in market share on average' and 'leadership's level of direct ivolvement'

As for the Kandall's tau test, since τ_b =0.511 and p=0.040<0.05, then there is a positive strong correlation between "leadership's level of involvement" and "average annual change in market share" at α= 0.05 level of significance. This result is in contrast with Kruskal-Wallis H test. However in combination with the information given in Table 4, it seems reasonable to assume that in fact a correlation exists between 'annual change in market share on average' and 'leadership's level of direct involvement'.

Company's Value

Since the total count for the group with the level of involvement equals to '4' is zero, this category is disregarded in the calculations and analysis. So the interpretation of the results is based on 3 degrees of freedom.

According to the above values for the KW and p-value, there is a statistically significant difference, at α= 0.01 level of significance, between 'change in value/size of the company' of the companies that their leaders are more involved in the lean transformation and the ones that their leaders are allegedly less involved in the transformation.

Based on the above values of Kandall's tau-b coefficient and p-value, there is a positive strong correlation between 'leadership's level of involvement' and 'change in value/size of the company' at α= 0.05 level of significance. This result supports the above result obtained from Kruskal-Wallis H test.

3-2- Association between leadership factors and 'the lean initiative's level of success'

As a complementary measure for assessing the effect of leadership on successful lean transformation, one extra measure is designed in form of an ordinal rank variable. This variable is represented by question 12 of the survey questionnaire (Appendix II), which asks respondents to indicate 'the Lean initiative's level of success' in achieving its goals.

In order to examine whether this more general metric follows the same pattern as the business metrics in relation to leadership or not, the correlation between this variable and each of the leadership-related variables (position of the initiator, and leadership's level of involvement) is measured.

In the first part of the analysis (correlation with position of the initiator), the variable is treated as a nominal variable with 5 levels according to the original classification of the answers. However, as it comes to the correlation with leadership's level of involvement, it is treated as an ordinal rank variable (Appendix V- table 5-1).

Using the SPSS statistical software, the applicable statistical tests are conducted in order to investigate the correlation between the leadership factors and 'lean initiative's level of success'. The results are summarized in Table 5.

Dependent variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
Position of the initiator	Chi-square	12.032	8	0.150	15.51	0.05
	Cramer's V	0.398	2			
Leadership's level of involvement	Kruskal-Wallis	14.091	4	0.007	9.49	0.05
	Kendall's tau	0.444		0.001		0.05

*Df stands for 'degree of freedom'
** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test

Table 5. Summary of the statistical correlation tests' results for leadership factors and 'lean initiative's level of success'

Position of the initiator and the lean initiative's level of success

A total of 38 legitimate pairs of answers are cross-tabulated in Appendix VI- Table 6-5.

A quick review of the joint frequency chart of 'position of the initiator' and 'the lean initiative's level of success' (Figure 8) implies the idea that as the proportion of leaders as initiators increases,

the success level also increases. However, statistical analysis of the two concerned variables provides a more solid basis for making conclusions.

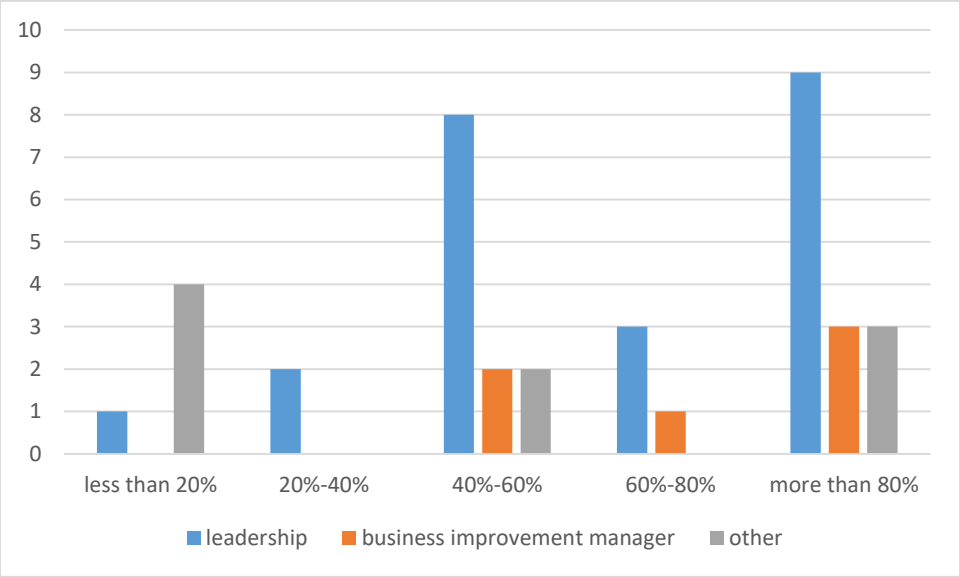

Figure 8. Joint frequency chart of the 'positon of the initiator' and 'lean initiative's level of success'

Since "Position of the initiator" is a nominal variables, the other variable (the lean initiative's level of success) is also treated as a nominal variable. Cramer's V coefficient and Chi-square test are used for gauging their correlation.

Based on the table of critical chi-square values (Appendix I), for 12 degrees of freedom and for α= 0.05, the Chi-square statistic should be greater than 15.51 for the null hypothesis (independency of the variables) to be rejected. So, according to Table 4 since 12.032<15.51 and p=150>0.05, then there is no considerable evidence of a significant association between the 'position of the initiator' and 'the lean initiative's level of success".

According to Cohen (1988), for 2 degrees of freedom a value of Cramer's V greater than 0.35 signals a large effect. Thus, in contrast to the result of chi-square test above, φ_c =0.398 suggests a correlation of large magnitude between the "position of the initiator" and "the lean initiative's level of success".

Leadership's level of involvement and level of success

Total number of legitimate pairs of answers are 41, which are cross-tabulated in Appendix VI-Table 6-6.

The joint frequency chart of 'the leadership's level of involvement' and 'the lean initiative's success level' suggests a positive association between the two variables. As demonstrated in Figure 9, for the two lowest levels of involvement (1 and 2), all the cases have achieved less than 80% of their goals. The proportion of successful cases (more than 80%) to unsuccessful ones (less than 80%) improves slightly as the level of involvement increases to 3 and 4. Following the same trend, for the highest level of leadership's involvement, the number of successful cases significantly exceeds the unsuccessful ones.

So, as the both variables are ordinal, Kruskal-Wallis H test and Kendall's tau-b are used for further statistical analysis.

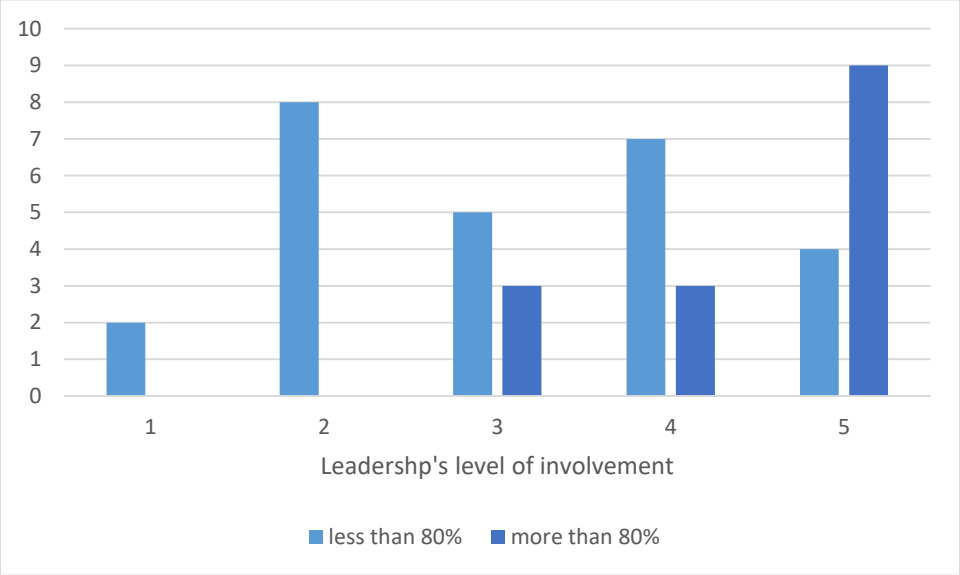

Figure 9- Joint frequency chart of "leadership's level of direct involvement" and "lean initiative's level of success"

According to the above values for the KW and p-value, for N=41, there is a statistically significant difference, at $\alpha = 0.01$ level of significance, between 'the lean initiative's level of success' of the companies that their leaders are more involved in the lean transformation and the ones that their leaders are allegedly less involved in the transformation.

Based on the above values of Kandall's tau-b coefficient and P-value, there is a positive and strong correlation between "leadership's level of involvement" and "lean initiative's success level".

3-3- Correlation between the two leadership factors

A total of 44 pairs of observations are used for analysis in this section, which are cross-tabulated in Appendix VI- Table 6-7. The question is originally in the form of an open-ended question that

asks the respondent to write the position (job title) of the initiator. However the collected data is categorized under three categories: 1- leadership, 2- business improvement manger, and 3- other (Appendix IV- Table 4-1).

The chart below (Figure 10) is the joint frequency chart of the two leadership factors. As demonstrated by the chart, while for lower levels of involvement (1, 2, 3, and 4) the number of leaders (as initiators) is lower than or at best equal to the number of other two categories, when it comes to the highest level of involvement (5), the proportion of leaders to the other two categories strikingly enhances. It implies that initiation of the lean initiative by leadership increases the chance of leadership being more involved in the initiative.

Since statistical analysis of correlation provide more solid and reliable material in support of the above allegation, Chi-square test and Cramer's V coefficient were deployed for further investigating the existence of such a relationship between the two leadership variables.

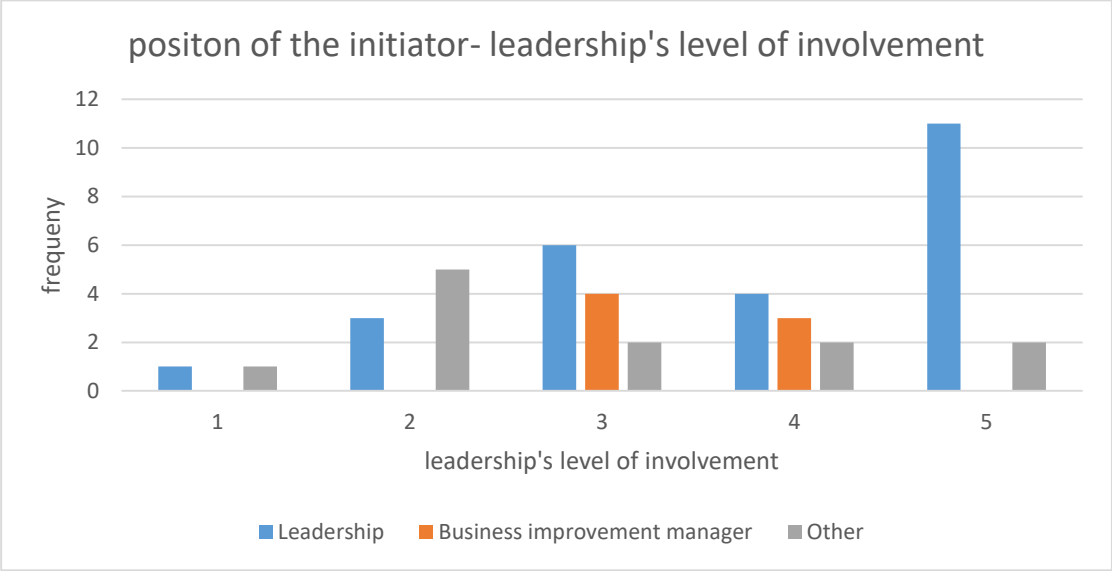

Figure 10- Joint frequency chart of "position of the initiator" and "leadership's level of direct involvement"

Using SPSS statistical software the following values were obtained for the test statistics:

1- Chi-square statistic = 15.589,

   Df = 8,

   P-value (sig. two tailed) = 0.049,

Based on the table of critical Chi-square values (Appendix I), for 8 degrees of freedom and for alpha= 0.05, the Chi-square statistic should be greater than 15.51 for the null hypothesis (independency of the variables) to be rejected. So, 15.589>15.51 provides enough evidence for rejecting the null hypothesis of independency, and confirms a strong correlation between the 'position of the initiator' and 'leadership's level of direct involvement.'

2- Cramer's V coefficient = 0.421

   Df = 2,

According to Cohen (1988), for 2 degrees of freedom a value of Cramer's V greater than 0.35 indicates a large effect size. Thus, in perfect accordance with Chi-square statistic, Cramer's V coefficient suggests a correlation of large magnitude between 'the position of the initiator' and 'the leadership's level of direct involvement.'

3-4- Conclusions

Table 6 summarizes the correlation analyses conducted between 'the position of the initiator' and the four business metrics.

Based on the table, the position of the person/people who has/have initiated lean has no meaningful impact on the business results.

Matrix of correlations with 'position of the initiator'					
		Statistical test/measure			
		Kruskal-Wallis	Kendall's tau-b	Chi-square test	Cramer's V effect size
Business metric (% of average annual change)	Gross sales	×		×	Medium
	Gross profit	×		×	Medium
	Market share	×		×	Medium
	Size/value	×		×	Medium

The cells marked with '✓' in the unshaded area of the table, indicate existence of a statistically significant correlation between the 'position of the initiator' and the concerned business metric based on the concerned statistical test.
The cells marked with '×' in the unshaded area of the table, indicate lack of a statistically significant correlation between the 'position of the initiator' and the concerned metric based on the concerned statistical test.
A shaded cell indicates that the concerned statistic test/measure was not applicable or was simply not deployed for the analysis.
For the Cramer's V test, if applicable, the identified effect size is indicated in the table.

Table 6. Summary matrix of the correlation of 'position of the initiator' and the business metrics

Table 7 summarizes the correlation analyses conducted between 'the leadership's level of involvement' and the four business metrics.

Based on the table, unlike 'position of the initiator', the level that the leadership is directly involved in lean may improve the chance of reaping more benefit from the lean initiative. It is true with regards to all four business metrics.

Matrix of the correlations with 'leadership's level of involvement'					
		Statistical test/measure			
		Kruskal-Wallis	Kendall's tau-b	Chi-square test	Cramer's V effect size
Business metric (% of average annual change)	Gross sales	✓	✓		
	Gross profit	✓	✓		
	Market share	×	✓		
	Size/value	✓	✓		

The cells marked with '✓' in the unshaded area of the table, indicate existence of a statistically significant correlation between the 'leadership's level of involvement' and the concerned business metric based on the concerned statistical test.
The cells marked with '×' in the unshaded area of the table, indicate lack of a statistically significant correlation between the 'leadership's level of involvement' and the concerned metric based on the concerned statistical test.
A shaded cell indicates that the concerned statistic test/measure was not applicable or was simply not deployed for the analysis.
For the Cramer's V test, if applicable, the identified effect size is indicated in the table.

Table 7. Summary matrix of the correlation of 'leadership's level of involvement' and the business metrics

The above results, in combination with the results of the correlation analysis between the leadership factors and 'the lean initiative's level of success' suggests the following conclusion:

The lean initiative's success level follows the same pattern as business metrics in relation to leadership-related variables. None of the business metrics show a strong correlation with 'position of the initiator' and in the same manner, 'Lean initiative's level of success' does not exhibit strong correlation with 'position of the initiator'. However, quite opposite to expectations, all of them except one (market share) demonstrate a strong positive correlation with 'leadership's level of involvement.'

	Leadership factor							
	Position of the initiator				Leadership's level of involvement			
	Type of statistical test/measure							
	Kruskal-Wallis	Kendall's tau-b	Chi-square	Cramer's V	Kruskal-Wallis	Kendall's tau-b	Chi-square	Cramer's V
Level of success			×	Large	✓	✓		

The cells marked with '✓' in the unshaded area of the table, indicate existence of a statistically significant correlation between the concerned leadership factor and the lean initiative's level of success, based on the concerned statistical test.
The cells marked with '×' in the unshaded area of the table, indicate lack of a statistically significant correlation between the leadership factor and the lean initiative's level of success, based on the concerned statistical test.
A shaded cell indicates that the concerned statistical test/measure was not applicable or was simply not deployed for the analysis.
For the Cramer's V test, if applicable, the identified effect size is indicated in the table.

Table 8. Summary matrix of the correlation of the leadership factors and 'lean initiative's level of success'

Although strong correlation does not necessarily mean cause-and-effect relationship, the precedence of leadership's involvement to bottom line business results and intuitive logic support speculation of such relationship. Ergo, while leadership's high level of involvement remains a much likely cause for better business outcomes, 'position of the initiator' can be ruled out as the direct cause, or driving force for a successful Lean transformation with outstanding business results. The figure below (Figure 11) depicts the dynamic of leadership factors' relationship with business results by a simple diagram.

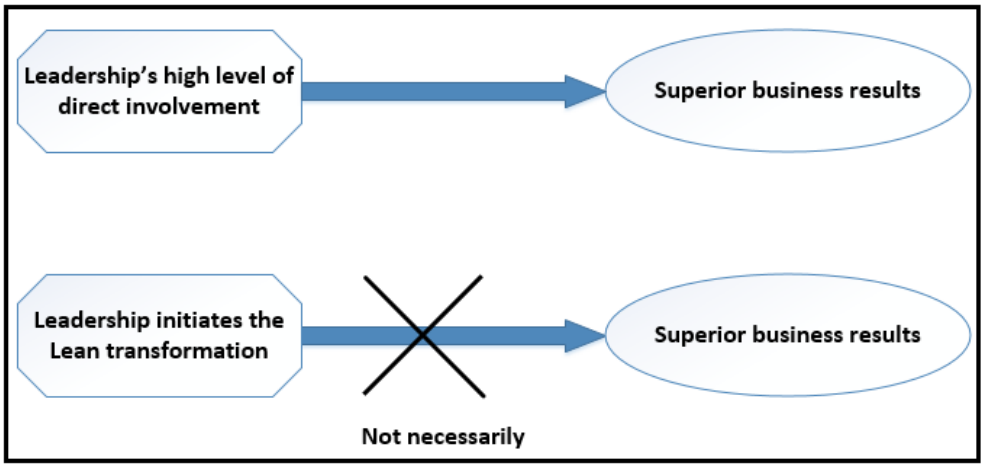

Figure 11- Dynamics of the relationship between "leadership factors" and "business results"

However, the medium effect size of 'the position of the initiator' on 'average annual change in gross profit', 'average annual change in market share', and 'average annual change in company's value/size', suggested by Cramer's V coefficient, triggered a more meticulous investigation of the correlation between the business metrics with 'position of the initiator". Toward this end, the

existence of correlation between the two leadership-related metrics is investigated in order to detect the possibility of an indirect association.

