STUDY OF ORGANIZATIONAL TRANSFORMATION FROM SOCIO-TECHNICAL PERSPECTIVE

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

DOCTOR OF PHILOSOPHY

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ABSTRACT

Organizations are constantly striving for effective and flexible means for managing challenges due to globalization and increasing customer expectations. Many in business community attempted to implement the Toyota Production System, or lean in their organizations to address the challenges. While the intent in many cases were to create a more flexible, effective and efficient organizations that meets the challenges of survival under external and internal pressures. However, the existing body of knowledge on lean is disperse and diverse in nature with respect to the application and implementation of lean tools and practices, making it difficult for researchers and practitioners to gain a real grasp of this topic. This research not only organizes the existing work on implementing lean but also documents challenges of implementation. The primary goal of this research is to study the organizational change and lean transformation from socio-technical perspective. In the process of discovery and empirical research, this work first, identifies challenges of organizational lean transformation. Second, it discovered organizational constructs from socio-technical perspective that has relevance on organizational challenge and lean transformation. Third, it proposed a hypothetical model, create a measurement model for predicting organizational change and lean transformation. Finally, this research tested a set of hypotheses. An Exploratory factor analysis (EFA) and subsequently a confirmatory analysis (CFA) was performed to identify the significance of latent organizational factors from socio-technical perspective as well as provide a theoretical model based on model fit indices exploiting path analysis (PA). This research contributed in providing a meaningful framework for organizational change and lean transformation and develop an instrument for measuring the organizational change and lean transformation for analyzing the gap or identify challenges in lean implementation from socio-technical perspective at organizational levels.

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DEDICATION

This dissertation is adoringly dedicated to my parents and grandparents:

late Shah J. M. Z. Islam, Dad

Masuda Islam, Mom

late Rahela Khatun, Nani

Md. M. H. Sarker, Nana Bhai

late Fatema Tuz Zohra, Dadi

late Mofiz U. Mondol, Dada Bhai

It was their lasting love and sacrifices that empowered me to achieve this goal.

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CHAPTER 1. INTRODUCTION

1.1. Introduction

Manufacturing and service organizations are constantly striving to develop more effective and flexible means for managing challenges due to globalization and increasing customer expectations. Yadav et al. (2010) suggest, "Mass production and efficiency models characterized by Taylor, Ford, and Sloan, while employing a high value on rationality, are based on the notion of strong division of labor and recommended rigid bureaucratic organizational forms." These organizational structures are no longer compatible with changing business environments, which require more flexible production systems and enhanced performance of service delivery. This has led to increased efforts by the business community to research and implement the Toyota Production System, or lean manufacturing, to address these challenges. TPS and lean manufacturing are often used interchangeably in most of the existing literature. The term "lean" was first introduced by Krafcik (1988), but was propagated by Womack, Jones, and Roos (1990) by using the term "lean production" in specifying the TPS. After studying the historical roots and context, chronological progression, and semantic differences of lean knowledge since the early 19th century, Shah and Ward (2007) defined lean production as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability." Over the years, organizations have witnessed attempts of implementation of lean of various scopes and reported mixed/poor implementation outcome despite of its wide acceptance. Failure to match Toyota's performance was reported in Yadav et al. (2010), partial implementation was reported in Emiliani et al. (2003) and Emiliani, M. L. (2006). Even Toyota's own failure to stick to its Toyota way was reported in Camuffo and Wilhelm, M. (2016). These research works exhibit consensus on the distortion of

complementarities among organizational elements and their functionalities. Yadav et al. (2017) has validated prior findings that lean implementation is a transformational process, therefore, requiring organizational level support and changes (Pearce & Pons, 2013). Particularly provided an in-depth analysis of the current state of lean transformation and challenges from a socio-technical perspective.

1.2. Research Rationale

To find reasons for failure in replicating lean in various organizational context after studying extant literature, this research undertook deeper study of lean implementation, organizational change, organizational transformation and socio-technical system theory as lean has been identified as socio-technical system in Shah and Ward (2007). Recognizing diverse views on these subject matters, this research has focused on the complementariness and integration of concepts instead of getting engaged in contradictions in discipline-specific research streams. Organizational change has been used as an umbrella for terms relating to organizational development and organizational transformation in Triscari, J. S. (2008) and provided various disciplinary perspectives on the topic. Many researchers worked on topics related to lean during the 1980s and the 1990s to describe the journey of TPS/lean under the term lean production (e.g., Abdulmalek, Rajgopal, & Needy, 2006; Huber, 1991; Ketchum & Trist, 1992; Kim, 1993; Krafcik, 1988; Liker, 1997; Ohno, 1988). However, the fundamental principles behind lean are derived from the work done by early quality gurus, such as Deming (1986), that helped realize the desired outcome of lean production with fewer resources. Citing their research, Yadav et al. (2010) argue that lean manufacturing and TPS are actually the same concept used interchangeably. Therefore, to avoid confusion, in this work the terms TPS, lean manufacturing, or lean production is referred to as "lean." Finding the absurdity of separate approaches to social

and technical system Trist (1950) envisaged work organizations as socio-technical system. Socio-technical system seeks joint optimization of social and technical factors. It also focuses on primary work system, whole organization system and macro social level.