Based on the results of the statistical analyses in section 3-3, there is a strong correlation between the 'position of the initiator' and 'the leadership's level of direct involvement'. Therefore, considering the chronological precedence of initiation of the lean transformation to leadership's engagement in the transformation, and also based on common logic, it seems reasonable enough to acknowledge position of the initiator as a cause factor for leadership's level of involvement. The combination of this strong causal relationship and strong correlation between business metrics and leadership's level of involvement, implies an indirect association between 'position of the initiator' and business metrics as shown in Figure 12.

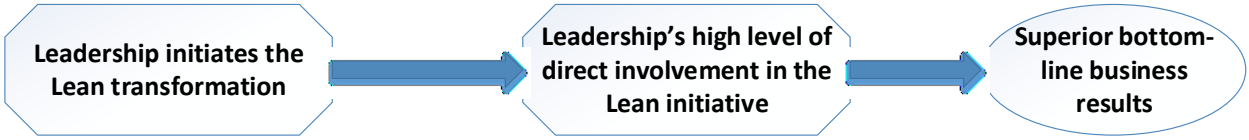

Figure 12- Indirect association between "position of the initiator" and "business results"

3-5- Summary

While all of the business metrics show no statistically significant correlation with the 'position of the initiator' based on the Chi-square and Kruskal-Wallis tests and are at the best under an effect of medium magnitude by 'position of the initiator', still existence of a statistically significant correlation between all of the four metrics and 'leadership's level of direct involvement', proves the determining role that leadership may play in gaining superior business results from the lean initiative.

Correlations between 'the lean initiative's level of success' and the two leadership factors follow the same trend as while 'position of the initiator' show no correlation, 'leadership's level of involvement' has a statistically significant correlation with the level of success.

Analysis of the correlation between the two leadership factors, suggests that the lean initiatives that are initiated by leadership are more likely to enjoy higher levels of leadership's direct involvement. This new insight reveals the possibility of an indirect association between 'position of the initiator' and the business results or level of success in achieving the goals. In other words,

since when leadership initiates a lean initiative, it is more likely to be actively involved in the initiative, then achieving better business results is also more probable.

Chapter 4- Development of the lean leadership model

4-1- Preliminary lean leadership model

Practicability and applicability of the lean leadership model is one of the main emphases of this study. In order to fulfill this requirement, a real-life case of a successful lean implementation is used as the basis for the model.

Wiremold, an iconic lean company, is selected as the benchmark case, due to five major reasons:

1- While Toyota is actually where lean originated from, its initial organizational and manufacturing structures were founded based on lean principles originated by Taiichi Ohno, Kichiro Toyoda, and its other legendary industrial engineers. However, most of leaders who wish to embark on their lean journey do not enjoy the luxury of leading a green-field organization. Unlike Toyota, Wiremold was an organization with all the conventional characteristics of a typical batch-and-queue system already in place and a well-entrenched American batch-and-queue culture. Hence, the leadership practices in Wiremold in the course of the transformation may serve as a better role model for other long-established organizations who are about to start their journey and face the extra challenge of replacing firmly established physical and cultural monuments of the batch-and-queue era.

2- The bottom-line business results obtained by Wiremold through its lean transformation were exceptional and rare in scope and magnitude.

3- Unlike most of the lean transformations, Wiremold leaders pulled off a sustainable transformation in the sense that they continued to reap outstanding benefits out of their lean efforts.

4- Many managers who oppose or are doubtful about lean attribute Toyota's success to unique Japanese cultural characteristics. They believe that lean has worked in Toyota but it will not work in other cultural settings (e.g. American companies), because other cultures are not compatible with lean tools and mentality. However, Wiremold as an undisputable lean success story, brings validity of such allegations into question.

5- Last but definitely not the least, Wiremold is almost the only fully lean company, for which sufficient, clear, and detailed information of the leadership practices is available.

Due to the above-mentioned reasons, two books served as the main basis for constructing the preliminary lean leadership model:

1- The Lean Turnaround: How Business Leaders Use Lean Principles to Create Value and Transform Their Company by Art Byrne (2012)
2- Better Thinking Better Results: Case Study and Analyze of an Enterprise-Wide Lean Transformation by Bob Emiliani (2007)

However, using only one company as the reference raises some doubts about the applicability of the leadership practices to other organizations with different cultural and economic settings. In addition, Toyota as the company where lean was born in, could not be totally overlooked. So, two following books, written based on Toyota's lean journey, are selected and used as complementary sources:

1- The Toyota Way to Continuous Improvement: Linking Strategy and Operational Excellence to Achieve Superior Performance by Jeffrey Liker and James Franz (2011)
2- Lean Thinking: Banish Waste and Create Wealth in Your Organization by James Womack and Daniel Jones (1996)

It is worth mentioning that the book "Lean Thinking" also includes success stories of a few of the other well-reputed lean transformers such as Pratt and Whitney, Porsche, and Lantech. Thus, it provides extra proof for applicability of lean practices in different cultures, economies and fields of business.

			Literature sources			
			Main sources		Complementary sources	
			The lean turnaround	Better thinking better results	Lean thinking	The Toyota way to lean leadership
Main elements of the lean leadership model	Respect for people	People development		✓	✓	✓
		No fear of mistakes	✓	✓	✓	
		Communication and transparency	✓	✓	✓	✓
	Self-development	Lean knowledge	✓	✓	✓	
		Lean sensei	✓		✓	✓
		On-the-job training (learning by doing)	✓	✓	✓	✓
		Genchi genbutsu	✓	✓		✓
	Overarching and supporting structures	Hoshin kanri		✓	✓	✓
		Lean function		✓	✓	
		Process-oriented performance metrics	✓	✓		
		System-oriented reward system	✓	✓	✓	✓
	Day-to-day management	Kaizen participation	✓	✓	✓	
		Standard work		✓	✓	✓
	Kaizen		✓	✓	✓	✓

Table 9. References for lean leadership model's components in the literature

As summarized in Table 9, leadership practices identified from the literature are classified into 4 main categories, and further each category is represented by one layer of the proposed lean leadership model. In a lower level, each category is represented by a number of leadership practices. The main categories of leadership practices and their sub-practices, in the order that they appear in the structure of the model beginning from the outer layer moving toward the inner layer, are:

1- Respect for people

1-2- No fear of mistakes (through encouraging and supporting new improvement ideas)

1-3- Communication and transparency

1-4- People development

2- Leadership's Self-development

2-1- Lean knowledge

2-2- Training under lean sensei's supervision

2-3- On-the-job application of lean (on-the-job training)

2-4- Genchi genbutsu

3- Overarching structures/systems

3-1- Hoshin kanri

3-2- Process-oriented performance metrics

3-3- system-oriented reward system

3-4- Lean function

4- Daily management (Continuous day-to-day leadership practices)

4-1- Kaizen participation

4-2- Standard work

5- Kaizen

Most of the lean tools, practices, structures, and principles are considerably intertwined and consequently, there are inevitable overlaps between these categories. Also, some variables representing each of these categories, also pertain to one or more other categories.

Based on the above classification, a preliminary leadership model is proposed (Figure 13).

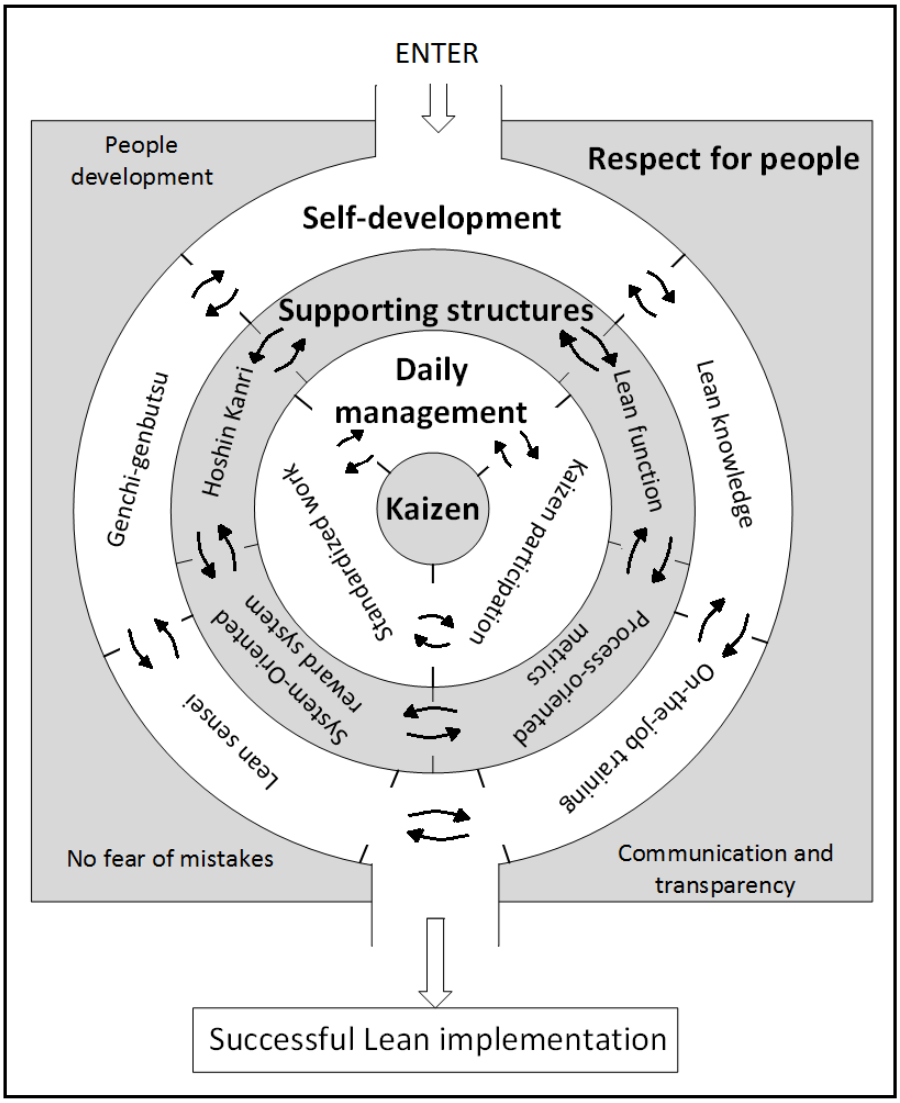

Figure 13. Preliminary lean leadership model

In order to explain the logic of the proposed model, each element is discussed briefly in the next sections. After refinement and finalization of the lean leadership model in the next step, each element that passes the correlation will be retained in the final model, and otherwise will be eliminated.

For the leaders who have resolved to undertake an enormous changeover in the way of thinking, learning, and doing business, this model is constructed to serve as practical and easy-to-apply instructions. It cannot be overemphasized that if lean is to help their business thrive, while all the layers and elements of the model need to be gone through constantly and iteratively, each layer of the model represent the precondition for the inner layers. It means as long as an outer layer is not operationalized to an acceptable extent, a respective inner layer may not be brought into reality. Having that in mind, in the following sections each element of the model is explained briefly.

It is also vital to remind the leaders that there is no single or rigid prescription for successful lean implementation. Each company needs its unique way and custom-designed tools for implementing lean. However in the following sections, some examples of how to operationalize these lean elements in practice are provided, to give leaders useful hints and ideas on how to carry out their lean turnaround. Each of these advises and instructions may be manipulated to fit the specific cultural, financial, business, or technical settings of an organization.

4-1-1- Respect for people

The most outer layer of the model signifies one of the two main cornerstones of lean: ‘respect for people’. This is actually the preparation step that precedes any endeavor for making a change toward leanness. Leaders needs to make sure that the proper cultural setting, embedding the ‘respect for people’ principle, exists before actually entering the cycle of leading a lean transformation. This requires ingraining trust, transparency, mutual respect, and no-fear-of-mistakes mindset in the organizational culture. Therefore, this is vital to create such a culture at the outset and more importantly sustain it throughout the infinite lean journey. This is a never-ending process. A culture that embraces ‘respect for people’ principle is the bedrock for all other lean leadership practices and processes.

No fear of mistakes

One way to create an environment of trust is developing a ‘code of conduct’ for everyone including the leaders and high-level managers and make sure that it is advocated and supported at all levels and under any circumstances. This ‘code of conduct’ better be simple, concise, easy-to-remember, and more importantly egalitarian. Besides, it needs to be constantly communicated through visual tools and in periodic staff meetings. Not blaming people for their innocent mistakes or for the problems or defects that are the result of ill-designed processes, should be incorporated in the code

of conduct. It is also necessary to make sure that everyone including the managers and leaders are treated equally in case of violating the code of conduct. This helps to create the environment of trust which is prerequisite of communication and transparency.

Communication and transparency

People need to feel that they are trusted and well-informed about the company current condition in terms of financial status, key performance metrics, market position, anticipated challenges, projected changes, and available resources. They also need to be thoroughly educated about company's values, short and long-term vision, periodic goals, and their own specific role in the company's path to the future, as well as their projected career path in the company. This sense of belonging to a circle of trust is indeed the greatest incentive for performing at their best in company's interest. Keeping the employees constantly updated about above-mentioned matters may be done by posting financial and performance metrics and goals and company's core values and vision on andon boards, walls, and bulletin boards, or sharing them with employees by periodic emails, internal brochures, and newsletters, or talking about them regularly in periodic staff meetings.

People development

Lean leaders should take responsibility for developing their workforce. All the associates should be provided with equal opportunities to be trained in lean principles and tools under the tutelage of a sensei or lean coach. The sensei may be the associate's immediate supervisor, who in turn has his/her own sensei. Leader has to make sure that the employees are learning by doing and the senseis are providing challenges, and structured opportunities for learning. A lean leader can help people realize their full potential by experiencing increasingly challenging problems and working in different functional areas. It is critical to bear in mind that leader's job is coaching and asking questions, not providing the answers. After each gemba walk, the leader should leave employees with new challenges. This is how people learn to think lean and apply it to their day-to-day jobs.

In the conventional business system with all the functional departments in place, people are able to fairly predict their future career path, which usually entails getting promoted gradually to a higher position in their own functional specialty. However, in the new lean business system, the conventional functional departments, and consequently the conventional function-based career paths are disappeared forever. So, to keep them motivated, leaders need to devise new value-

stream-based career paths that fulfill employees' need for growth and self-actualization. While each company has to devise its own promotion system, it will be illustrated by an example. For instance, each employee can be rotated in different functional field of activity (i.e. working in each functional field for a few years), and if managed to master all will be promoted to the manager of a value stream.

4-1-2- Self-development

Once the proper setting is established, the leader should start self-development. A lean leader needs to act as a role model for its entire workforce. Thus, he/she needs to think lean, act lean, and speak lean. Self-development as a lean leader is a manifestation of 'continuous improvement' principle of lean, in the sense that it is a perpetual cyclic process. Working under direct supervision of a lean sensei, applying lean tools continuously in doing daily activities, and obtaining lean knowledge, over the long-run, equip the leader with necessary and deep-enough lean knowledge and insight. Genchi-genbutsu (go to gemba and see), standardizing leadership activities as much as possible, and apportioning strong time and resource commitment to lean help the leaders pave their way.

Lean knowledge

Obviously a leader who is supposed to lead a lean turnaround needs to be equipped with at least a rudimentary level of knowledge on lean. Today there are plenty of lean workshops, seminars, and in-class or online courses held by universities, consulting companies, or educational institutes that may be attended by leaders. There are also numerous amount of books, articles, and on-line materials on lean which are readily accessible to leaders. So, lean leaders who resolved to make a leap toward lean, should take time to familiarize themselves with lean concepts and tools through these available resources.

Training under lean sensei's supervision

Using lean senseis, who are employed by the company, or outside lean consultants, who are at company's service by a contract, is strongly recommended as leaders need help and guidance especially at the outset. It should be noted that if outside consultants are deployed, they should only be used for training purposes; because the main goal of using lean consultants is leaders' self-development and cultivation of local lean capabilities. At the beginning for few years, it is fine to use consultants' help for choosing kaizen opportunities, running kaizen events, and create one-piece flow. However, leadership need to make sure that the educational and training purposes are

sufficiently adhered to, in a way that in long run the company's own staff including shop-floor workers, manager, and leaders are well-equipped with lean knowledge and skills for implementing kaizen. Furthermore, leadership is responsible to make sure that the company's values, main strategy, and long-term vision are well-communicated with the senseis and lean consultants. This is specifically more important as it comes to outside consultants, because unfamiliarity with the organization's core values and vision may cause them to mislead the leaders. Finally, necessity of a perpetual commitment to self-development by the leaders, implies the necessity of a long-term relationship with the lean sensei. This long-term training under senseis' supervision is also one of the rare traits of Toyota that further signifies its long-term and profound commitment to leaders' self-development.