Ford-Tayloristic work design practices primarily focus on efficiency but comes short on organizational effectiveness given its lack of interest on organizational change perspective. Lean, requires respect for people, knowledgebase processing controlled by workers and management together that is not as ingrained Ford-Tayloristic work design practices as in TPS/lean. Organizations are not insulated elements thus organizational effectiveness must be open in understanding and responding to environmental variation originated from customer demand, customer preference, economic and social climate. Hannan and Freeman (1984) argued that the adaptation of organizational structures to environments occurs at the population level with forms of organization replacing each other as conditions change. The concept of inertia, flexibility and isomorphism was used by Ginsburg and Buchholtz (1990) to refer to the content of the organizational change. Hannan and Freeman (1984) discussed as set of internal and external structural arrangements and environmental constraints resulting inertial pressure. These include organization's investment in plant, equipment, specialized personnel, limited use of information by leaders that flow through organizational structures relating activities within the organization and relevant environmental contingencies and finally internal political constraints. Aaker and Mascarenhas (1984) has been widely cited when it comes to define organizational flexibility that is reflected by correspondence between behavioral capabilities and their respective environments. Zucker (1988) emphasized isomorphism organizational tendencies toward conformity and legitimization. External institutional norms can encourage reliability and accountability per Zucker (1987) and Ginsburg and Buchholtz (1990) in terms of organizational

behavior and will tend to reflect inertia. Whereas when external institutional norms encourage innovation and change organizational behavior will a reflected by flexibility. Organizational responsiveness can be best understood and predicted through exploring inertial forces in organizational context per Buchholtz (1990). Adler et al. (1999) studied NUMMI for Toyota's success of not trading off between flexibility and efficiency and reported a contradiction from acceptance of such tradeoff in traditional organizational preferences. At NUMMI organic and bureaucratic structures and roles were integrated instead of veering off and leadership played a key role in committing to such direction. Socio-technical system theory has been proposed as an intervention strategy as part of strategic change plan for organizational development by Appelbaum (1997). Effective organizational development is needed for successful organizational change and performance. As Weick and Quinn (1999) noted, "Most organizations have pockets of people somewhere who are already adjusting to the new environment. The challenge is to gain acceptance of continuous change throughout the organization so that these isolated innovations will travel and be seen as relevant to a wider range of purposes at hand." This cannot happen without attention to and intervention of socio-technical factors within organizational context. A continuation of the work of Yadav et al. (2017) this research work is dedicated in achieving a better understanding of a system level perspective on lean implementations, thereby identifying the missing links and their root causes to the failures of implementation. This research contributes to a greater understanding of organizational transformation through lean implementation.

1.3. Research Questions

The objective of this study is to provide in depth understanding of organizational change and lean transformation from socio-technical perspective. More specifically, this study aims to

identify specific socio-technical constructs that can influence and predict organizational change and lean transformation. A hypothetical model is then proposed to test the relationship between the identified constructs and to understand the effect of those constructs on organizational change and lean transformation. It explores integration of socio-technical system perspective as organizational development to contribute to organizational change and lean transformation.

1.3.1. Research Question 1

The challenge of lean transformation is multifaceted due to its nature, scope, timeline, internal organizational and external environmental factors. Yadav et al. (2010) stated that "many of the companies that reported initial gains from lean implementation often found that improvements remained localized and these companies are unable to have continuous improvement going on. One of the reasons, we believe, is that many companies or individual managers who adopted lean approach did not have complete understanding and as a result, could not be able to gain all the benefits of lean approach that the Toyota was able to accomplish." Yadav et al. (2017) mentioned about organizational barriers that can hinder successful lean implementation. In summarizing the complexity and challenge of an organization change, Burke and Litwin (1992) commented that the number of variables changing at the same time, the magnitude of environmental change, and the frequent resistance of human systems create a whole confluence of process are extremely difficult to predict and almost impossible to control. Thus, the research question: **What are the challenges of organizational lean transformation?**

1.3.2. Research Question 2

Existing engineering management and organizational science literature sheds light on organizational barriers that organizations must overcome for the successful implementation of lean. For example, through their empirical research, Hambrick and Mason (1984) demonstrated

that organizational outcomes, such as strategic choices and the effectiveness of an organization, reflect the "values and cognitive bases" of their top management or other influential people in an organization. Further, Brown and Duguid (1991) argue that the traditional view of considering organizational work, learning, and innovation as separate activities should shift towards a unified view of these activities to truly improve or transform an organization. More importantly, researchers in both engineering management and organization science suggest that organizational transformation should be managed as a structured process to advance the learning from the individual level to an organizational level (Huber, 1991). Mehta and Shah (2005) proposed a conceptual framework to explore the impact of lean on labor outcomes and other work design characteristics. Shah and Ward (2007) stressed on viewing lean implementation from socio-technical system and by doing so stressed to integrate organizational development within the organizational change paradigm. Ultimately, a deep exploration of lean implantation literature, organizational change and lean transformation frame work and organizational change from socio-technical system frame work concepts needed to be integrated into the study of organizational change and lean transformation from socio-technical perspective. Based on the research a hypothetical model can be developed based on current practices in industry that can shed light on factors that are relevant for organizational change and lean transformation. Thus, the research question: **What are the organizational constructs from socio-technical system perspective that are relevant to organizational change and lean transformation from socio-technical perspective?**