On-the-job application of lean

While acquiring lean knowledge through participation in training classes, seminars, and workshops may be a good first step toward self-development, however, applying lean tools and principles in practice while doing day-to-day job is the most effective method for developing lean skills. Identifying value streams, removing conventional functional departments and reorganizing based on value streams, using a combination of lean tools like kanban, andon, poka-yoke, and 5S for creating one-piece-flow, and introducing standardized work, takt time and Heijunka to the operations, are real-life training practices that help leaders master lean principles by being actively engaged in them.

Genchi genbutsu (go and see)

In order to be actively involved in the aforementioned changes and to be able to lead the subordinates in the process of changing over to lean ways, this is vital that the leaders be present in the gemba to grasp a deeper understanding about the way the work is done, the challenges ahead, and also the way lean tools may improve a process. Active presence in the shop floor (i.e. the place where the work is being done), is presented by a technique called genchi genbutsu (go and see) in lean parlance. The leaders should plan for regular and frequent walk-around meetings in different work cells or operation areas to review performance data, talk about the problems and the proposed counter measures, and initiate a kaizen event if required. When people believe that they will get blamed or punished if their suggested improvement ideas fail in practice or if they talk about the problems, it will prevent them from revealing the problems honestly or contributing generously by

proposing improvement ideas. Leaders shall not force their own solutions in these gemba meetings. Instead, decisions should be made, whenever possible, by those who actually do the job and have an intimate knowledge of what is happening and what potential solutions to any problem are. The leaders should only motivate, encourage participation, support and lead the team toward a consensus.

4-1-3- Overarching and supporting systems

Hoshin kanri

If the lean improvement activities are to make meaningful and sustainable benefits, they have to be goal-oriented, and efficiently measured. Otherwise, diverging improvement activities will produce conflicts and confusion, and most probably cause regression rather than progression. It necessitates the establishment of clear goals in different levels of organization that all converge to operationalize the highest level organizational goals. In other words, the goals of any improvement activity should be set in a way that the aggregated outcome of all the improvement activities positively contributes to the realization of the organizations' strategic goals. The corporate goals as a unifying and integrating mechanism guarantee alignment of strategic and long-term decisions with micro short-term decisions. Well-established vision and goals bring consistency over long run, and serve as a compass that provides direction, harmony, and consensus across functional boundaries. The lean philosophy insists on two necessary characteristics for the goals; they must be: 1- system-oriented (i.e., interests of the entire system has priority over functional interests), and 2- process-oriented (i.e., good process generates good results. So focusing on improving the process automatically has priority over merely focusing on improving results, because numbers can be manipulated easily). The lean tool for developing this hierarchy of converging goals is called 'hoshin kanri' or 'policy deployment.' Here are some guidelines for developing and promoting company's long-term vision and lean goals:

1- There should not be any tradeoff between costs, quality, and delivery.
2- Growth strategy is an essential part of the long-term goals.
3- Explicit financial or cost-saving targets hinder lean implementation.
4- Stretch goals are the driving engine behind continuous improvement. However, unrealistic and unachievable goals are major source of discouragement. Hence, balance is the key.
5- Clear time frames make the goals meaningful.

6- Top-level goals should be broken down to lower level goals all the way to daily performance targets.
7- In the staff meetings, the connection between the long-term goals of the organization and short-term financial interest of the employees should be clarified.
8- All the employees need to be well-informed and well-educated about the goals and understand and own their portion of the big picture.
9- Managers at each level work closely with their subordinates for devising action plans for accomplishing the company's goals.
10- Hoshin kanri is not a one-way mandate. Expansive data collection, an intensive process of leading two-way conversations at all levels, and building consensus are indeed the challenging parts of the hoshin kanri. Therefore, in essence hoshin kanri is a bottom-up process.
11- Leaders must engage their senior managers in the process of setting strategic goals. They also have to make sure that this procedure is followed all the way down the chain to the lowest level. That means first-line managers engage the team members under their supervision in the process of setting actionable and achievable long, and short-term goals for their work team.
12- Nevertheless, at the earlier stages of the lean implementation, since many managers at different levels are not sufficiently developed for running and leading a hoshin kanri process, a more top-down approach may be deployed. But as the level of lean knowledge and skills increases, a shift toward a top-to-bottom participation should be made gradually.
13- Use the same approach for developing the company's long-term vision. Don't impose a complete vision to the company. Use the PDCA cycle for refining the ideas that the people in the gemba have about the right vision for the company. This PDCA cycle that is fed by the ideas from gemba, ensures balance between stretch goals and realistic goals.
14- The company's vision should be simple and not limited by the current boundaries of the company or the respective industry.
15- Prioritization of the goals, selecting the most effective ones and allocating available resources to them, should not be overlooked. Otherwise, the viability of the entire lean initiative will be jeopardized.

Once the goals are clearly defined, two overarching elements of a reward system and progress monitoring system need to be designed in a way that impose system-oriented and process-oriented approaches and reinforce them.

Process-oriented performance metrics

The progress and performance metrics should be defined with focus on elimination of waste from processes rather than financial results. Encouraging the efforts and tracking the progress of improvements is the ultimate goals of the performance measurement rather than controlling the people. While the performance measurement systems should be customized based on particular needs and realities of each organization, the following guidelines may give some practical hints to lean leaders:

1- Performance measurement systems that report negative variance from a stretch goal should be avoided. Instead, a system of reporting actual non-financial operational actions and trends and their resulted financial outcomes should be devised.
2- The overall performance measurement system of an organization comprises of several local measurement systems at different levels of the organization that support locally-defined performance metrics which the people who work at that specific work area can relate to and have power to affect.
3- In addition to daily performance reports, the people on the shop floor who work at cell level, need to be updated about higher level performance metrics at least monthly. Such a report should be short and concise and may contain a few numbers on financial results such as sales but should mainly focus on key process-related metrics.
4- At least once a year, all the senior managers and heads of functional departments should be informed about the financial and non-financial results and work together to set future goals and encounter problems.
5- The exhaustive process of calculating return on investment (ROI) is redundant and even harmful, as it convert the focus on short-term cost-saving.
6- Performance metrics such as cost-per-piece for purchasing officers, or number of produced parts per hour for manufacturing workers are counter-lean and in fact encourage piling inventory and hiding defects and scrap. So, think it thoroughly before selecting a performance metric.

System-oriented reward system

Similarly, the employee reward system should encourage a system-oriented approach and motivate people to give priority to the interests of the whole system instead of their own functional department. Again there is no simple prescription to be used for leaders here. Each organization has to devise its own reward system based on its size, available resources, and cultural settings. However, the following guidelines may be used as examples of how to operationalize a system-oriented reward system:

1- All the employees better be paid a common market wage based on their qualifications and then get rewarded based on the overall company's performance.
2- A profit sharing program that is offered to all the employees, makes it possible for the people to enjoy the benefits of lean in short term and serves as an incentivizing tool.
3- Tying specific metric to a specific reward should be avoided, otherwise people focus narrowly only on what is measured and it also encourages individualism rather than team orientation.
4- adjusted bonus schemes based on product family is not recommended because given the supposedly even pace of work inside each product family it seems irrelevant and it can also generate continuous conflict due to job rotations.
5- Pay out employees' share of benefit at least quarterly.
6- Profit-sharing meeting should be held regularly each time the employees' shares of profit are distributed and in the meeting preferably the leader personally share briefly the financial and process results and explain the improvement plans for the next interval.
7- Complicated gain-sharing formulas or plans that pay out only above a target level that keeps climbing up should be avoided. This will make it look as if the company is manipulating the system.
8- One type of non-financial reward system that besides motivating people also promote kaizen as an imperative, is assigning highly productive and high-potential employees to the kaizen team for the next kaizen process as an acknowledgement of their superior performance.

Lean function

In order to pull all the required resources together, reinforce the imperative of lean and in particular continuous improvement (kaizen), follow up on the improvements, and assure that the whole transition is on track, a dedicated lean function, with the required level of authority and access to resources, shall be created. Someone with proven lean knowledge and skills should be assigned as the head of the lean function. This person should be delegated enough authority, probably report directly to the CEO, in order to be able to effectively follow up on the changes and take required resources out of other functions as appropriate to be deployed for kaizen events or execute improvement plans. One other advantage of creating such a lean function and permanent lean-related positions is that it shows the determination and persistence of the leaders in actually effecting enormous changes. This proves that lean is not just another 'flavor of the month' or merely a tuneful motto. The lean office better be staffed with few lean experts from outside, but the main part of its staff should be selected from highly qualified and motivated people from throughout the organization. Devising a system for identifying high-potential people in the organization and rotating them temporarily for an appropriate length of time (1 to 2 years) to the lean office and sending them back to their function of specialty afterwards, may serve as an effective strategy for promulgating lean throughout the organization and nurturing local lean advocates.

4-1-4- Daily management

Leadership and management are two intertwined concepts. Managers at the top of the organization and senior managers are usually the ones who take leading positions. Since this model is supposed to provide leaders with a comprehensive instruction guide, day-to-day management activities of leaders are also incorporated in this model as an inseparable part of the leaders' job.

Kaizen participation

First-to-do in the leadership's list of daily activities should be participation in kaizen events. If the subordinated are expected to allocate time to kaizen and give it priority, then the leadership needs to act as the role model. Leadership's time commitment plays a crucial role in instilling the culture of continuous improvement. The following list provide some examples of how leaders can demonstrate their commitment to lean by being involved in kaizen:

1- For initial kaizen activities, leader should carefully select kaizen opportunities with the largest impact on the entire system.

2- In each kaizen event, the leader may acquire ideas about what to tackle next from his/her subordinates.
3- Being physically present in kaizen events is particularly influential in early stages of the lean turnaround.
4- The leader has to force his/her direct reports to participate in kaizens.
5- The responsibility of the leader is not providing solutions. What a lean leader should do is providing energy, motivating people, setting stretch kaizen goals, and asking lots of questions.
6- While kaizen is expected to be a daily activity that happens at every level of the organization, leaders should lead the kaizen activities that have a broad impact across many functions and lead to major changes.
7- A leader should be at least available for the weekly kickoff sessions and final report meetings as often as possible.
8- If a new company or business division is acquired, it is preferable that the leadership conducts the initial kaizen trainings. It shows leadership's determination and persistence in implementing lean to the new staff.

Standard work

Lean uses standardized work basically as a tool for creating baselines for improvement. However, doing the job based on standardized work also is a part of knowledge and skill development. As a person becomes comfortable and highly experienced in doing a particular activity by repeating a standardized procedure over and over again, gradually s/he will come to realize the deficiencies of the procedure and will come up with more creative improvement solutions. The lean philosophy spurs initiation and generation of improvement ideas in the lowest level possible by the people who actually do the job. So, in order to realize the benefits of such employee-driven improvements, one of the tools in leadership's disposal is enforcing standardized work procedures.

Another aspect of standardized work is related to the daily activities of the leaders themselves. Although the daily duties of the leaders seems as intellectual activities that may not be standardized due to their non-repetitive nature, in fact leaders can develop their leadership skills by following standard procedures such as participating in kaizen for certain number of times per month, holding staff meetings for face-to-face communication in regular intervals, doing gemba walks regularly

during a week, and following a standard procedure for asking questions and following up on changes during their gemba walks.

4-1-5- Kaizen

Kaizen is at the heart of the model. In fact, the ultimate goal of this model is embedding kaizen in the culture of the organization. If a leader passes the outer layers of the model successfully, s/he will be able to reify the ideal state of kaizen. It is noteworthy that two main components of lean, respect for people and kaizen (continuous improvement), are positioned at the outermost and innermost layer of the model respectively. That is to say, the former is a prerequisite for actualization of the latter.

4-2- Statistical analysis of the lean leadership model's components

Defining the population under study and selecting a suitable representative sample, necessitates recognition of a suitable definition for 'leadership' or 'leader', based on which the population for study will be defined. As mentioned earlier in section 2-2, two available definitions in the literature were selected as being compatible with the lean philosophy:

Winston and Patterson (2006) define 'leader' as: "one or more people who selects, equips, trains, and influences one or more follower(s) who have diverse gifts, abilities and skills and focuses the follower(s) to the organizations' missions and objectives causing the follower(s) to willingly and enthusiastically expand spiritual, emotional, and physical energy in a concerted coordinated effort to achieve the organizational mission and objective." According to this definition, a leader needs to cultivate certain set of skills and competencies in order to influence, lead, encourage, and inspire their followers. However, the prerequisite to do so in practice, is being in a position of high authority and influence over a group of people (followers).

Emiliani (2007) suggests a new definition for 'leadership': "beliefs, behaviors, and competencies that demonstrate respect for people, improve business conditions, minimize or eliminates organizational politics, ensure effective utilization of resources, and eliminate confusion and rework." In a similar way, this definition for 'leadership' requires high level of power and influence by the leader.

Hence, in order to identify the leadership practices, the sample needed to be refined to include only the respondents whose organizational position fit the above-mentioned definitions of leadership.

Among the total of 49 participants in the survey, the ones in leadership, top-management, and middle-management positions are shortlisted due to having enough authority, influence and power to be qualified as a 'leader'. As the result, total of 14 respondents, who were in first-line-management, or lean advisor/consultant/coach/specialist positions, are eliminated from the sample.

In this step, correlation between each element of the preliminary model with 'the lean initiative's level of success', represented by question 12 of the survey questionnaire (Appendix II) is examined. Thereby, given the available responses to questions 12 and 5, the final sample for most of the correlation analyses contains a total of 33 respondents, unless otherwise indicated. In some cases where logically the respondent's position is not a matter of concern in analyzing the data and interpreting the results, the sample is larger.

Responses to question 12 (lean initiative's level of success), due to the style of the multiple choices that were originally available in the questionnaire for the respondents to choose from, are in the form of a nominal variable. However, ordinal data, when studied against other ordinal data in terms of correlation, often provide more meaningful information, particularly regarding the direction/sign of the correlation. Furthermore, inherent concept of this variable is ordinal. So, the collected responses were converted to ranks according to Appendix V-Table 5-1.

4-2-1- Respect for people

The first layer of the model, respect for people, comprises of three main elements. Each of these elements are represented by one or more variables in the form of questions in the survey questionnaire (Appendix II). The analyses of correlation between the variables (sub-elements of the model) and 'the lean initiative's level of success' are conducted using the SPSS statistical software. The results are summarized in Table 10.

Element	Variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
People development	Subordinates' competency in applying lean tools	Kruskal-Wallis	13.654	4	0.008	9.49	0.05
		Kendall's tau	0.415		0.002		0.05
No fear of mistakes	Improvement ideas from subordinates	Kruskal-Wallis	18.366	4	0.001	9.49	0.05
		Kendall's tau	0.555		0.000		0.05
Communication and transparency	Number of communication methods	Kruskal-Wallis	20.271	6	0.002	12.59	0.05
		Kendall's tau	0.548		0.000		0.05
	Frequency of communication	Chi-square	32.136	28	0.269	41.34	0.05
		Cramer's V	0.454	4			
		Kruskal-Wallis	12.696	6	0.048	12.59	0.05
		Kendall's tau	0.376		0.007		0.05
*Df stands for 'degree of freedom' ** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test							

Table 10. Summary of statistical correlation tests' results for sub-elements of 'respect for people' and 'lean initiative's level of success'

People development

Development of the employees is represented by question 32 of the survey questionnaire (Appendix II): "On a scale of 1 to 5, how much your subordinates' competency in applying lean tools have improved in the course of the initiative (1 for no progress, and 5 for extreme progress)". The position of a respondent is not a matter of concern for this criterion, so a total of 41 legitimate pairs of data are cross-tabulated in Appendix VI- Table 6-8.

According to Table 10, since KW=13.654>9.49 and p=0.008<0.05, for N=41 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations of the respondents with different level of 'improvement of the subordinates' competency in applying lean tools.'

Based on the values of Kandall's tau coefficient (τ_b=0.415) and p-value (p=0.002<0.05), for N=41 at α= 0.05 level of significance, there is a positive significant correlation between "improvement in the subordinates' competency in applying lean tools" and "the lean initiative's level of success". This is in accordance with the result of Kruskal-Wallis test above.

No fear of mistakes

This element of the model is represented by question 33 of the survey questionnaire (Appendix II): "How much of the implemented improvement ideas has come/came from your subordinates?" When there is an environment where mistakes are considered as sins that deserve punishment,

people try to avoid it by adhering to current methods and procedures, no matter how inefficient and wasteful they are. There is always an inherent risk in using new methods, tools, or procedures. So, leaders who cultivate a culture of blame, pointing fingers, and fear, inadvertently discourage creativity and block the flow of new ideas. In this sense, the amount of improvement ideas that comes from a lower level of the organization is an indication of the level of 'fear of mistakes' in the organization.

Again, due to the format of the question, the original responses were in the form of nominal data which were later converted to ordinal (rank) data according to Appendix V-Table 5-2.

The position of a respondent is not a matter of concern here, so again a total of 41 legitimate pairs of data are cross-tabulated in Appendix VI- Table 6-9.

According to the values for the KW statistic (KW=18.366>9.49) and p-value (P=0.001<0.05), for N=41 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' for the respondents with different level of 'improvement ideas from subordinates'.

According to Table 10, since τ_b=0.555 and p=0.000<0.05, for N=41 at α= 0.01 level of significance, there is a positive significant correlation between 'amount of improvement ideas that came/has come from the subordinates' and 'the lean initiative's level of success'. This is in accordance with the result of Kruskal-Wallis test above.

Communication and transparency

This element is represented by questions 36 and 37 of the survey questionnaire (Appendix II).The collected data through each of the questions provides insight about different aspect of this element.

Question 36: "In which ways the performance/progress reports are/were communicated with the people (including shop-floor workers) involved in the initiative? (You may choose more than one answer)"

This question was originally designed in the form of a multi-choice question with 8 options to choose from. The variable of concern in this section is the number of communication methods used. Therefore, the collected responses were converted to rank variables.

As for this question, the position of the respondents did not have any impact on the meaningfulness of the responses. So a total of 41 pair of responses are cross-tabulated in Appendix VI- Table 6-10.

According to Table 10, since KW=20.271>12.59 and p=0.002, for N=41 at α=0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations that use different number of communication methods.

Based on the above values of Kandall's tau-b coefficient (τ_b=0.548) and p-value (p=0.000<0.05), for N=41 at α= 0.05 level of significance, there is a positive significant correlation between 'number of communication methods' and 'the lean initiative's level of success'. This is in accordance with the result of Kruskal-Wallis test above.

Question 37: "which of the following options best describes the frequency of communication of updated progress/performance measurements with involved people (including shop-floor workers)?"

This question is originally designed in the form of a multi-choice question with nominal options to choose from.

Although the first seven choices are intrinsically ordinal, the 8th and 9th choices ('completely randomly' and 'other') prevented treating the data as purely ordinal. So, the data is analyzed in two steps:

Step 1- The original data is retained as-is. The analysis of data is conducted using the statistical methods for nominal data including Chi-square test and Cramer's V coefficient.

A total of 39 pair of responses (i.e. cross-tabulated in Appendix VI- Table 6-11) are used as the sample for this step of analysis.

Based on the table of critical Chi-square values (Appendix I), for N= 39 and 28 degrees of freedom, at α= 0.05 level of significant, the chi-square statistic should be greater than 41.34 for the null hypothesis (independency of the variables) to be rejected. So, since 32.136<41.34 and p=0.269>0.05 (Table 10), there is not enough evidence for a significant association between the 'frequency of the communication' and 'the lean initiative's success level'.

According to Cohen (1988), for 4 degrees of freedom a value of Cramer's V greater than 0.25 signals a large effect. Thus, completely contrary to chi-square test, φ_c =0.454 suggests a correlation of large magnitude between the 'frequency of communication' and 'the lean initiative's success level'.

The quite large contrast between the results of the two above tests, motivated further analysis of the data, which is done in step 2.

Step 2- In answering question 37, only one respondent had used the 'other (please specify)' option and his answer is categorized as 'completely randomly'. As the 'completely random' answers actually do not provide much insight and information about the level of communication in the organization, in the second step they are eliminated from the sample. Thereby, the total legitimate pair of responses in step two, are 35. The original responses to question 37, which are nominal, are converted to ordinal data based on Appendix V- Table 5-3.

A total of 35 legitimate pair of answers are cross-tabulated in Appendix VI- Table 6-12.

Now that all the data are in the form of ordinal variables, the statistical methods for analyzing the relationship between ordinal variables can be used.

According to Table 10, since KW=12.696>12.59 and p=0.048<0.05, for N=35 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations with different 'frequency of communicating progress/performance measurements'.

Based on the values of Kandall's tau-b coefficient (τ_b =0.376) and p-value (p=0.007<0.05), for N=35 at α= 0.05 level of significance, there is a positive significant correlation between 'frequency of communicating progress/performance measurements' and 'the lean initiative's level of success'. This is in accordance with the result of Kruskal-Wallis test above.

4-2-2- Self-development

The second layer of the model, self-development, comprises of four main components. Each of these components are similarly represented by one or more questions in the survey questionnaire (Appendix II). The results of the correlation analyses between the sub-elements of the model and

'the lean initiative's level of success' are conducted using the SPSS statistical software and are summarized in Table 11.

Element	Variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
Lean knowledge	Level of acquaintance with lean	Kruskal-Wallis	9.652	4	0.047	9.49	0.05
		Kendall's tau	0.355		0.017		0.05
	Level of knowledge on kaizen	Kruskal-Wallis	8.546	3	0.036	7.81	0.05
		Kendall's tau	0.402		0.008		0.05
	Conception about real essence of kaizen	Chi-square	2.878	4	0.578	9.49	0.05
		Cramer's V	0.295	1			
	Amount of in-class training	Kruskal-Wallis	10.911	4	0.028	9.49	0.05
		Kendall's tau	0.068		0.653		0.05
	Quality of the in-class training	Kruskal-Wallis	8.495	4	0.075	9.49	0.05
		Kendall's tau	0.445		0.004		0.05
Lean sensei	Amount of training under sensei's supervision	Kruskal-Wallis	6.467	4	0.167	9.49	0.05
		Kendall's tau	0.245		0.095		0.05
	Existence of a lean sensei	Chi-square	6.890	4	0.142	9.49	0.05
		Cramer's V	0.405	1			
	Quality of sensei's performance	Kruskal-Wallis	4.073	3	0.254	7.81	0.05
		Kendall's tau	0.242		0.125		0.05
On the job training	Amount of on-the-job application of lean	Kruskal-Wallis	14.734	3	0.002	7.81	0.05
		Kendall's tau	0.539		0.000		0.05
Genchi genbutsu	Office-time vs. gemba-time	Kruskal-Wallis	8.979	3	0.030	7.81	0.05
		Kendall's tau	-0.407		0.007		0.05

*Df stands for 'degree of freedom'
** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test

Table 11. Summary of statistical correlation tests' results for sub-elements of 'self-development' and 'lean initiative's level of success'

Lean knowledge

Acquiring lean knowledge by the leadership is studied from five different perspective, each represented by one question in the survey questionnaire (Appendix II).The data collected through each of the questions is analyzed separately in the following sections:

Question 13 – leadership's level of acquaintance with lean from their own perspective

This variable was originally a nominal variable. However, to grasp a clearer understanding of the nature of the correlation between the two variables, all the responses are converted to ranks according to Appendix V- Table 5-4.

A total of 33 legitimate pair of answers are cross tabulated in Appendix VI- Table 6-13.

According to Table 11, given the values of KW statistic (KW=9.652>9.49) and p-value (p=0.047<0.05), for N=33 at α= 0.05 level of significance, there is a statistically significant

difference between 'the lean initiative's level of success' of the organizations with different 'leadership's level of acquaintance with lean'.

Based on the values of Kandall's tau-b coefficient (τ_b =0.355) and p-value (p=0.017<0.05), for N=33 at α= 0.05 level of significance, there is a positive significant correlation between 'leadership's level of acquaintance with lean' and 'the lean initiative's level of success'. This is in accordance with the result of Kruskal-Wallis test above.

Question 16 – leadership's level of knowledge on 'kaizen' from their own perspective

This question was originally in the form of a multi-choice question, and the respondents were asked to rank their level of knowledge on kaizen on a 1-to-5 scale. Hence, the collected data was in the form of ordinal variable and no conversion was needed.

A total of 33 pairs of answers are cross-tabulated in Appendix VI- Table 6-14.

According to Table 11, since KW=8.546>7.81 and p=0.036<0.05, for N=33 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations with different 'leadership's level of acquaintance with lean'.

Based on the values of τ_b=0.402 and p=0.008<0.05, for N=33 at α= 0.01 level of significance, there is a positive significant correlation between 'leadership's level of knowledge on kaizen' and 'the lean initiative's level of success'. This is in accordance with the result of Kruskal-Wallis test above.

Question 17 – leadership's conception about real essence of kaizen

Question 17 of the survey questionnaire (Appendix II) asks the respondents to choose, among 5 available choices, the one that they think best describes the essence of kaizen.

Only the third choice conforms to the true meaning of kaizen. Therefore, all the collected responses are categorized into two groups of either conforming to the real essence of kaizen or non-conforming.

A total of 33 legitimate pair of answers are cross-tabulated in Appendix VI- Table 6-15.

Based on the table of critical Chi-square values (Appendix I), for N= 33 and 4 degrees of freedom, at α= 0.05 level of significant, the Chi-square statistic should be greater than 9.49 for the null

hypothesis (independency of the variables) to be rejected. So, since 2.878<9.49 and p=0.578, there is not enough evidence for a significant association between the 'leadership's conception about true essence of kaizen' and 'the lean initiative's success level'.

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V between 0.10 and 0.30 signals a small effect. Thus, in accordance with the chi-square test, φ_c =0.295 does not suggest a correlation of large or even medium magnitude between the 'leadership's conception about true essence of kaizen' and 'the lean initiative's success level'.

Question 24- amount of in-class training received by the leadership

This variable is represented by question 24 of the survey questionnaire (Appendix II). The original collected data was in the form of nominal variable. But, for the same reason as for the previous variables, the responses are converted to ordinal rank variables according to Appendix V- Table 5-5.

A total of 33 legitimate pair of answers are cross tabulated in the Appendix VI- Table 6-16.

According to Table 11, since KW=10.911>9.49 and p=0.028<0.05, for N=33 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations with different 'amount of in-class training received by the leadership'.

Based on the values of τ_b=0.068 and p=0.653, for N=33 at α= 0.05 level of significance, there is no significant correlation between 'amount of in-class training received by the leadership' and 'the lean initiative's level of success'. This is totally opposite to the result of the Kruskal-Wallis test.

The significant contrast between the results of the two above tests, prompted further investigation of this criteria through collected data about the quality of the in-class training received by the leaders. This variable was represented by question number 25 of the survey questionnaire.

Question 25- quality of the in-class training

Question 25 of the survey questionnaire (Appendix II) asks the respondents to rank the quality of the in-class training that they have received on a 1 to 5 scale.

A total of 29 legitimate pair of answers are cross-tabulated in Appendix VI- Table 6-17.

Given the values of KW=8.495<9.49 and p=0.075 (Table 11), for N=30 at α= 0.05 level of significance, there is no statistically significant difference between 'the lean initiative's level of success' of the organizations with different 'quality of the in-class training received by the leadership'.

Based on the above values of τ_b =0.445and p=0.004<0.05, for N=30 at α= 0.05 level of significance, there is a significant correlation between 'quality of the in-class training received by the leadership' and 'the lean initiative's level of success'. This is in contrast to the result of the Kruskal-Wallis test above.

Lean sensei

This variable is represented by question 23 of the survey questionnaire: "How much training have you received on lean under a sensi/coach/mentor's direct guidance?" The original collected data was nominal. So, to grasp a better understanding of the nature of the correlation, the responses are converted to ordinal rank variables according to Appendix V- Table 5-6.

A total of 33 legitimate pair of answers are cross-tabulated in Appendix VI- Table 6-18.

According to Table 11, given values of KW=6.467<9.49and p=0.167>0.05, for N=33 at α= 0.05 level of significance, there is no statistically significant difference between 'the lean initiative's level of success' of the organizations with different 'amount of training received by the leadership under a sensei's direct supervision'.

Given the values of τ_b=0.245 and p=0.095>0.05 (Table 11), for N=33 at α= 0.05 level of significance, there is no significant correlation between 'amount of training received by the leadership under a sensei's direct supervision' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

The interesting results of the above two tests triggered further investigation of the role of senseis in a lean turnaround. The data collected through questions 21 and 22 are used for this purpose:

First, through analyzing the responses to question 21, this hypothesis is tested: "The organizations that use lean senseis in the process of their lean transformation, are more successful in achieving the goals of their lean initiative."

Afterwards, for the organizations who had lean sensei(s), effect of the quality of the sensi's performance on their lean initiative's level of success is examined.

Question 21: "Were there any sensei(s)/coach(s)/mentor(s) involved in the lean initiative?"

Since the hypothesis to be tested in this section is concerned with effect of existence of a lean sensei in general on the organization's level of success in achieving its lean initiative's goals, the position of the respondents does not matter in the analysis. A total of 42 legitimate pair of responses were used as the sample for analysis, which are cross-tabulated in Appendix VI- Table 6-19.

Based on the table of critical Chi-square values (Appendix I), for 4 degrees of freedom, at $\alpha= 0.05$ level of significant, the Chi-square statistic should be greater than 9.49 for the null hypothesis (independency of the variables) to be rejected. So, since $6.890<9.49$ and $p=0.142>0.05$, there is not enough evidence for a significant association between the 'deployment of (a) lean sensei(s)' and 'the lean initiative's success level'.

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V between 0.30 and 0.50 signals a medium effect. Thus, $\varphi_c=0.405$ suggests an effect of medium magnitude by the 'deployment of (a) lean sensei(s)' on 'the lean initiative's success level'.

Although Cramer's V test also did not support existence of a strong correlation between the two variables, analyzing the responses to the next question could provide further insight about the impact of deployment of lean sensei(s) on the success level.

Question 22: "On a scale of 1 to 5, how do you rank the quality of the sensei's contribution to the initiative? (1 for 'no contribution' and 5 for 'very high level of positive contribution')

Again the position of the respondents does not matter in the analysis. However, only the organizations that had used lean sensei(s) (the respondents who has answered "Yes" to the previous question) are under study in this section. So, a total of 33 legitimate pair of responses were used as the sample for analysis, which are cross-tabulated in Appendix VI- Table 6-20.

According to Table 11, since $KW=4.073<7.81$ and $p=0.254$, for $N=33$ at $\alpha= 0.05$ level of significance, there is no statistically significant difference between 'the lean initiative's level of success' of the organizations that enjoyed different levels of 'quality of the lean sensei(s)'s contribution'.

Based on the values of τ_b =0.242 and p=0.125, for N=33 at α= 0.05 level of significance, there is no significant correlation between 'quality of the lean sensei(s) contribution' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

On-the-job training (on-the-job application of lean)

This element is represented by question 26 of the survey questionnaire. The original collected data was in the form of nominal variable. But, for the same reason as for the previous variables, the responses are converted to ordinal rank variables according to Appendix V- Table 5-7.

One of the responses to question 26 was irrelevant and as the result was discarded from the sample. So, a total of 32 legitimate pair of answers have been cross-tabulated in Appendix VI- Table 6-21.

According to Table 11, since KW=14.734>7.81 and p=0.002<0.05, for N=32 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations that enjoyed different level of 'on-the-job application of lean by the leadership'.

Based on the above values of τ_b=0.539 and p=0.000<0.05, for N=33 at α= 0.05 level of significance, there is a significant correlation between 'level of on-the-job application of lean by the leadership' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

Genchi genbutsu (Office-time vs. Gemba-time)

This variable is represented by question 14 of the survey questionnaire (Appendix II). The original nominal data, for the same reason as above, is converted to ordinal rank data according to Appendix V- Table 5-8.

A total of 33 legitimate pair of answers have been cross-tabulated in Appendix VI- Table 6-22.

Given the values for the KW=8.979>8.71 and p=0.030<0.05 (Table 11), for N=32 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of

success' of the organizations that their leaders spend different amount of time in their office as compared to in the gemba.

Based on the values of τ_b =-0.407 and p=0.007<0.05, for N=33 at α= 0.05 level of significance, there is a significant correlation between 'amount of time spent in the office by the leadership as compared to in the gemba' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

4-2-3- Overarching and supporting systems

The third layer of the model, overarching and supporting systems, comprises of four main elements. The variables representing each of these elements are subject of correlation analyses done by SPSS. The results of these analyses between the sub-elements of the model and 'the lean initiative's level of success' are summarized in Table 12.

Element	Variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
Hoshin kanri	Departmental plans-organization's vision alignment	Kruskal-Wallis	10.140	3	0.017	7.81	0.05
		Kendall's tau	0.401		0.003		0.05
	Initiative's vision-organization's vision alignment	Kruskal-Wallis	13.813	3	0.003	7.81	0.05
		Kendall's tau	0.485		0.000		0.05
Lean function	Existence of a lean function	Chi-square	15.606	4	0.004	9.49	0.05
		Cramer's V	0.617	1			
	Quality of the lean function's performance	Kruskal-Wallis	4.533	2	0.104	5.99	0.05
		Kendall's tau	0.284		0.102		0.05
Process-oriented metrics	Process-oriented vs. results-oriented metrics	Chi-square	9.784	4	0.044	9.49	0.05
		Cramer's V	0.602	1			
System-oriented reward system	Existence of a reward system	Chi-square	9.234	4	0.056	9.49	0.05
		Cramer's V	0.487	1			
	Type of the reward system	Chi-square	19.103	8	0.014	15.51	0.05
		Cramer's V	0.618	2			

*Df stands for 'degree of freedom'
** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test

Table 12. Summary of statistical correlation tests' results for sub-elements of 'overarching and supporting' and 'lean initiative's level of success'

Hoshin Kanri (Policy deployment)

This element of the model is represented by questions 9, 10, 18, and 19 of the survey questionnaire (Appendix II):

Question 9: "The lean initiative's vision: … "

Question 10: "The lean initiative's goals: …"

Question 18: "On a scale of 1 to 5, how much do you think current short-term/annual plans in your respective department are aligned with the organization's vision? (1 for 'not aligned at all' and 5 for 'completely aligned')"

Question 19: "On a scale of 1 to 5, how much do you think the initiative's vision is aligned with organization's goals and vision? (1 for 'not aligned at all' and 5 for 'completely aligned')

Question 9 is in the form of open-ended question. Even a quick review of the responses in the editing step of the data collection phase, revealed some interesting facts:

Among the 45 participants who had answered this question, only 9 responses (20%) had an acceptable level of compatibility with the requirements of a well-defined and clear vision for a lean effort. Indeed, the first step toward having a meaningful and sustainable improvement initiative of any kind is creating a clear vision of what the organization wants to be and what is its ultimate purpose of existence. This vision is what determines the direction of the whole transformation. Any step taken in the lean journey should be a step in the path of actualizing that vision. A well-defined lean vision of an organization is something beyond making more money. However, the results of this survey shows that in majority of the cases, there is either no vision to direct the efforts toward the right destination, or the vision is vague, confusing, or ill-defined.

There is a readily-observable confusion between the goals of the initiative or the respondent's conception about lean's mission and the vision of the initiative.

As for question 10, similar problems are encountered. Efficient and well-defined lean goals need to be actionable, measurable, and process-oriented. If the goals focus nearly on final results (e.g. increased sales, reduced cost, etc.), they will not be as effective as they should be and the achieved results will definitely not be sustained. People are actually good at gaming the system and tend to manipulate the numbers when they are to be evaluated merely based on the final monetary results.