1.3.3. Research Question 3

Once findings from the existing literature work is evaluated for measurement and structural validity. A subset or all the identified factors has the potential to be significant based

on the field data in the confirmatory stage of this research. Thus, the research question: **What organizational constructs has significant effect on organizational change and lean transformation from socio-technical perspective?**

1.3.4. Research Question 4

Yadav et al. (2017) suggested investigating the practical challenges of implementing the lean concept by studying the interactions among various socio-technical elements in an organization, and finding the reasons for the lack of organizational commitment and participation of leadership in lean transformations and suggested that future research should include an empirical investigation of current industry practices, or lack thereof, to validate the research findings that argue that the transformation process starts with people based on fundamental scientific knowledge and theories of lean principles and organizational practices based on priorities. Once organizational factors are identified, the hypothetical model can be tested with empirical data. Thus, the research question: **To what extent the organizational constructs can predict organizational lean transformation and organizational change?**

1.4. Structure of the Dissertation

The remainder of this dissertation is organized as follows. Chapter 2 provides a literature review of three different research streams that are pertinent to the formulation of the research model. Most of this chapter consists of extensive review of lean implantation literature, organizational change and lean transformation frame work literature as well as background on socio-technical system theory. Then, a comprehensive organization of the existing work on implementation of lean manufacturing in a more structured way, to enable engineering management practitioners to more easily identify knowledge and best practices and document/identify gaps in the extant literature. Finally, drawing from the organizational science

literature, this body of work will provide important insights on organizational change and lean transformation from the perspective of organizational learning, innovation, and \culture with relevance to socio-technical system, open system concept in identifying key organizational constructs from socio-technical perspective.

Chapter 3 provides the theoretical arguments for the conceptualization of the hypothetical model consistent with the mission of answering research questions posed in this chapter. It contains elaborate discussions on the socio-technical factors as to how they potentially contribute to the organizational change and lean transformation. This chapter identified organizational constructs and rationale for the set of hypotheses presented in developing the research model and measurement instrument presented in chapter four. It also includes a set of common factor models based on theoretical basis to contribute to item creation in Chapter 4. This common factor model becomes the foundation for item selection and measurement instrument development.

Chapter 4 presents research methodology employed in this research work. Covering issues of unit of analysis and unit of observation, target responded characteristics, sample frame, data collection, issues relevant to sample size and data analysis, construct measurement including questionnaire development and hypothetical research model. In addition, it also contains short description of latent constructs and list of items produced from common factor models presented in chapter three.

Chapter 5 contains results from data analysis. More specifically, results of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). It discusses issues related to factor retention, sample size concerns and path analysis for model fit.

Finally, Chapter 6 describes a summary of this dissertation. It contains, specifically the key findings from the data analysis. It draws a list of contributions of this research relevant to industry and academics. It also covers the limitations and future research opportunities that this research work has left open to future researchers.

CHAPTER 2. LITERATURE REVIEW[1]

2.1. Historical Background

The existing body of knowledge on lean is disperse and diverse in nature with respect to application and implementation of lean tools and practices, making it difficult for researchers and practitioners to have a real grasp of the subject. Companies across industries that attempted to implement lean concepts report initial localized gains but failed to replicate Toyota's performance and were unable to sustain continuous improvement efforts. In other words, successfully implementing lean is a unique challenge for managers and researchers. Given the importance of organizational improvement and transformation, a review of the existing literature regarding lean was performed to gather relevant knowledge to contribute to the evolution of lean transformation at an organizational level. Measures were taken to ensure that the work is well grounded in both qualitative and quantitative analysis and are relevant, accessible, and valid resource for practitioners and academics.

2.2. Methodology of Literature Survey

A literature survey was employed as a first step of the research methodology in this study to gain an understanding of lean implementation and organizational transformation from an organizational perspective. The literature search on lean transformation was focused on such topical areas as operations management, enterprise transformation, industrial engineering and

[1] The material in this chapter was co-authored by Md. Mahabubur Rahaman and Dr. Om Prakash Yadav. Md. Mahabubur Rahaman had primary responsibility for conducting literature review on lean implementation and organizational transformation. Md. Mahabubur Rahaman was the primary contributor on the materials that are advanced here. Md. Mahabubur Rahaman wrote the initial draft and Dr. Om Prakash Yadav has revised all versions of this chapter. Dr. Om Prakash Yadav served as proofreader and checked the analysis conducted by Md. Mahabubur Rahaman.

management, production and manufacturing research, organizational change management, industrial psychology, quality research, and production economics. For the sake of rigor, dissertations and unpublished working papers were excluded from the search. Several classic lean, TPS, and lean transformation books were studied for greater understanding of the general scope of the challenges and contemporary views. Several databases on engineering and management literature, such as Compendex, INSPEC, Applied Science & Technology, Web of Science, and Google Scholar search engines, were used to search for relevant articles and literature. In all, about 350 research articles were considered for initial review. Based on the preliminary review, only 105 of the most relevant publications were selected for the in-depth review and analysis. These articles serve as a representative sample to shed light on prior research works related to lean implementation. The preliminary review was conducted by considering multiple criteria, such as relevancy to the review topic (lean implementation), the type of publication (peer reviewed or not), and the research approach (level of rigor, scientific methodology, etc.). The frequency distribution of articles, along with names of the journals included in this review, is shown in Table 1.

Table 1. Frequency Distribution of Journals Cited in the Review

Journal Name	Frequency
Journal of Operations Management	19
Harvard Business Review	9
International Journal of Production Research	7
Engineering Management Journal	4
Journal of Organizational Change Management	4
Organization Science	3
Sloan Management Review	3
Academy of Management Review	2
Human Factors and Ergonomics Society	2
International Journal of Operations & Production Management	2
Journal of Manufacturing Technology Management	2
Total Quality Management	2
Behaviour & Information Technology	1
Construction Management and Economics	1
Human Relations	1

Table 1. Frequency Distribution of Journals Cited in the Review (Continued)

Journal Name	Frequency
Institute of Industrial Engineers	1
Int. J. Production Economics	1
International Journal of Lean Six Sigma	1
International Journal of Production Economics	1
International Journal of Services and Operations Management	1
Journal of Business Ethics	1
Journal of Cleaner Production	1
Journal of Distribution Science	1
Journal of Enterprise Transformation	1
Journal of Industrial Engineering	1
Journal of Industrial Engineering and Management	1
Journal of Management History	1
Journal of the Operational Research Society	1
Management Science Letters	1
Managing Times Press	1
Organizations and Society	1
Perspectives on Organization Design and Behavior	1
Proceedings of the 2010 International Conference on Industrial	1
Engineering and Operations Management	1
Proceedings of the World Congress on Engineering 2010	1
Quality and Reliability Engineering International	1
Production & Manufacturing Research	1
Production Planning and Control	1
Research and Practice	1
Russell Sage Foundation	1
Society for Organizational Learning	1
Strategic Finance	1
Works Management	1
XIMB Journal of Management	1
Books	15
Total	**105**

2.3. Classification of Lean Implementation Literature

Lean implementation requires instilling lean thinking at all levels of the organization. Researchers who studied and documented TPS and numerous principles and tools used by Toyota Adler (1993), Liker (1997), Sobek II and Liker (1998), Spear and Bowen (1999), Womack and Jones (1994) described their production system as “lean manufacturing” due to their ability to achieve and realize more with “fewer resources” Yadav et al. (2010). After studying the historical roots and context, chronological progression, and semantic differences of lean knowledge since the early 19th century, Shah and Ward (2007) defined lean production as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently

reducing or minimizing supplier, customer, and internal variability." The evolution of lean manufacturing is described in great detail in classic books written by Monden (2011), Ohno (1988), Shingo and Dillon (1989), Womack et al. (1990), and Womack and Jones (2010). The recent work of Stone (2012a) describes five phases of history of lean in chronological order as "discovery phase (1970–1990), dissemination phase (1991–1996), implementation phase (1997–2000), enterprise phase (2001–2005), and the most recent phase of performance (2006–2009)." The existing knowledge base shows efforts to comprehend the chronological order of lean and related challenges due to its multi-faceted nature.

Table 2. Some of the Highly Used Keywords in the Reviewed Literature

Description of keywords	Frequency
Lean production, lean operations	18
Lean implementation, lean implementation initiatives, lean management, lean manufacturing, lean manufacturing practices	14
Quality, six-sigma, total quality management, continuous improvement	12
Learning, learning curves, organizational learning, organizational structure	11
Manufacturing systems, system design, system theory, systems thinking	10
Performance, performance measurement, lean performance metrics, lean process improvement, process improvement, productivity	9
Organizational performance, organizational change, organizational adaptation, organizational behavior	7
Lean, lean taxonomy, lean thinking, lean transformation	6
Corporate culture, culture, lean culture, organizational culture	6
Change, change capacity, change management	5
Socio-technical change, socio-technical systems	3
Leanness, leanness measure, lean assessment	3

In this research, existing body of the selected research work on the topic of lean implementation was classified based on their focal point of the work. A very high-level content analysis was performed through keywords mapping to determine the direction of research in the extant literature and classify the existing knowledge. Table 2 depicts the findings of the keywords mapping analysis in terms the most frequently-used keywords in the reviewed articles.