For example, they can easily defer the backorder cost to future cycles or increase process productivity and hide the actual waste of the process by producing massive piles of inventory. Effective, efficient, and seamless processes are naturally followed by excellent results. So, it is vital for the results to be real and sustainable that the goals be process-oriented. Clear timeframe is another critical feature of a well-defined lean goal.

A quick review of the responses to question 10, reveals following prevalent problems among the 45 responses:

1- No timeframe,
2- Confusion of the goals with the methods to be used for achieving the goals,
3- Focus on the financial results,
4- Confusion between stated goals with the actual achieved results,
5- Confusion between the goals and their conception about lean's mission/definition,
6- Confusion between vision and actionable goals.

Since all the responses were sharing one or more of the above problems, reliability and precision of the responses are under question. Therefore, before conducting any analysis on the gathered data through question 10 and making any further conclusions, doing a more comprehensive and detailed study on application of hoshin kanri (policy deployment), probably through more extensive surveys and interviews, is necessary.

Reviewing the responses to questions 9 and 10 raises concern about legitimacy of the responses, in terms of reliability, precision, and inclusion. Hence, for the purpose of this study, only the collected data through questions 18 and 19, were deployed for analysis and for making inferences.

Question 18: "On a scale of 1 to 5, how much do you think current short-term/annual plans in your respective department are aligned with the organization's vision? (1 for 'not aligned at all' and 5 for 'completely aligned')"

The position of the respondents does not matter in the analysis. So, a total of 42 legitimate pair of answers are cross-tabulated in Appendix VI- Table 6-23.

According to Table 12, given the values of $KW=10.140>7.81$ and $p=0.017<0.05$, for $N=42$ at $\alpha=0.05$ level of significance, there is a statistically significant difference between 'the lean initiative's

level of success' of the organizations that enjoyed different level of 'departmental goals-lean vision alignment'

Based on the values of τ_b =0.401 and p=0.003<0.05, for N=42 at α= 0.01 level of significance, there is a significant correlation between 'departmental goals-lean vision alignment' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

Question 19: "On a scale of 1 to 5, how much do you think the initiative's vision is aligned with organization's goals and vision? (1 for 'not aligned at all' and 5 for 'completely aligned')

The positions of the respondents do not matter in the analysis. So, a total of 42 legitimate pair of answers are cross-tabulated in Appendix VI- Table 6-24.

According to Table 12, since KW=13.813 and p=0.003<0.05, for N=42 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations that enjoyed different level of 'lean initiative's vision with organization's goals and vision alignment'

Based on the values of τ_b =0.485 and p=0.000<0.05, for N=42 at α= 0.05 level of significance, there is a significant correlation between 'alignment of the lean initiative's vision with organization's vision and goals' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

Lean function

This element is studied from two perspective. First, it is examined whether the existence of a function or department, specifically dedicated to lean, enhances the chance of a successful lean turnaround. Then, the impact that the quality of its performance has on the lean initiative's success level.

1- Existence of a lean function

'Existence of a lean function' is a dichotomous variable represented by question 34 of the survey questionnaire (Appendix II).

The total number of legitimate answers which are used for the analysis is 41. The responses are cross-tabulated in Appendix VI- Table 6-25.

Based on the table of critical Chi-square values (Appendix I), for 4 degrees of freedom, at $\alpha = 0.05$ level of significant, the chi-square statistic should be greater than 9.49 for the null hypothesis (independency of the variables) to be rejected. So, since 15.606>9.49, the above results suggest a statistically significant correlation between the 'existence of a lean function' and 'the lean initiative's level of success.'

According to Cohen (1988), for 1 degree of freedom a value of Cramer's V greater than 0.50 signals a large effect. Thus, $\varphi_c = 0.617$ also suggests an effect of large magnitude by the 'existence of a lean function' on 'the lean initiative's success level'.

In order to obtain a deeper insight about the nature of the correlation, the joint frequency chart of the two concerned variables (Figure 14) is useful.

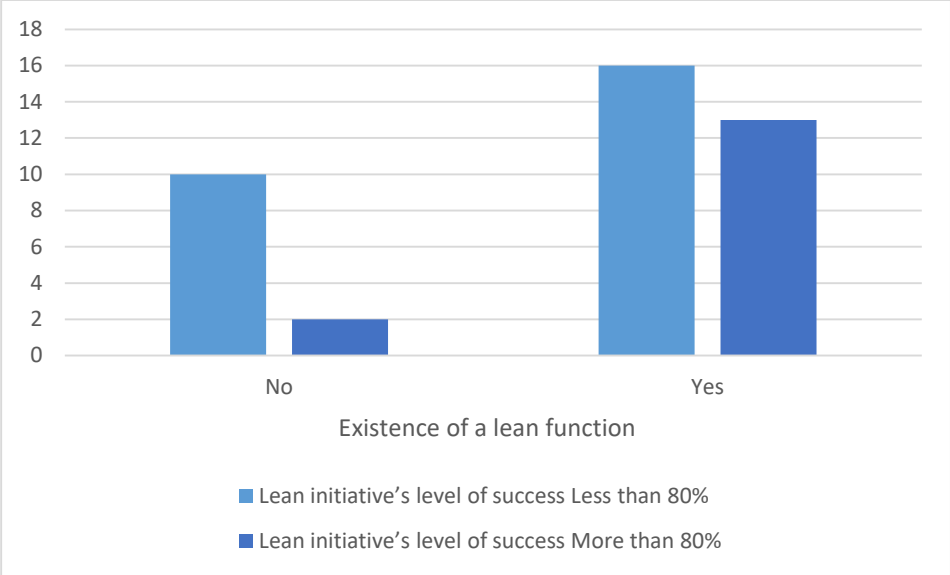

Figure 14. Joint frequency chart of 'existence of a lean function' and 'lean initiative's level of success

As demonstrated by the chart, the proportion of successful cases (more than 80% success level) to unsuccessful cases (less than 80% success level) is obviously much better for the organizations that have a lean function as compared to ones that have not any supporting function for their lean initiatives.

2- Quality of the lean function's performance

In question 35, the respondents whose answer to previous question was 'Yes' (who confirmed existence of a lean function in their organization), were asked to rank the quality of the lean

function's performance on a 1-5 scale. A total of 28 legitimate responses are cross-tabulated in Appendix VI- Table 6-26.

According to Table 12, since KW=4.533<5.99 and p=0.104, for N=28 at α= 0.05 level of significance, there is no statistically significant difference between 'the lean initiative's level of success' of the organizations whose lean functions had different level of performance.

Based on the values of τ_b =0.284 and p=0.102, for N=28 at α= 0.05 level of significance, there is no statistically significant correlation between 'quality of the performance of the lean function' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

Process-oriented performance metrics

In order for lean tools to work and for lean culture to be ingrained in the organization, the performance metrics used for measuring and monitoring the progress must be in line with lean mentality. Waste-less and customer-driven processes bring in good business and generate excellent financial results. So, the performance metrics need to also support the process-oriented mentality.

This variable is represented by question 38 of the survey questionnaire (Appendix II): "What are/were the progress/performance measurement metrics used in the initiative?" This question is in the form of an open-ended question. The original collected responses are converted to categorical data by being categorized as being either process-oriented or result-oriented.

The position of the respondents are not of concern in analysis of this variable. So, given the available responses to questions 12 and 38, a total of 23 pairs of responses are used for the analysis which are cross-tabulated in Appendix VI- Table 6-27.

Based on the table of critical Chi-square values (Appendix I), for N=27 and 4 degrees of freedom, at α= 0.05 level of significant, the Chi-square statistic should be greater than 9.49 for the null hypothesis (independency of the variables) to be rejected. So, the value of chi-square statistic being 9.784>9.49 and p=0.044<0.05 suggest a statistically significant correlation between 'process-oriented performance metrics' and 'the lean initiative's level of success.'

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V greater than 0.50 signals a large effect. Thus, in accordance with the chi-square test's results above, φ_c=0.602 suggests an effect of large magnitude by 'process-oriented performance metrics' on 'the lean initiative's success level'.

System-oriented reward system

The reward system should also support the performance-monitoring system and similarly be in line with lean mentality. The incentivizing method should avoid playing people and departments against each other. So, the performance metrics based on which people are evaluated and rewarded, should also be process-oriented and focus on the overall success of the whole system rather than the departmental or individual interests.

This variable is represented by question 39 of the survey questionnaire (Appendix II): "Which of the following options best describes the reward system for incentivizing people in the initiative? (You may choose more than one answer)."

The role of reward system in the success of a lean initiative is studied from 2 different perspectives in the following sections:

1- Whether existence of a reward system (of any kind) has influence on the success level of a lean initiative or not.
2- For the organizations that use a reward system for motivating their employees, whether the type of the reward system that is being used has any effect on the success level of their lean initiative.

1- Existence of a reward system

As for this variable, again the position of the respondent does not matter. So, a total of 39 pair of responses are used as the sample for the analysis, which are cross-tabulated in Appendix VI- Table 6-28.

Based on the table of critical Chi-square values (Appendix I), for N=37 and 4 degrees of freedom, at $\alpha = 0.05$ level of significant, the Chi-square statistic should be greater than 9.49 for the null hypothesis (independency of the variables) to be rejected. Based on Table 12, the value of chi-square statistic being marginally greater than the critical value ($9.234 < 9.49$ and $p=0.056 > 0.05$) fails to provide sufficient evidence for a statistically significant correlation between 'existence of a reward system' and 'the lean initiative's level of success'. However, since the difference is marginal, care must be taken in interpreting the results and the outcome of the Cramer's V test should be considered before making any inference.

According to Cohen (1988), for 1 degrees of freedom a value of Cramer's V between 0.30 and 0.50 signals a medium effect. Thus, $\varphi_c=0.487$ suggests an effect of medium magnitude by 'existence of a reward system' on 'the lean initiative's success level'. However, in this case also, the value of φ_c is just slightly smaller than the threshold for 'large' effect size. So, ruling out this element based on the outcomes of the two above tests seems unreasonable.

2- Type of the reward system

In question 39, the respondents are provided with 6 types of reward system (given they use a reward system) to choose from. However, for the sake of analysis, all the collected responses are categorized into one of the following groups:

1- Bonus reward system (which focuses on individual or team/departmental performance)
2- Profit-sharing reward system (which focuses on the overall performance of the whole system)
3- Non-monetary reward system

25 respondents who claimed to use some kind of reward system in their respective organizations, are used as the sample for this section. The 20 pairs of responses are cross-tabulated in Appendix VI- Table 6-29.

Based on the table of critical Chi-square values (Appendix I), for N=21 and 8 degrees of freedom, at α= 0.05 level of significant, the Chi-square statistic should be greater than 15.51 for the null hypothesis (independency of the variables) to be rejected. So, the above results (19.103>15.51) (Table 12) provide sufficient evidence for suggesting a statistically significant correlation between 'type of the reward system' and 'the lean initiative's level of success.'

According to Cohen (1988), for 2 degrees of freedom a value of Cramer's V greater than 0.35 signals a large effect. Thus, in accordance with the chi-square test's results above, φ_c=0.618 suggests an effect of large magnitude by 'type of the reward system' on 'the lean initiative's success level'.

Since the data is nominal in nature, the frequency chart below (Figure 15) may serve as a supplementary source of information for gaining a better insight about the nature of the correlation.

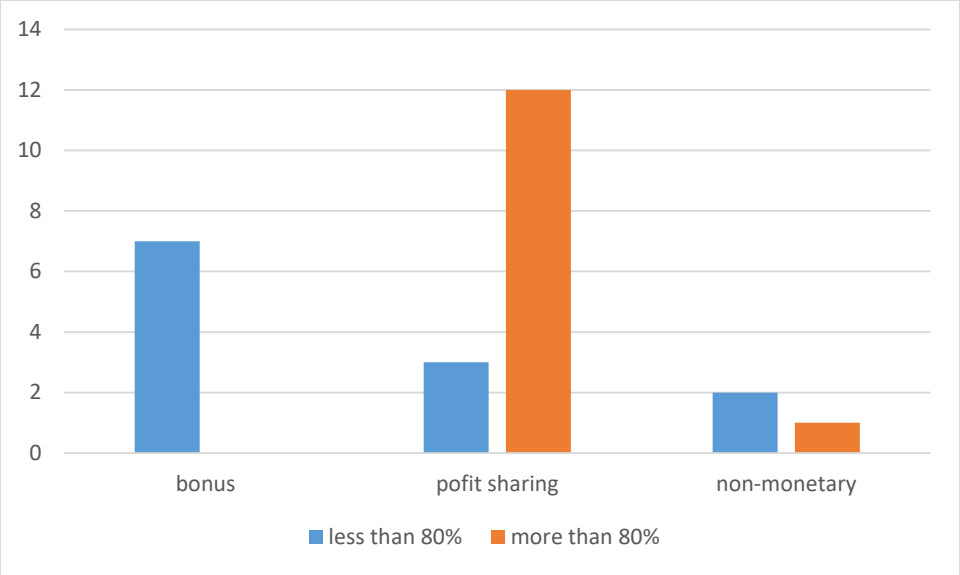

Figure 15. Joint frequency chart of 'type of reward system' and 'lean initiative's level of success'

According to the chart, the organizations that use profit sharing as their reward system perform significantly better that the ones which use bonus system or non-monetary reward system.

4-2-4- Day-to-day management

Besides preparing a cultivating setting for the lean initiative to thrive, the leaders also need to support and spur lean by their day to day activities. So, the fourth layer of the model represent day-to-day management. Two criteria represent this element of the lean leadership model which are examined separately in the following sections.

The variables representing each of these sub-elements of the model are tested for correlation with 'the lean initiative's level of success' using SPSS and the results are tabulated in Table 13.

Element	Variable	Statistical method	Test statistic	Df*	p-value	Critical value	α
Kaizen participation	Frequency of kaizen participation	Kruskal-Wallis	16.801	5	0.005	11.07	0.05
		Kendall's tau	0.607		0.000		0.05
Standard work	Application of standard work	Chi-square	39.687	20	0.005	31.41	0.05
		Cramer's V	0.525	1			
		Kruskal-Wallis	8.573	3	0.036	7.81	0.05
		Kendall's tau	0.383		0.007		0.05
*Df stands for 'degree of freedom' ** The shaded cells signify inapplicability of the concerned parameter to the respective statistical test							

Table 13. Summary of statistical correlation tests' results for sub-elements of 'day-to-day management' and 'lean initiative's level of success'

Kaizen participation

This element of the model is represented by question 30: "Which of the following best describes the frequency of you participation in kaizen/improvement activities?"

For this question, only the answers provided by the people in leadership position are qualified for making an inference. So, a total of 33 pair of responses are used for the analysis which are cross-tabulated in Appendix VI- Table 6-30.

According to the above values for the KW statistic (KW=16.801>11.07) and p-value (P=0.005<0.05), for N=33 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations with different level of 'leadership's frequency of participation in kaizen events.'

Given the values of τ_b=0.607 and p=0.000<0.05, for N=33 at α= 0.05 level of significance, there is a statistically significant correlation between 'leadership's frequency of kaizen participation' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

Standard work

This element of the model is represented by question 15 of the survey questionnaire (Appendix II):

Question 15: "Which of the options below best describes the application of standardized work in your organization?" This question was originally in the form of a multi-choice question with 6 options to choose from.

This question will be tackled by 2 different approaches:

1- The collected responses will be treated as-is, as nominal data. So, the correlation between 'the lean initiative's level of success' and 'application of standardized work' will be examined using nominal-by-nominal correlation methods such as Chi-square test and Cramer's V coefficient.
2- The collected responses will be converted to ordinal data. So, the correlation between 'the lean initiative's level of success' and 'application of standardized work' will be examined

using ordinal-by-ordinal correlation methods such as Kruskal-Wallis H test and Kendall tau-b coefficient.

1- Nominal approach

The position of the respondent is not a matter of concern here. So a total of 36 pairs of responses are used as the sample for analysis, which are cross-tabulated in Appendix VI- Table 6-31.

Based on the table of critical Chi-square values (Appendix I), for N=36 and for 20 degrees of freedom, at α= 0.05 level of significant, the Chi-square statistic should be greater than 31.41 for the null hypothesis (independency of the variables) to be rejected. So, the above results (χ^2 =39.687>31.41 and p=0.005<0.05) (Table 13) suggest a statistically significant correlation between the 'existence of a lean function' and 'the lean initiative's level of success.'

According to Cohen (1988), for 4 degrees of freedom a value of Cramer's V greater than 0.25 signals a large effect. Thus, φ_c=0.525 also suggests an effect of large magnitude by the 'existence of a lean function' on 'the lean initiative's success level'.

The ordinal approach that follows, helps in grasping a better understanding about the nature of the correlation between the two concerned variables.

2- Ordinal approach

In this approach, the collected responses first are converted to ordinal data based on Appendix V-Table 5-9.

The 36 pair of responses used as the sample for the analysis are cross-tabulated in Appendix VI-Table 6-32.

According to Table 13, since KW=8.573>7.81 and p=0.036<0.05, for N=36 at α= 0.05 level of significance, there is a statistically significant difference between 'the lean initiative's level of success' of the organizations that enjoyed different level of 'application of standardized work.'

Based on the above values of Kandall's tau-b coefficient (τ_b=0.383) and p-value (p=0.007<0.05), for N=36 at α= 0.05 level of significance, there is a significant correlation between 'application of standardized work' and 'the lean initiative's level of success'. This is in accordance with the result of the Kruskal-Wallis test above.

4-2-5- Kaizen

Kaizen as one of the cornerstones of lean, is assumed to be at the heart of the model. Based on the literature, in a true lean organization kaizen is supposed to be the way that the job gets done. Kaizen is not an extracurricular activity. It is rather an indispensable part of the day-to-day job.

In the following sections, truthfulness of the above statements is verified by studying the correlation between the logic based on which kaizen events take place in the organizations and their lean initiative's level of success

This element of the model is represented by question 29 of the survey questionnaire (Appendix II):

Question 29: "When do/did kaizen events usually take place?"