2.4. Status of Lean Implementation by Focal Area in Existing Literature

2.4.1. Implementation of Lean with Respect to Principles, Practices, and Rules

According to Toyota (2014), the main building blocks of lean are Kaizen, continuous improvement, just-in-time (JIT), jidoka and interaction, and interdependence of suppliers with TPS mediation. Just-in-time manufacturing and other features of the TPS work well when they are a common basis for synchronizing activity throughout the operational sequence. TPS expects three outcomes (Toyota, 2014). The first is providing products to customers with the "highest quality," "lowest possible cost," "shortest possible lead times," and on-time delivery by engaging the whole value chain that stems from design concept to ultimate delivery of the finished product. The second is providing job satisfaction, job security, and unbiased treatment to employees by establishing an effective work environment. The third outcome is ensuring that a company has built-in flexibility to respond to changing market requirements, attaining profit by reducing costs, and enjoying continuous success. In order to achieve these desired outcomes, responsiveness and flexibility are two critical features of TPS.

A large number of prior research works have focused on the topic of lean implementation, principles, practices, and rules. Yadav et al. (2010) conducted an exhaustive study and identified underlying fundamental principles of lean manufacturing in an effort to gain insights on the success of TPS. Several other researchers have discussed these principles and practices separately as a part of understanding the inner workings of TPS. For example, Adler (1993); Sobek II and Liker (1998); Spear and Bowen (1999); and Sobek, Ward, and Liker (1999) discovered that standardization was a key element of lean thinking in TPS. By standardizing its activities, Toyota has been able to gain higher productivity, balanced lines, lower work in process inventory, and lower operational variability Monden (2011), Yadav et al. (2010). Adler

(1993) credits the success of New United Motor Manufacturing, Inc. (NUMMI) to its intense focus on standardization, which also increases learning efficiency Shingo and Dillon (1989).

Spear and Bowen (1999) highlight lean manufacturing practices in the form of four basic rules: how people work (activities), connections between activities, pathways followed to establish these connections, and continuous improvement. Researchers find that the "activities, connections, and production flows in Toyota's factory are rigidly scripted yet its operations are enormously flexible and adaptable" Yadav et al. (2010) as well as Sobek II and Liker (1998) also discuss smooth integration and flexibility in the Toyota product development process. This work stresses the importance of an overall, well-calibrated system to reap the advantage of individual best practices and tools used by employees at all levels within Toyota. Fullerton, McWatters, and Fawson (2003) examined the relationship between lean practices, such as just-in-time (JIT) and financial performance. Ohno (1988) noted that the basis of TPS was the absolute elimination of waste; the two pillars needed to support the system were JIT and autonomation or automation with a human touch. Subsequently, Womack and Jones (2010) introduced five principles of lean thinking, which focused on value, the value stream, flow, pull, and the quest for perfection. Ohno (1988) compared business organizations with that of the human body that exerts autonomous reflexes under different scenarios making a case that human responses are not always dictated by the central nervous system, but rather may simply be motor reflexes.

Finally, for achieving improvement at Toyota, it was essential that required improvement must be made based on the scientific method, with the help of a teacher and the shop floor level in the organization. This clearly indicates that lean is a people-centric philosophy. The people-centric philosophy focuses on how people think, how they act or react in certain situations, how well they all are aligned to work for a common goal, and ultimately how well the individual

attitude and the organizational culture are aligned in the eyes of the employees from a socio-technical perspective. Trist (1981) states that it makes a difference whether one is considering a solely individual attitude or a social change involving norms and values. The author suggests that employees' commitment to changes depends very much upon the organization's long-term commitment towards its own employees. This is more effective if employees realize that changes in the norms and values of the wider society are aligned with the direction of the new paradigm. The lean implementation process thereby needs to be understood at all three levels of the socio-technical system for effective transformation.

2.4.2. Implementation of Lean with Respect to the Lean Tool Box

The fundamental principles of lean manufacturing have evolved from basic tools and concepts developed over a period of time. These tools and concepts come from different disciplines of science and engineering and are abundantly discussed in the literature. For example, Shingo and Dillon (1989) explain set-up reduction by analyzing the process of die exchange to identify and eliminate non-value adding activities while using very basic industrial engineering tools. According to Monden (2011) and Ohno (1988), Kanban or production planning and scheduling in a lean manufacturing environment plays a very critical role, not only for designing a smooth and integrated production system, but also in reducing work-in-process inventory, eliminating non-value adding tasks, and balancing production lines. Spear and Bowen (1999) conclude that TPS creates a community of scientists that follows scientific methods for improvement by creating and testing hypotheses using design of experiments and other statistical tools and methods. Based on his study of NUMMI, Adler (1993) emphasizes that one of the reasons Toyota has succeeded in employing TPS concepts is by enhancing workers' motivation and satisfaction using basic concepts of socialization based on motivational and leadership

theories. Sobek II and Liker (1998) discuss smooth integration of product development (PD) processes using very basic tools, such as the A3 form (named after the international paper size in which the presenter has to fit his/her report), highly formalized rules, and standards for effective communication. Yadav et al. (2010, p. 6) argue that "set-based concurrent engineering is another example of Toyota's exceptional PD capability." Mazur, Chen, and Prescott (2008) discuss the use of problem-solving tools, such as value stream mapping and A3, with regard to the second-order problem solving in the health-care industry.

Further, Mostafa, Dumrak, and Soltan (2013) discuss some misapplication of lean practices and identify the choices and selection of tools as a reason for low success rates of lean implementation. Misapplications can happen mainly because of the "use of the wrong tool to solve a problem, use of a single tool to solve all of the problems and use of the same set of tools on each problem" (Pavnaskar, Gershenson, & Jambekar, 2003, p. 3077). Ramesh and Kodali (2012) stress the selection of the appropriate tools by offering suggestions for greater optimization of the system. The literature clearly shows that the tools and methods used in lean are the same basic tools and concepts used by every other organization or industry. Our in-depth analysis of the lean literature indicates that set-up time reduction, Kanban (planning and scheduling), line balancing, design of experiments, statistical methods, value stream mapping, and standardized form of communication (e.g., the A3 form) are some of the most common and critical tools for effective lean transformation. What makes TPS unique is an effective integration of these tools in the problem-solving process along with rules and principles that grew gradually over six decades of work Spear and Bowen (1999).

2.4.3. Implementation of Lean with Respect to Lean Framework

Monden (2011) laid out a total framework of lean by defining its purpose and structural elements stating that the primary purpose of becoming lean is profit through cost reduction, elimination of overproduction, quality assurance, and respect for humanity. He also explained that "just-in-time" and automation, flexible workforce, and originality and ingenuity are the backbone of the Toyota organization, which allowed establishing a much-needed Kanban system to institute the pull system. The Kanban system was established and reinforced by smoothing of production, standardization of tasks, set-up time reduction, proper layout design, and automation. Spear and Bowen (1999) clearly outlined a framework of TPS that "can be captured in four basic rules which guide the design, operation, and improvement of every activity," connections between activities, and pathways for every product and service Yadav et al. (2010). Adler (1993) discovered that NUMMI's production system was built on a strong commitment to the social context at the workplace and with an intense focus on standardized work. The whole framework is based on exceptional consistency in its strategies and principles that carefully build consensus in the decision-making process ensuring effective communication of results and other essential information. The research works carried out by Adler (1993) and Spear and Bowen (1999) reveal that distinctive features of lean principles are standardization and simplification of activities and tasks performed by people.

Recently, Mohanty, Yadav, and Jain (2007) proposed a seven-pillar framework for manufacturing practices leading to a lean enterprise system. Along with the seven-pillar framework, the authors also identified critical success factors linked to fundamental lean principles. Saurin, Marodin, and Ribeiro (2011) presented a framework for assessing the use of lean, which focuses on assessing the extent to which lean production practices are used at the

manufacturing cell level including a model of the relationships among lean practices, illustrating the necessity of a systemic view. Their framework includes a set of 18 lean practices and their respective attributes that might be used in a manufacturing cell. The authors classified these practices into three broad categories: the human resources system, the production planning and control system, and the process technology system.

Mostafa et al. (2013) proposed a framework for lean implementation as a project-based implementation approach. The proposed framework consists of four phases (conceptualization, implementation design, implementation, and evaluation) required for complete lean transformation that was presented in the form of a toolbox for practitioners. The authors emphasized that the human element is an inherent integral component of a lean system. The poor mindset and misunderstanding of the lean concept limits the lean implementation process and reduces the expected benefits for the organization. Mostafa et al. (2013) studied 28 initiatives and nine success factors regarding lean implementation. Their study found that none of the initiatives they studied contained all of the nine success factors. For example, the expert team building, lean monitoring, and controlling factors are rarely included in lean implementation while lessons learned, review, and documentation factors are mostly omitted. Therefore, the above-mentioned project-based view of lean implementation requires further scrutiny because of the continuous and organic nature of lean implementation.

In summary, many of the previously proposed lean frameworks have commonalities in terms of their focus on standardization of activities/processes, the human element, and use of lean principles to simplify processes. On the other hand, some of the more recently proposed frameworks, such as Saurin et al. (2011) and Mostafa et al. (2013), differ in terms of lean implementation by proposing more focus on project-based approaches and on specific lean tools.

Similarly, the framework proposed by Mohanty et al. (2007) focuses on the organizational level with the intent to create a lean enterprise system. However, these more recent frameworks still need to be tested to assess their success and strength before comparing them with the TPS framework.

2.4.4. Implementation of Lean with Respect to Organizational Culture Change

Organizational culture is the everyday manifestation of underlying values and traditions of a firm Goetsch and Davis (1994). Culture is reflected in how employees behave on the job, their expectations of the organization and each other, and what is considered normal in terms of how employees approach their jobs. The value systems of leaders and other decision makers are also reflected in organizational culture. Deetz, Tracy, and Simpson (1999) concluded that culture is comprised of and mutually constituted by both the internal and the external factors in which values affect behaviors and vice-versa. Together, the two create organizational culture. Thus, culture should not be treated as a product that an organization has; rather, it is an ongoing process of what an organization is. According to Conti (2010), culture can be considered as the "DNA of the human social systems, reflecting the ensemble of values, beliefs, history, traditions, way of thinking, and doing all of which link members of the organization together and shape the organization's identity." The main ingredient of the cultural fertilizer is "values," provided they are properly identified (a leader's task) and shared among members so that they become social values of the organization Conti (2010).