Question number 29 is originally in the form of a multi-choice question and the respondents are provided with 7 options to choose from.

For the sake of statistical analysis, the collected responses are categorized as either conforming to lean mentality (i.e. this category includes only the respondents who chose '(almost) on a daily basis as part of the routine job'), or non-conforming (i.e. this category includes the respondents who had chosen any of the other 6 options).

For the data to be legitimate for analysis in this section, the position of the respondent does not matter. So, a total of 42 pair of responses are used as the sample for the analysis, which are cross-tabulated in Appendix VI- Table 6-33.

Using the SPSS statistical software, the following results are obtained:

1- Chi-square statistic = 11.629,

   Df = 4,

   P-value = 0.020

Based on the table of critical Chi-square values (Appendix I), for N=42 and for 4 degrees of freedom, at $\alpha = 0.05$ level of significant, the Chi-square statistic should be greater than 9.49 for the null hypothesis (independency of the variables) to be rejected. So, the above results suggests a

statistically significant correlation between the ‘reason for kaizen’ and ‘the lean initiative’s level of success.’

2- Cramer’s V coefficient = 0.526,

Df = 1

According to Cohen (1988), for 1 degree of freedom a value of Cramer’s V greater than 0.5 signals a large effect. Thus, Cramer’s V coefficient also suggests an effect of large magnitude by the ‘reason for kaizen’ on ‘the lean initiative’s success level’.

Since the data are treated as categorical, to grasp a better understanding about the nature of the correlation, joint frequency chart (Figure 16) of the two concerned variables is of much help.

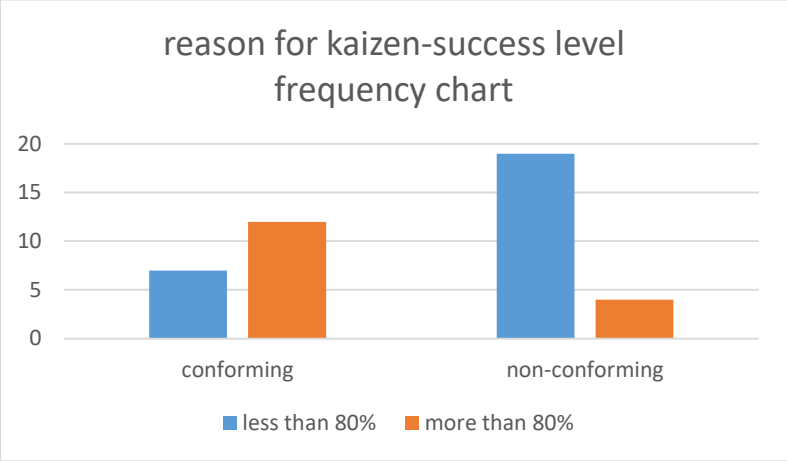

Figure 16. Joint frequency chart of 'reason for kaizen' and 'lean initiative's level of success'

As demonstrated by the bar chart above (Figure 16), while in the conforming category, the number of organizations that have been more than 80% successful in their lean initiatives exceeds the unsuccessful ones considerably, the situation in the nonconforming group is vise-versa. So, it may be concluded that organizations in which kaizen is part of the daily activity rather than a pre-scheduled, mandated, or training activity, have a better chance of achieving superior results from their lean efforts.

4-3- Refinement of the lean leadership model

Table 14 summarizes the results of the correlation analyses of the previous section.

			Question number		Statistically significant correlation with "the lean initiative's level of success"				No correlation (only small or medium effect size)
					Kruskal-Wallis	Kendall tau-b	Chi-square	Cramer V effect size	
Main elements of the lean leadership model	**Respect for people**	People development	32		✓	✓			
		No fear of mistake	33		✓	✓			
		Communication & transparency	36		✓	✓		(large)	
			37		✓	✓			
	Self-development	Lean knowledge	13		✓	✓			
			16		✓	✓			
			17					Small	small
			24			✓			
			25			✓			
		Lean sensei	21					medium	medium
			22						✓
			23						✓
		On-the-job training	26		✓	✓			
		Genchi genbutsu	14		✓	✓			
	Overarching structures	Hoshin kanri	18		✓	✓			
			19		✓	✓			
		Lean function	34				✓	Large	
			35						✓
		Process-oriented metrics	38				✓	large	
		System-oriented reward system	39	Existence			✓*	Large**	
				type			✓	large	
	Day-to-day management	Kaizen participation	30		✓	✓			
		Standard work	15				✓	large	
	Kaizen		29				✓	large	

*Although the p-value for the Chi-square test is slightly higher than the significant level, since the difference is marginal, existence of a correlation between 'existence of a reward system' and 'the lean initiative's level of success is accepted.

**Since the value of Cramer's V is marginally lower than the lower threshold for large effect size, 'existence of a reward system' is considered as having a large effect size on 'the lean initiative's level of success'

Table 14. Summary of the correlation analyses between the lean leadership model's components and 'lean initiative's level of success'

A quick review of the above table's last column brings into attention the variables, representing elements or sub-elements of the model, that showed no or weak correlation with 'the lean initiative's success level.' Each of these elements will be discussed in this section, along with the decision to remove or keep the corresponding element in the leadership model.

Question 17

The variable represented by question 17 is ‘leadership’s perception about real essence of kaizen’. This is a sub-element of ‘lean knowledge’ in the ‘self-development’ layer of the model.

As kaizen is one of the main cornerstones of lean, it is placed at the core of the model as the ideal state that a leader wishes to achieve by going through the layers of the model. Hence, prudence is necessary in eliminating such a sub-element.

In order to make a decision about retaining or removing this sub-element, results of the analysis of the data from question 29, is used as supplementary source of information. Question 29 represents ‘the reason for kaizen’ in the organization. As mentioned in section 4-2-5, the organizations in which kaizen is integrated in the daily activity of the workforce, are considerably more successful in achieving the goals of their lean initiatives. Therefore, as leaders are supposed to lead the lean initiative, it seems logical that they have correct understanding about the way kaizen is supposed to function in the organization. Thereby, when elaborating on the subject of acquiring ‘lean knowledge’ by leadership as one of the elements of the model, neglecting the significance of having a true conception about the essence of kaizen, sounds unwise.

However, the fact that the results of the survey show no correlation by one type of statistical test (Chi-square), and only small effect size by the other test (Cramer’s V), raises questions that need to be further investigated by future research.

Questions 21, 22, and 23

All the three questions represent the variables related use of lean sensei in the process of leadership self-development. Questions 21, 22, and 23 pertain the existence of lean sensei in the initiative, amount of time the leader has been trained under sensei’s direct supervision, and quality of the sensei’s contribution to the initiative respectively.

As all the lean-sensei-related variables have not shown any correlation (or large effect size) with the lean initiative’s level of success (i.e. except amount of training under sensei’s supervision which had medium, but still not large, effect on the lean initiative’s level of success), then it was concluded that having a lean sensei does not necessarily help leaders through their self-development process. As the result, this element is removed from the final leadership model.

Question number 35

The variable represented by question 35 is ‘the quality of the lean function’s performance’. While existence of a lean function shows a strong association with ‘the lean initiative’s level of success’, ‘quality of the lean function’s performance’ does not. However, making decision about removing the element from the model, demands further examination of the data.

As demonstrated by the joint frequency chart below (Figure 17), 100% of the respondents who had evaluate performance of the lean function at the highest degree (5), also selected ‘more than 80%’ for ‘the lean initiative’s level of success.’ Almost the opposite is true for the respondents who had evaluated the performance of the lean function at a mediocre level (3, which is the lowest level selected). It is to say that quick review of the chart implies that the organizations whose lean function perform better, are more likely to be more successful in achieving the goals of their lean initiative.

However, two more details captures the attention in the chart, which may explain this contradiction with the results of the statistical analyses:

1- Only 29 respondents claimed to have a lean function in their organization. This translated into having only less than 60% of the total surveyed population in the sample. This relatively small sample leaves room for misinterpretation.
2- More than 65% of the responses belong to one group (level 4 of the ‘quality of the lean function’s performance’). So, it is a plausible that the sample is not good representative of the population in this matter.

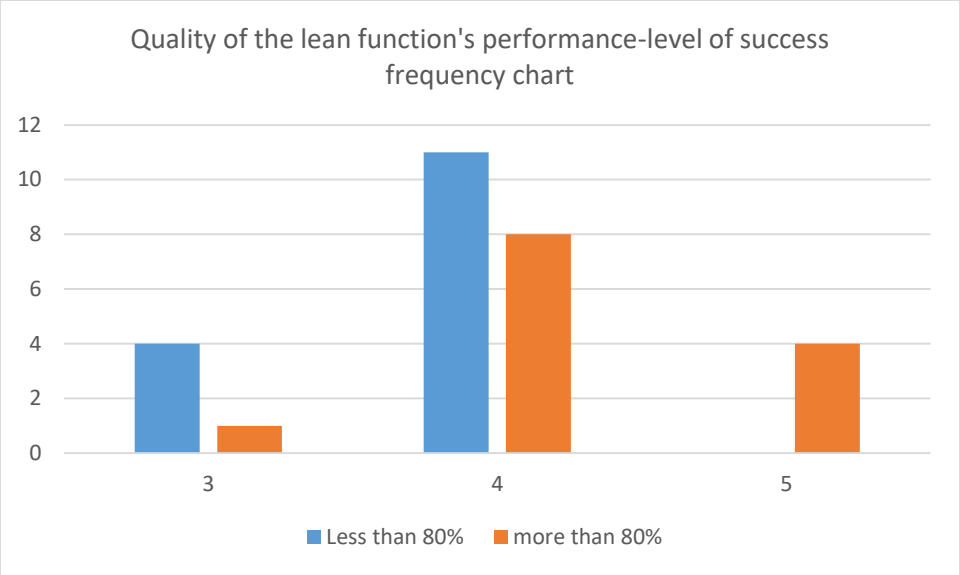

Figure 17. Joint frequency chart of 'quality of lean function's performance' and 'lean initiative's level of success'

The above-mentioned possibilities, along with the fact that 'the existence of a lean function' has strong correlation with 'the lean initiative's level of success', support the retention of 'lean function' in the leadership model.

The finalized version of the lean leadership model

Based on the above arguments, only 'lean sensei' is removed from the model and the rest stays the same. So, Figure 18 depicts the final version of the lean leadership model.

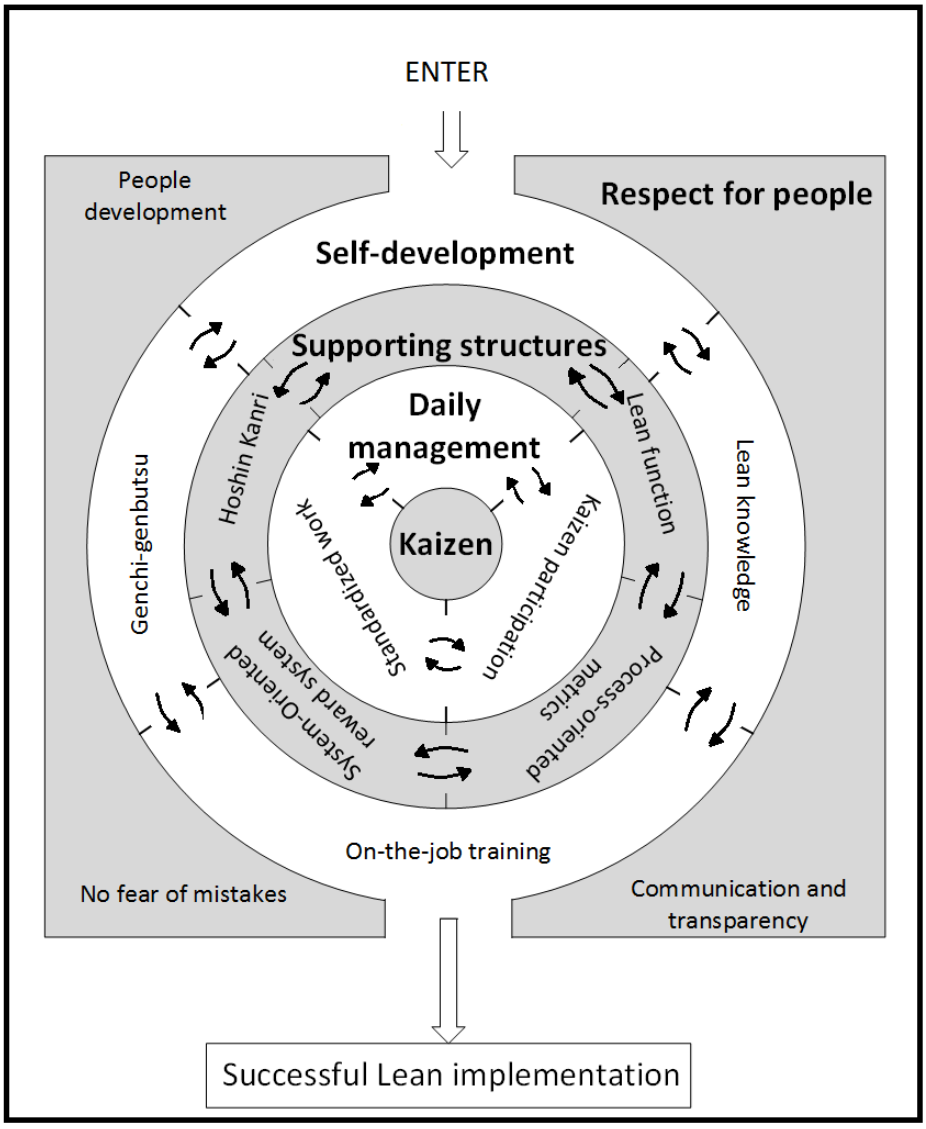

Figure 18. Lean leadership model

There are a number of points about the lean leadership model that cannot be overemphasized:

1- Although the outer layers are prerequisites to the inner ones, almost all the layers and elements of the model are inherently continuous. The leaders need to recognize that for the lean benefits to be sustainable, they need to go through all the layers and elements of the model in perpetual iterative steps.

2- There is no distinct line between the elements of the model. There are overlaps between the different components of the model. For instance, 'kaizen participation' is categorized under 'day-to-day management', however, it is indeed one of the most effective 'self-development' tools at leadership's disposal. The same is true for 'communication and

transparency'. While it is one of the main enablers of 'respect for people' principle, the tools and methods used for its realization, such as visual management tools, are indispensable part of the leadership's 'day-to-day management' duties.

Chapter 5- Conclusions and limitations

5-1- Conclusions

Albeit well-established organizations seek visions beyond just monetary benefits, still what guarantees viability of an organization is its bottom-line. Therefore, the effectiveness of lean as a change strategy is also scrutinized based on the business results it delivers.

While a handful of lean organizations have reaped astounding financial benefits out of their lean efforts, a plethora of others either struggle to realize any benefit in the first place or have really hard time sustaining them. This study proves leadership is a driving factor with considerable impact on the business results. Leadership can definitely be responsible, at least partly, for the divergence in the magnitude and sustainability of business results that lean transformers secure through their lean endeavors.

The lean initiatives in which leadership is more actively and directly involved, deliver better business results. This fact highlights the determining role of lean leadership in successful lean implementation. Although leadership was already acknowledged as a key factor (either as a contributor and inhibitor) in lean implementation, still it has not been given enough attention by the industry and academic society. The strong positive association between the achieved business results and leadership's level of involvement in the lean initiative that is exposed by this study may motivate further attention to exploration of different aspects of lean leadership.

The lean efforts that are not initiated by leadership are not doomed to fail and no evidence of a direct association between position of the initiator and business results has been found. However, the results of statistical analyses of this study suggest that leaders are more likely to get more involved in lean when it is initiated by leadership itself.

Given the significance of lean leadership as a driving force toward superior business results, a holistic lean leadership model is proposed. 'Kaizen' and 'respect for people' as two indisputable and indispensable cornerstones of lean, are both incorporated in the model. Kaizen, or so-called continuous improvement, is the core of lean thinking and 'respect for people' is the road to kaizen. People are the most valuable asset in the organization's disposal in the course of its endless lean adventures. So, leaders' first step toward leanness is operationalization of 'respect for people' through honesty, communication, transparency, employee-development, and coaching.

Acting as a role model, coaching the subordinates, and setting the bar demands constant self-development by the leader. In fact, leader is the first one who has to give up on the old ways of doing the job and adapt lean in his/her daily routine. It takes willingness-to-change and strong determination from leadership for entering into a continuous iterative cycle of self-development. Despite initial expectations, the results of this study shows that the lean senseis/mentors do not necessarily improve or accelerate the self-development process. Notwithstanding, the reasons lying behind the ineffectiveness of lean senseis need to be further investigated.

Once the culture becomes conductive enough to lean and the leadership acquires sufficient lean competencies and knowledge to kick off the lean turnaround, the next step for the leader is putting in place structures and processes that support and reinforce lean. This includes establishing an effective hoshin kanri (policy deployment) process that serves as a compass for all activities. The reward, and progress and performance measurement systems also need to be revolutionized in order to be compatible with and support lean. Creation of a lean function with enough authority and resource can reinforce lean values and culture and also keep the lean train on track by following up on the improvements and constantly monitoring the progress. It may also manifest leadership sincere and strong commitment to lean.

Last but definitely not least, leadership has to integrate lean into its day-to-day management routines, if the benefits of lean are to be sustained. Frequent and active participation in kaizen events as well as establishing and reinforcing standardized work procedures are leadership's weapons against inertia of old batch-and-queue routines.

Examination of the correlation between role of leadership in lean and the achieved business results is one of the exclusive contributions of this study. Besides the lean leadership model proposed in this study fills a critical gap in the literature as it includes all the different aspects of leading an organization, ranging from embedding the desired cultural values to day-to-day micromanagement activities. In addition, it adds practical flavor to fuzzy leadership concepts and help leaders in implementing lean by providing them with practical instructions.

5-2- Limitations

As the research study began, the practical and theoretical limitations became evident. These limitations are listed below:

1- More than 25 years have passed since the introduction of lean to the academic society, and during this quarter of a century, plenty of books, papers, and articles have been published on lean manufacturing and lean tools. However, the soft aspect of lean has almost been left unexplored by scholars. Among the scarce available resources on human-related aspect of lean, the domains of 'lean leadership' and 'lean management' in particular, are even less explored by the academic researchers and scholars.

   In addition, except very few companies (Wiremold and Toyota as far as identified by literature review of this study), so far other successful lean organizations have not been open to sharing their leadership and managerial experiences during their lean journey.

   This lack of access to sufficient theoretical bases and information to begin the study with, has limited the scale, precision, and inclusion of this study.

2- The objective of the first phase of this study was investigation of the impact of leadership on the business results that may be achieved from lean. However, reluctance of the respondents for giving financial information and lack of clear and precise information decreased the response rate of the business-results-related questions of the survey. The participation rates for the respective questions were from as low as 22.4% to high of 34.7%. So, any inference made in this study has to be used with caution.

3- Credibility and reliability of the proposed lean leadership model may be increased through deployment of focus groups, consisting of, particularly, lean practitioners from successful lean organizations who can examine the model from a practical point of view. Pilot Implementation and refinement of the model based on repeated audits can also increase its credibility. However, the amount of available time and resources for this study, did not allow such practices.

5-3- Future work

The limitations mentioned in section 5-2 indeed introduce ample opportunities for future research. Below the main domains that presents great opportunities for future work are listed:

1- **Lean culture**: Although culture has been mentioned in the majority of the literature, either directly or indirectly, most of these references just scratch the surface. Identification of the defining characteristics of lean culture, extend of its impact on lean implementation, current cultural trends in lean organizations, dynamics of manager-employee relationship

in lean culture, tools for lean culture operationalization, development of a roadmap to lean culture, defining roles of managers and leaders in lean culture, establishing criteria for measuring cultural leanness, and lean change management may all be subject of future research.

2- **Lean leadership tools**: The proposed lean leadership model in this thesis provides leaders, who are about to embark on their lean journey, with a starting point to better understand and conquer the path ahead of them. However, operationalizing each of the elements of the model in itself is highly challenging. So, as the literature suffers an obvious gap in the realm of leadership tools, the development of some leadership-tools packages for the realization of lean leadership duties seems necessary.

3- **Lean leadership benchmarking**: As mentioned earlier, there is hardly any information available on the managerial and leadership practices of the successful lean organizations, except a few cases like Wiremold and Toyota. The same is true when it comes to achieved business results. Therefore, extensive and detailed benchmarking studies may provide the academic society as well as the industry, with deeper and more precise insights about the way lean works and how it brings astonishing benefits to its true implementers.

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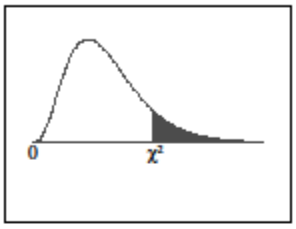
Appendixes

Appendix I- Chi-square distribution table

Chi-Square Distribution Table



The shaded area is equal to α for $\chi^2 = \chi^2_\alpha$.

df	$\chi^2_{.995}$	$\chi^2_{.990}$	$\chi^2_{.975}$	$\chi^2_{.950}$	$\chi^2_{.900}$	$\chi^2_{.100}$	$\chi^2_{.050}$	$\chi^2_{.025}$	$\chi^2_{.010}$	$\chi^2_{.005}$
1	0.000	0.000	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

Appendix II- Survey questionnaire

This survey is part of a research project entitled "*Building a Sustainable Lean Culture*". The focus of this project is on lean leadership practices and enablers as the most prominent key factors in any successful lean initiative. By answering the following questions, you will help us to identify companies that use lean as their improvement strategy and also the business results that they have obtained as the outcome of their improvement endeavor. The ultimate goal of this study is to develop a lean leadership model, based on the leadership practices of the most successful lean transformers. Your collaboration in answering the following questions would be truly appreciated. All the information provided by you is considered confidential and will be employed as data for this project. We will also provide you with the results of the study, which may prove to be useful for your future lean efforts.

Thanks you for your participation.

1- Your name (optional):
2- Name of your company/organization:
3- Your email address (optional):

4- Have you ever had any improvement/transformation initiative(s) under lean umbrella or as a part of it?

- o Yes- please answer the following questions
- o No- please disregard the following questions

5- What is the level of your current position in your company's organizational chart?

- o First-line management
- o Middle management
- o Top management (president of sub-divisions/vice president)
- o Leadership (CEO/Corporate's President/chairman)
- o Other (please specify):

*If you do NOT have enough information to answer any of the following questions, please answer by writing "N/A" in the applicable space.

6	Starting date of the improvement/transformation initiative:	
7	Position of the initiator(s):	
8	Name of the department/plant/project where the initiative took/takes place (if it is an organization- wide initiative please answer by writing "All"):	
9	The initiative's vision:	
10	The initiative's goals:	

11- Please indicate lean's level of contribution to the initiative:

oLess than 20% o20%-40% o40%-60% o60%-80% o More than 80% oI don't know

12- Please indicate initiative's level of success in achieving its goals:

oLess than 20% o20%-40% o40%-60% o60%-80% oMore than 80% oI don't know

13- How do you rank your level of acquaintance with lean?

- o No knowledge
- o primary knowledge- I know what lean is about
- o basic technical knowledge- I know about lean tools
- o intermediate knowledge- I know about lean tools and principles and I have practiced some of them
- o advanced knowledge- I have several years of working in a lean organizations and have implemented lean principles for many years
- o professional knowledge- I am a lean sensei
- o Other (please specify): …

14- How do you rank the amount of time you spend in your office as compared to on the shop-floor?

- o I spend more than 75% of my time in my office
- o I spend 50%-75% of my time in my office
- o I spend 25%-50% of my time in my office
- o I spend less than 25% of my time in my office

15- Which of the options below best describes the application of standardized work in your organization?

- o There is no standardized procedure in our organization
- o Only a few number of jobs in different departments are done by standardized procedures
- o Some of the jobs in different department are being done by standardized procedures
- o Only people who perform simple manufacturing or assembly functions follow standardized procedures
- o There are some documented standardized instructions for different functions but they are rarely used.
- o All the jobs in different functional departments are being done based on standardized procedures
- o Other (please specify):

16- On a scale of 1 to 5, how do you rank the level of your knowledge on "kaizen"?

- o I have never heard the word 'kaizen'-please go to question number 18
  - o 1 o 2 o 3 o 4 o 5

17- Which of the following, in your opinion, best describes the essence of kaizen?

- o Kaizen is an event which takes place in previously set intervals with the goal of making improvements
- o Kaizen is an activity which is done when a problem arises
- o Kaizen is a continuous improvement process which takes place on daily basis
- o Kaizen is a useless activity which is a waste of time and money
- o Kaizen is a training activity which simulates on-the-job challenges
- o Other (please specify): …

18- On a scale of 1 to 5 how much do you think current short-term/annual plans in your respective department are aligned with the organization's vision? (1 for not aligned at all and 5 for completely aligned)

o 1 o2 o3 o4 o5

19- On a scale of 1 to 5, how much do you think the initiative's vision is in line with organization's goals and vision? (1 for not aligned at all and 5 for completely aligned)

o 1 o2 o3 o4 o5

20- Which of the following best describes your role in the initiative? (You may choose more than one answer)

- o (One of the) initiator(s)
- o Active participant in the process of setting goals (hoshin kanri)
- o Active participant in kaizens/improvement events
- o Passive observer- just reading reports and monitoring the progress
- o Active supporter- monitoring the progress and providing resources/help as needed
- o Passive executer- just executing what I was asked/ordered
- o Active opposition- trying to demonstrate futility of the project
- o Passive opposition- knowing that it will not work but not doing anything to prove that
- o Other- Please explain: …

21- Were there any sensei(s)/mentor(s) involved in the lean project?

o Yes oNo- please go to question number 24

22- On a scale of 1 to 5 how do you evaluate the quality of the sensei(s)/mentor(s)/coach(s)'s contribution to this project? (1 for no contribution and 5 for very high level of contribution)

o 1 o2 o3 o4 o5

23- How much training have you received in lean under a sensei/coach/mentor's direct guidance?

oNone o Less than 5 months o 6 months to 1 year o 1-5 years o More than 5 years

oOther (please specify):

24- How do you rank the amount of in-class training (seminars/workshops/class lectures) you have received on lean?

oNone - please go to question 26 oLess than 5 hrs o5-10 hrs o10-20 hrs oMore than 20 hrs

25- On a scale of 1 to 5 how do you rank the quality of the in-class training? (1 for very poor and 5 for excellent)

o1 o2 o3 o4 o5

26- Which of the following options best describes the on-the-job training you have received on lean?

- o None- if your answer is "None" please go to question number 27
- o I have tried lean tools in real situations a limited number of times after lean seminars/workshops/classes
- o I implement lean tools occasionally on my actual job
- o I implement lean tools usually on my actual job
- o I use lean tools in daily basis as standard way of doing my job
- o Other- please explain: …

27- On a scale of 1 to 5 how do you rank the level of leadership's direct involvement in the project? (1 for no involvement and 5 for high level of involvement)

o 1 o2 o3 o4 o5

28- On a scale of 1 to 5 how do you rank the availability of required resources (financial /technological/ human/ knowledge) to the project?

o 1 o2 o3 o4 o5

29- When do the kaizen events mainly take place? (You may choose more than one answer)

- o Never – Please go to question number 32
- o In case of severe problems
- o In case of any kind of problem
- o Only in sever crisis
- o Based on a fixed schedule
- o (Almost) on daily basis
- o Whenever asked by top management/highest authority in the project
- o Other- please explain: …

30- Which of the following best describe the frequency of your participation in kaizen events?

- o Never participated
- o Once or twice per year
- o Once or twice per quarter
- o Once or twice per month
- o Once or twice per week
- o Almost daily
- o Other- please explain: …

31- Which of the options below best describes your role in kaizen? (You may choose more than one answer)

- o Never participated physically in any kaizen event, just reading the reports and making the final decision
- o Never participated in any kaizen, and have not any type of engagement in kaizen activities
- o Problem solver- analyzing the problem and provide the solution
- o Passive observer- just attending the events to observe the process
- o An equal team member- participating in the problem solving process just as every other team member
- o Coach - guiding other team members toward right way of doing root cause analysis by asking questions
- o Final decision maker- attending the events and just making the final decision at the end
- o Consensus builder- building consensus and resolving conflicts as they arise
- o Other- please explain: …

32- On a scale of 1 to 5 how your subordinates' competency in applying lean tools improved in the course of the project? (1 for no progress and 5 for extreme progress)

o 1 o2 o3 o4 o5

33- How much of the implemented improvement ideas has come/came from your subordinates?

o none oless than 25% o25%-50% o50%-75% oMore than 75%

34- Was there any function or department/function specifically dedicated to the lean/improvement/ excellence initiative?

o Yes oNo- if your answer is "No" please go to question number 35

35- On a scale of 1 to 5 how do you rank the performance of the lean function/department? (1 for very poor and 5 for excellent)

o 1 o2 o3 o4 o5

36- In which ways were the progress reports/performance measurements communicated with the people (including shop-floor workers) involved in the project?

- o Not applicable as they were not being shared- Please go to question number 37
- o In regular meetings
- o In annual staff meetings
- o In internal bulletins/brochures/leaflets
- o On walls, boards and monitors that were visible to everyone
- o Periodically by emails
- o Face to face by the head of each department
- o Other: please explain: …

37- Which of the options below best describe the frequency of communication of updated progress/performance measurements with involved people (including shop-floor workers)?

- o Annually

- Every 6 months
- Quarterly
- Monthly
- Biweekly
- Weekly
- Daily
- Completely randomly

38- What were/are the progress/performance evaluation metrics used in the initiative?

39- Please explain the reward system used for incentivizing people?

- There is no reward system
- Bonus system tied to individual's performance
- Bonus system tied to team's performance
- Profit sharing available to all employees
- Profit sharing available to employees with a given years of experience in the company
- Stock option available to all employees
- Stock option available to employees with a given years of experience in the company
- Other (please specify):

40- Do you consider the lean project as a successful project?

- Yes- if your answer is "Yes" please answer questions number 40 to 44
- No – if your answer is "No" please answer questions number 45 to 47

41- What do you think were the key factors which contributed to the success of the initiative?

42- What further improvements do you think were possible within this initiative?

43- What do you think were the impediments to the project's progress?

44- What do you think the leadership could have done/can do differently to facilitate or accelerate the progress?

45- What do you think you could have done/can do differently to make more contribution to the initiative?

46- What do you think were the key factors which led to failure of the initiative?

47- What do you think the leadership could have done/can do differently if the initiative was/is to succeed?

48- What do you think you could have done/can do differently if this initiative was/is to succeed?

*** As there might be some confidentiality consideration in answering the following questions by exact numbers, you also have the option of answering either in percentage terms or by indexed numbers.**

49	Increase/decrease in company's gross sales	Gross sales at the start of the program (exact/indexed numbers) :	
		Gross sales in last year's annual report (exact/indexed numbers):	
		Percentage of increase/decrease in gross sales:	
50	Increase/decrease in company's gross sales	Gross profit at the start of the program(exact/indexed numbers):	
		Gross profit in last year's annual report (exact/indexed numbers):	
		Percentage of increase/decrease in gross profit:	
51	Increase/decrease in number of company's inventory turns	Number of inventory at the start of the program (exact/indexed numbers):	
		Number of inventory turns in last year's annual report (exact/indexed number):	
		Percentage of increase/decrease in number of inventory:	
52	Increase/decrease in company's available space (i.e. storage, administrative, manufacturing, and …	Inventory at the start of the program (exact/indexed numbers):	
		Inventory in last year's annual report (exact/indexed number):	
		Percentage of increase/decrease in inventory turns:	
53	Increase/decrease in company's number of employees	Number of employees at the start of the program (exact/indexed numbers):	
		Number of employees in last year's report (exact/indexed number):	
		Percentage of increase/decrease in the number of employees:	
54	Increase/decrease in company's market share	Market share at the start of the program:	
		Market share (last year):	
55	Increase/decrease in company's size/value of business (please answer in percentage terms):		

Appendix III- Business results' conversion-to-categorical-data guides

Sales

NO.	Years of lean implementation	Original response	Average annual change in gross sales (%)	Corresponding category
1	3	+15% annually	+15% increase	10% to 30% increase
2	1	-30%	30% decrease*	Same/decrease
3	3	+2.5%	0.83% increase	less than 9.9% increase
4	4	+100%	25% increase	10% to 30% increase
5	2	+109%	21.8% increase	10% to 30% increase
6	8	+500%	62.5% increase	more than 30% increase
7	2	-30%	15% decrease	10% to 30% increase
8	2	0%*	No change*	Same/decrease
9	3	+14%	4.66% increase	Less than 10% increase
10	6	+40%	6.66% increase	less than 10% increase
11	4	+95%	23.75% increase	10% to 30% increase
12	9	75%+ annually	75% increase	more than 30% increase
13	5	+240%	48% increase	more than 30% increase
14	4	+20%	5% increase	less than 10% increase
15	4	+170%	42.5% increase	more than 30% increase
16	7	+35% in 5 years	7% increase	10% to 30% increase
17	6	+40%	6.66% increase	Less than 10% increase

Table 3-1- Gross Sales

Profit

NO.	Years of lean implementation	Original response	Average annual change in gross profit (%)	Corresponding category
1	1	-50%	50% decrease	Same/decrease
2	3	+4%	1.33% increase	less than 9.9% increase
3	4	+30%	7.5% increase	less than 9.9% increase
4	1	+5%	5% increase	less than 9.9% increase
5	8	+300%	37.5% increase	more than 30% increase
6	2	-10%	5% decrease	Same/decreased
7	2	0%	No change	Same/decreased
8	3	+5%	1.66% increase	less than 9.9% increase
9	6	+30%	5% increase	less than 9.9% increase
10	4	+72%	18% increase	10%- 29.9% increase
11	9	+46% annually	46% increase	more than 30% increase
12	5	+160%	32% increase	more than 30% increase
13	4	+5%	1.25% increase	less than 9.9% increase
14	4	+130%	32.5% increase	more than 30% increase
15	5	+23%	4.6% increase	less than 9.9% increase
16	6	-5%	0.83% decrease	Same/decreased

Table 3-2- Gross Profit

Market share

NO.	Years of lean implementation	Original response	Average annual change in market share (%)	Corresponding category
1	3	+20%	6.67% increase	5% to 10% increase
2	7	+50%	7.14% increase	5% to 10% increase
3	1	+5%	5% increase	5% to 10% increase
4	1	+18%	18% increase	more than 10%
5	8	+60%	7.5% increase	5% to 10% increase
6	2	-20%	10% decrease	same or decreased
7	2	0%	No change	same or decreased
8	3	0%	No change	same or decreased
9	4	+15%	3.75% increase	less than 5% increase
10	9	+37%	4.1% increase	less than 5% increase
11	4	+15%	3.75% increase	less than 5% increase

Table 3-3- Market Share

Company's value

NO.	Years of Lean implementation	Original response	Average annual change in value/size (%)	Corresponding category
1	1	-30%	30% decrease	decreased value
2	7	+53%	7.6% increase	less than 9.9% increase
3	1	+5%	5% increase	less than 9.9% increase
4	2	+50%	25% increase	10%-50% increase
5	8	+300%	37.5% increase	10%-50% increase
6	2	0%	No change	less than 9.9% increase
7	2	0%	No change	less than 9.9% increase
8	3	+5%	1.67% increase	less than 9.9% increase
9	4	+60%	15% increase	10%-50% increase
10	9	+600%	66.7% increase	more than 50%
11	5	+75%	15% increase	10%-50% increase
12	4	+60%	0.15% increase	less than 9.9% increase
13	5	+50%	10% increase	10%-50% increase