A reasonable amount of references to culture were made by several researchers, including Emiliani, (2006), Roh and, Lee (2013), Sobek II and Liker (1998), Stone (2012b), and Taylor and McSweeney (2013), suggesting that the success and survival of lean transformation is closely linked to prevailing culture and ongoing efforts to create a conducive environment and

value system. Mintzberg (2009) states that managing takes place within a triangle when art, craft, and the use of science meet. Art brings in the ideas and the integration; craft makes the connection while building on tangible experiences; and science provides the order through systematic analysis of knowledge Mintzberg (2009). In their analysis of 62 very successful companies, Peters and Waterman (1982) found eight common themes that exemplified the culture of these businesses. These themes are: bias for action, closeness to the customer, autonomy and entrepreneurship, productivity through people, hands-on and value driven, stick to the knitting, simple form and lean staff, and simultaneously loose-tight properties Peters and Waterman (1982). These themes are central to the fundamental concept of TPS. In describing the necessity of encompassing the system's thinking for lean system development, Mohanty et al. (2007) state that lean principles are "not steps, prescriptions, or recipes." The authors suggest that lean principles are instead critical elements of any system that need to be seamlessly integrated into the culture and entire system of the organization.

Senge (1990) states that an organization which wants to discover how to tap into people's commitment and capacity to learn at all levels in the organization requires a leadership that is able to identify those capabilities and channel them accordingly to create an effective social system within the organization. The social system in lean environment is characterized by "an atmosphere of trust and respect, consensus, effective communication, sense of realism, equal opportunity for excellence, participative decision making, and team approach" Yadav et al. (2010). Sobek II and Liker (1998) describe the impact of Toyota's intense mentoring, training, and socializing engineers in ways that instill in-depth technical expertise and effective communication. Adler (1993) credits NUMMI's success in the comprehensive socialization process with instilling a set of values in the workforce that shapes and alters the attitude of both

workers and managers. Another dimension of building trust and respect between workers and leaders is the evolution of teaching and learning through unique relationships among managers, supervisors, and workers. In the process of collective learning, leaders (such as managers and supervisors) act as enablers, coaches, or advisers instead of acting like a commander who simply gives work orders Spear and Bowen (1999). Based on these findings, the authors conclude that effective socialization among "Toyota's employees and management" played a critical role in creating an effective work culture with "an environment of trust and respect." In other words, the "exceptional consistency in actions, consensus around decision making, and effective communication mechanisms create a fertile ground to accelerate the socialization process in Toyota" Yadav et al. (2010). Based on the existing knowledge base about the success of Toyota, it is clear that the fundamental knowledge of tools, techniques, technology, and basic concepts is very important, but an effective social environment (i.e., culture) in which people feel empowered and motivated is critical. Culture acts as a glue to keep the whole system together and running to create value and growth for all stakeholders of the organization.

2.4.5. Implementation of Lean with Respect to Complementarities and Synergistic Approach

Yadav et al. (2010) discovered that most organizations have been very successful in implementing techniques and tools, but these tools have not been very effective in achieving consistent and sustainable improvement. The authors suggest that several companies achieved early benefits from lean but that remained localized without further improvement, and many failed to implement lean concepts in totality. The authors concluded that many of the "companies adopting lean did not have a complete understanding of the approach and hence could not realize all the benefits" Yadav et al. (2010). In their research, the authors realized that many of these

companies appear to be looking for a step-by-step method (i.e., a "cookbook" approach) without developing a complete understanding of lean principles and concept.

Spear and Bowen (1999) clearly laid out four rules that help establish a seamless production system complemented by scientific tools, methods, and very detailed (standardized) tasks at each level. Every improvement or change is made by following a problem-solving approach that uses an explicit logic of hypothesis and scientific method. Shah and Ward (2007) identified 10 factors by synthesizing 48 lean tools and practices and suggested that "the complementary and synergistic effects of these ten distinct yet highly inter-related factors provide lean production with a unique character and a superior ability to achieve multiple performance goals." The authors claim, although "each factor by itself is associated with better performance, firms that are able to implement the complete set achieve distinctive performance outcomes that can result in sustainable competitive advantage" Shah and Ward (2007). Of the "ten factors" identified in their study, three deals with "supplier involvement," one with "customer involvement," and the other six deals with "internal issues." Collectively, these factors establish an "operational complement" to "lean production principles and characterize distinct dimensions of a lean system" Shah and Ward (2007). Thus, it is important to note that these studies clearly support the need for seamless integration of various lean principles as a whole system using the appropriate tools and scientific knowledge base while involving every individual at all levels.

2.4.6. Implementation of Lean with Respect to Measurement and Metrics

To measure the success of lean implementation, or degree of leanness in manufacturing companies, several researchers have attempted to develop appropriate measures or indexes. Zanjirchi, Tooranlo, and Nejad (2010) developed a leanness index, which is an information

fusion consolidating the fuzzy ratings and fuzzy importance weights of all the lean enablers that influence a firm's leanness. They claim that their fuzzy leanness index represents overall organizational leanness. Their approach to develop a fuzzy method to measure organizational leanness was motivated by the need to reduce the potential ambiguity and multiple probabilities related to one person`s perception and judgment about a number used for estimating leanness and to limit the estimator's choices, preferences, and subjective judgments given the vagueness and uncertainty in human evaluation.