Table 3-4- Value of the company

Appendix IV- 'Position of the initiator' categorization table

NO.	Original response	Corresponding category	NO.	Original response	Corresponding category
1	Business improvement manager	Business improvement manager	24	Consultants	Other
2	Lean leader-UK wide	Business improvement manger	25	Supervisor of material planning	Other
3	CEO	Leadership	26	CEO	Leadership
4	Managing director	leadership	27	Team leaders	Other
5	Site manager	Other	28	VP commercial operations	Leadership
6	Director of operations	leadership	29	Usually an affiliate manager level: sometimes system-level	Business improvement manger
7	Lean lead	Business improvement manger	30	CEO	Leadership
8	Senior leader	Leadership	31	Lean project manager	Business improvement manger
9	Lean transformation manager	Business improvement manger	32	Director	Leadership
10	Operations director	Leadership	33	CEO	Leadership
11	Lean specialist	Other	34	Commercial manager	Leadership
12	Business solutions manager	Business improvement manger	35	GM	Leadership
13	General manager	Leadership	36	Chief executive	Leadership
14	Top management	Leadership	37	Leadership (CEO, COO,)	Leadership
15	CEO	Leadership	38	CEO	Leadership
16	Senior vice president	Leadership	39	Chief executive	Leadership
17	VP operations, master black belt, CI leaders	Leadership	40	President	Leadership
18	Body shop director	Other	41	Vice president of operations	Leadership
19	Operations and the managing director	Leadership	42	Assembly line manager	Other
20	President	Leadership	43	Head of after -sales department	Other
21	Deputy chief constable	Leadership	44	Sales manager- Hydraulic Division	Other
22	Director of operational effectiveness	Business improvement manger	45	Project manager- middle east	Other
23	faculty director	Leadership			

Table 4-1- 'position of the initiator' categorization guide

Appendix V- Nominal-to-ordinal conversion guides

Response	Corresponding rank
Less than %20	1
20%-40%	2
40%-60%	3
60%-80%	4
More than 80%	5

Table 5-1. Ranking guide for 'lean initiative's level of success'

Response	Corresponding rank
None	1
Less than 25%	2
25%-50%	3
50%-75%	4
More than 75%	5

Table 5-2. Ranking guide for 'amount of ideas from subordinates'

Original response	Corresponding rank
Once per year	1
Once per 6 months	2
Once per quarter	3
once per month	4
Once per 2 weeks	5
Once per week	6
(almost) daily	7

Table 5-3. Ranking guide for 'frequency of the communication of the progress/performance'

Response	Corresponding rank
Primary knowledge	1
Basic technical knowledge	2
Intermediate knowledge	3
Advanced knowledge	4
Professional knowledge	5
*in the survey questionnaire, the respondents also had "no knowledge" as one of the available choices. However, since no one had selected it as his/her answer, it was disregarded in the final ranking procedure. ** In the survey questionnaire, the respondents were also provided with an additional option labeled as "other-please specify: …" and the concerned responses have later been categorized in one of the above 5 groups as appropriate.	

Table 5-4. Ranking guide for 'leadership's level of acquaintance with lean'

Response	Corresponding rank
None	1
Less than 5 hours	2
5 to 10 hours	3
10 to 20 hours	4
More than 20 hours	5

Table 5-5. Ranking guide for 'amount of in-class training received by the leadership'

Response	Corresponding rank
None, I have never worked under a sensei/mentor/coach's supervision	1
Less than 6 months	2
6 months to 1 year	3
1-5 years	4
More than 5 years	5
* In the survey questionnaire, the respondents were provided with an additional option labeled as "other-please specify: …" and the concerned responses have later been categorized in one of the above 5 groups as appropriate.	

Table 5-6. Ranking guide for 'amount of training under sensei's supervision'

Response*	Corresponding rank
None- I have never received any on-the-job training on lean	1
I have practiced lean principles and used lean tools in simulated problems as a part of a formal lean training program I have used lean tools in real situations a limited number of times after lean seminar(s)/ workshop(s)/lecture(s)/class(es)	2**
I implement lean tools usually in my actual job	3
I use lean tools on daily basis as standard way of doing my job	4
* In question number 26 of the survey questionnaire, the respondents were provided with 6 options to choose from. However, since no one had chosen "I implement lean tools occasionally in my actual job", it was eliminated from the table and also in the analysis. ** Two choices of "I have practiced lean principles and used lean tools in simulated problems as a part of a formal lean training program" and "I have used lean tools in real situations a limited number of times after lean seminar(s)/ workshop(s)/lecture(s)/class(es)" were merged and are represented by rank 2 in the ranking scheme *** The respondents were also given an additional choice of "other (please specify)". The responses in this category were later categorized in one of the above 4 categories.	

Table 5-7. Ranking guide for 'amount of on-the-job training'

Response	Corresponding rank
I spend less than 25% of my time in my office	1
I spend 25% to 50% of my time in my office	2
I spend 50% to 75% of my time in my office	3
I spend more than 75% of my time in my office	4

Table 5-8. Ranking guide for 'amount of office-time versus gemba-time'

Original response	Corresponding rank
There is no standardized procedure in our organization OR There are some documented standardized instructions for different functions but they are rarely used	1
Only a few number of jobs in different functions are done by standardized procedures	2
Some people performing simple manufacturing or assembly functions follow standardized procedures OR Some of the jobs in different functional departments are being done by standardized procedures	3
(almost) all the jobs in different functional departments are being done by standardized procedures	4

Table 5-9. Ranking guide for ‘application of standard work’

Appendix VI – Contingency tables

		Percentage of annual change in gross sales on average				total
		Decreased or same	Less than %9.9 increase	%10-%29.9 increase	More than %30 increase	
Position of the initiator	Leadership	1	3	3	3	10
	Other	2	3	1	1	7
Total		3	6	4	4	17

Table 6-1. Cross-counts of 'annual change in gross sales on average' and 'position of the initiator'

		Percentage of annual change in gross profit on average				total
		Decreased or same	Less than %9.9 increase	%10-%29.9 increase	More than %30 increase	
Position of the initiator	Leadership	1	4	2	2	9
	Other	3	3	0	1	7
Total		4	7	2	3	16

Table 6-2. Cross-counts of 'annual change in gross profit on average' and 'position of the initiator'

		Percentage of annual change in market share on average				total
		Same or decreased	Less than 5% increase	5%-10% increase	More than 10% increase	
Position of the initiator	Leadership	1	2	3	0	6
	Other	2	1	1	1	5
Total		3	3	4	1	11

Table 6-3. Cross-counts of 'annual change in market share on average' and 'position of the initiator'

		Percentage of annual change in value/size on average				total
		Same or decreased	Less than %9.9 increase	%9.9-%50 increase	More than %50 increase	
Position of the initiator	Leadership	1	2	3	1	7
	Other	2	2	2	0	6
Total		3	4	5	1	13

Table 6-4. Cross-counts of 'annual change in company's value on average' and 'position of the initiator'

		Lean initiative's level of success in achievement of its goals					total
		Less than %20	%20-%40	%40-%60	%60-%80	More than %80	
Position of the initiator	Leadership	1	2	8	3	9	23
	Business improvement manager	0	0	2	1	3	6
	Other	4	0	2	0	3	9
Total		5	2	12	4	15	38

Table 6-5. Cross-counts of 'lean initiative's level of success' and 'position of the initiator'

		The lean initiative's level of success					total
		less than 20%	20%-40%	40%-60%	60%-80%	more than 80%	
Leadership's level of direct involvement	1	0	1	1	0	0	2
	2	4	0	3	1	0	8
	3	1	0	2	2	3	8
	4	0	1	6	0	3	10
	5	0	1	2	1	9	13
Total		5	3	14	4	15	41

Table 6-6. Cross-counts of 'lean initiative's level of success' and 'leadership's level of direct involvement'

		Leadership's level of direct involvement					total
		1	2	3	4	5	
Position of the initiator	Leadership	1	3	6	4	11	25
	Business improvement manager	0	0	4	3	0	7
	Other	1	5	2	2	2	12
Total		2	8	12	9	13	44

Table 6-7. Cross-counts of 'leadership's level of direct involvement' and 'position of the initiator'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Improvement in subordinates' competency in applying lean tools	1	0	0	1	0	0	1
	2	4	1	2	0	0	7
	3	1	1	4	2	5	13
	4	0	1	6	2	8	17
	5	0	0	1	0	2	3
Total		5	3	14	4	15	41

Table 6-8. Cross-counts of 'improvement in subordinates' competency in applying lean tools' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Amount of improvement ideas from the subordinates	1	1	0	1	0	0	2
	2	3	0	1	0	0	4
	3	1	1	5	2	2	11
	4	0	2	5	1	3	11
	5	0	0	2	1	10	13
Total		5	3	14	4	15	41

Table 6-9. Cross-counts of 'amount of improvement ideas from the subordinates' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Number of communication methods	0	1	0	0	0	0	1
	1	3	1	4	0	1	9
	2	1	0	4	0	0	5
	3	0	1	3	2	5	11
	4	0	1	3	2	2	8
	5	0	0	0	0	4	4
	6	0	0	0	0	3	3
Total		5	3	14	4	15	41

Table 6-10. Cross-counts of 'number of communication methods' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Frequency of communication of the progress/performance	Daily	1	2	2	0	7	12
	Weekly	0	2	1	1	2	6
	Biweekly	1	1	0	1	1	4
	Monthly	0	4	1	0	2	7
	Quarterly	0	1	0	0	1	2
	Every 6 months	1	0	0	2	0	3
	Annually	0	0	0	1	0	1
	randomly	0	2	0	0	2	4
Total		3	12	4	5	15	39

Table 6-11. Cross-counts of 'frequency of communication of the progress/performance' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Frequency of communication of progress/performance	Daily	1	0	0	0	0	1
	Weekly	2	1	0	0	0	3
	Biweekly	0	0	1	0	1	2
	Monthly	0	0	4	1	2	7
	Quarterly	1	1	1	0	1	4
	Every 6 months	1	0	2	1	2	6
	Annually	0	1	2	2	7	12
Total		5	3	10	4	13	35

Table 6-12. Cross-counts of 'frequency of communication of progress/performance' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Leadership's level of lean knowledge	1	1	0	1	0	0	2
	2	2	1	0	0	0	3
	3	1	0	1	2	3	7
	4	0	2	4	1	7	14

	5	1	0	1	0	5	7
Total		5	3	7	3	15	33

Table 6-13. Cross-counts of 'leadership's level of lean knowledge' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Leadership's level of knowledge on 'kaizen'	2	2	0	1	0	0	3
	3	1	1	1	2	0	5
	4	1	1	4	0	7	13
	5	1	1	1	1	8	12
Total		5	3	7	3	15	33
* In the original question in the survey questionnaire, the respondents were provided a 1-to-5 scale to choose from, however, since none of the respondents had chosen rank '1', the corresponding row is eliminated from the table.							

Table 6-14. Cross-counts of 'leadership's level of knowledge on kaizen' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Leadership's conception about essence of kaizen	Conforming	3	1	5	2	12	23
	Non-conforming	2	2	2	1	3	10
Total		5	3	7	3	15	33

Table 6-15. Cross-counts of 'leadership's conception about essence of kaizen' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Amount of in-class training received by the leadership	1	1	0	1	1	0	3
	2	2	0	0	0	0	2
	3	0	1	0	0	3	4
	4	0	0	0	0	4	4
	5	2	2	6	2	8	20
Total		5	3	7	3	15	33

Table 6-16. Cross-counts of 'amount of in-class training received by the leadership' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Quality of the in-class training	1	1	1	1	0	0	3
	2	1	0	1	1	0	3
	3	1	0	3	0	3	7
	4	0	1	1	1	3	6
	5	1	1	0	0	9	11

Total	4	3	6	2	15	30

Table 6-17. Cross-counts of 'quality of in-class training' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Amount of training under sensei's supervision	1	3	1	1	1	1	7
	2	0	0	0	0	1	1
	3	0	1	2	1	4	8
	4	1	1	3	1	4	10
	5	1	0	1	0	5	7
Total		5	3	7	3	15	33

Table 6-18. Cross-counts of 'amount of training under sensei's supervision' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Existence of (a) lean sensei(s)	No	3	1	3	1	1	9
	Yes	2	2	11	3	15	33
Total		5	3	14	4	16	42

Table 6-19. Cross-counts of 'existence of (lean) sensei(s)' and 'lean initiative's level of success'

		Lean's initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Quality of the lean sensei(s)'s contribution	2	1	0	0	0	0	1
	3	0	0	2	0	1	3
	4	1	1	3	1	4	10
	5	0	1	6	2	10	19
Total		2	2	11	3	15	33

*in question number 22 of the survey questionnaire, the respondents were originally asked to rank the quality of the sensei's contribution on a 1-to-5 scale. However, since no one had chosen rank '1', the corresponding row was eliminated from the table and in the analysis.

Table 6-20. Cross-counts of 'quality of the lean sensei's contribution' and 'lean initiative's level of success

		Lean's initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
On-the-job application of lean tools	1	2	0	1	0	0	3
	2	2	2	0	0	0	4
	3	1	1	0	3	3	8
	4	0	0	6	0	11	17
Total		5	3	7	3	14	32

Table 6-21. Cross-counts of 'on-the-job application of lean' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Office time-vs. gemba-time	1	0	0	2	0	3	5
	2	1	0	4	0	10	15
	3	2	2	0	2	2	8
	4	2	1	1	1	0	5
Total		5	3	7	3	15	33

Table 6-22. Cross-counts of 'office time vs. gemba time' and 'lean initiative's level of success'.

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Level of departmental goals-lean vision alignment	2	1	1	4	0	0	6
	3	1	1	2	1	0	5
	4	1	3	6	2	12	24
	5	0	0	2	1	4	7
Total		3	5	14	4	16	42
*in question number 22 of the survey questionnaire, the respondents were originally asked to rank the alignment of departmental goals with lean vision on a 1-to-5 scale. However, since no one had chosen rank '1', the corresponding row was eliminated from the table and in the analysis.							

Table 6-23. Cross-counts of 'level of departmental goals-lean vision alignment' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Level of organizational goals-lean vision alignment	2	0	4	1	0	0	5
	3	0	1	3	0	0	4
	4	1	1	8	2	8	20
	5	0	1	2	2	8	13
Total		1	7	14	4	16	42
*in question number 22 of the survey questionnaire, the respondents were originally asked to rank the alignment of the lean initiative's vision with the organization's vision and goals on a 1-to-5 scale. However, since no one had chosen rank '1', the corresponding row was eliminated from the table and in the analysis.							

Table 6-24. Cross-counts of 'level of organizational goals-lean vision alignment' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Existence of a lean function	No	5	1	4	0	2	12
	Yes	0	2	10	4	13	29
total		5	3	14	4	15	41

Table 6-25. Cross-counts of 'existence of a lean function' and 'lean initiative's level of success'

		Lean initiative's level of success				total
		2**	3	4	5	
Quality of the lean function's performance	3*	0	2	2	1	5
	4	2	7	2	8	19
	5	0	0	0	4	4
Total		2	9	4	13	28

* In the survey questionnaire the respondents were originally provided with a 1-5 ranking scale for 'quality of the lean function's performance'. However, since in this section's sample the total counts for rank 1 and 2 were zero, they have been eliminated from the calculations.
** In the survey questionnaire the respondents were originally provided with a 1-5 ranking scale for 'lean initiative's level of success'. However, since in this section's sample the total counts for rank 1 was zero, it has been eliminated from the calculations.

Table 6-26. Cross-counts of 'quality of the lean function's performance' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Type of performance metrics	Process-oriented	1	1	3	3	10	18
	Result-oriented	3	2	3	0	1	9
Total		4	3	6	3	11	27

Table 6-27. Cross-counts of 'type of performance metrics' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Existence of a reward system	No	3	1	7	0	3	14
	Yes	2	2	4	4	13	25
Total		5	3	11	4	16	39

Table 6-28. Cross-counts of 'existence of a reward system' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Type of reward system	Bonus	2	2	2	1	0	7
	Profit-sharing	0	0	1	2	12	15
	Non-monetary	0	0	1	1	1	3
Total		2	2	4	4	13	25

Table 6-29. Cross-counts of 'type of reward system' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Frequency of leadership's participation in kaizen events	1	2	0	0	0	0	2
	2	2	2	1	0	1	6
	3	0	1	3	0	0	4
	4	1	0	1	2	4	8
	5	0	0	1	0	3	4
	6	0	0	1	1	7	9
Total		5	3	7	3	15	33

Table 6-30. Cross-counts of 'frequency of leadership's participation in kaizen' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	
Application of standardized work	No standardized procedure	2	0	0	0	0	2
	Few jobs in different functions	0	1	0	1	1	3
	Some in manufacturing	1	0	1	1	0	3
	Some rarely-used standards	2	0	7	1	1	11
	Some jobs in different functions	0	0	2	0	2	4
	(almost) all the jobs	0	2	2	0	9	13
Total		5	3	12	3	13	36

Table 6-31. Cross-counts of 'application of standardized work' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Application of standardized work	1	4	0	7	1	1	13
	2	0	1	0	2	2	5
	3	1	0	5	0	3	9
	4	0	2	0	0	7	9
Total		5	3	12	3	13	36

Table 6-32. Cross-counts of 'application of standardized work' and 'lean initiative's level of success'

		Lean initiative's level of success					total
		Less than %20	20%-40%	40%-60%	60%-80%	More than 80%	
Reason for kaizen	conforming	0	1	4	2	12	19
	Non-conforming	5	2	10	2	4	23
Total		5	3	14	4	16	42

Table 6-33. Cross counts of 'reason for kaizen' and 'lean initiative's level of success'