Wan and Chen (2008) quantify the level of leanness of a manufacturing system based on a benchmark of ideal leanness obtained from historical data using data envelopment analysis. Their leanness scores demonstrate how lean the system is. However, the effectiveness of leanness measures is limited when the input data is incorrect or difficult to gather. Though their leanness score represents the leanness level of a system, it cannot explain how lean an organization should be. The measurement of leanness was also found to be confounded with organizational effectiveness. Stone (2012a) offered a three-tier lean transformation model adopting the Burke Letwin organizational performance and change model. This research studied 14 dimensions of the Burke Letwin model and their statistical and practical significance on a firm's perceived leanness and claimed some association between the leanness and the firm's objective financial data. Sadaghiani and Sadaghiani (2014), based on an empirical investigation, identify nine important factors found to contribute positively to the implementation of lean production planning. Though efforts have been made to develop measures, or performance indicators, for leanness, there is still much work needed to establish effective measures that provide a meaningful link between lean implementation efforts and financial measures.

2.5. Lean Transformation at the Organizational Level

Despite the widespread availability and open access to literature on lean production systems, a study by Spear (1999) found that not many companies have been successful in lean implementation. According to Baker (2002), less than 10% of organizations, which implemented lean in the U.K., were successful. Likewise, Mohanty et al. (2007) studied lean implementation in automotive plants in the U.K., U.S., and India and reported a low success rate. Similar findings have been reported by other authors, and there appears to be a consensus that the incomplete understanding of lean concepts and practices leads to the failure of lean implementation efforts (Yadav et al., 2010). A plethora of publications report initial success of lean implementation in different companies with improvements failing to be sustained over time. These findings triggered the need to get a better understanding of lean principles and how they integrate within an organization as a whole, leading to lean transformation of the organization.

Lean transformation of an organization or, for that matter, any system means achieving seamless integration of lean principles and practices into the culture and entire physical system of the organization. Based on the readings of lean literature and the understanding of lean principles, it is very clear that TPS in essence represents a very effective and integrated socio-technical system Langstrand and Elg (2012), Shah and Ward (2007) that leads to a complete organizational transformation at all levels. Realizing that lean transformation represents the seamless integration of a socio-technical system, it is important to understand the principles and factors of a socio-technical system that play a critical role in lean implementation and organizational transformation. The following sections analyze socio-technical principles, factors, and challenges from a socio-technical perspective.

2.5.1. Socio-Technical System

Within an organization, the technical sub-system is comprised of equipment, technology, and processes, while the social subsystem consists of people and relationships (Ketchum & Trist, 1992). A socio-technical system is explicitly grounded in general systems theory, which is contextual as well as organizational Trist (1981). Any social system must perform certain functions for survival; therefore, it needs integration with a technological system to be complete. Therefore, to build a robust and effective whole system, the social and technical systems need to be integrated by combining technical, political, and social dimensions of a complex system. As the historical process of society unfolds, the changes in values and expectations of individuals towards their work responsibilities cause changes in the parameters of organizational design. On the other hand, technological changes result in changes in values, cognitive structures, life styles, habitats, and communications that significantly affect a society and its potential of growth and survival. An optimal socio-technical system based on fundamental lean principles facilitates the lean transformation of the organization to provide sustained growth and a competitive edge.

2.5.2. Optimization of Socio-Technical Systems

Spear (1999) provides a very clear description and unique example of effective integration and optimization of complex social and technical systems. In general, organizations are seen as consisting of two interdependent and linked systems; namely, the technical and social system. It has been realized that organizational objectives are best met by jointly optimizing these two systems rather than treating them independently Cummings (1978) Ketchum and Trist (1992), Trist (1981). Yadav et al. (2010) highlight the failure of lean implementation efforts that were undertaken without considering the whole system and the interfaces within it. However, this requires effective leadership with a broader perspective and complete knowledge of the way

technical and social systems behave independently, in addition to an integrated system Cherns (1976). In other words, a holistic view of socio-technical systems is a prerequisite for lean implementation and organizational transformation. Therefore, at the organizational level it is critical to have fundamental knowledge of both engineering and social sciences in order to provide a seamless integration of these two systems.

2.5.3. Factors of Socio-Technical Systems

Bélanger, Watson-Manheim, and Swan (2013) identify multiple factors with respect to various elements of socio-technical systems that are critical for transforming work system inputs to outputs. These elements are the technical subsystem, personnel subsystem, organization structure, and external environment to the work system. The technical subsystem includes several factors, such as technologies, policies, and practices that describe the modes of production; the actions individuals take on an object when performing work; the strategy for reducing uncertainty in the process; and the degree of process/workflow integration. The personnel subsystem includes at least three types of the following factors: demographic characteristics of the workforce, psychosocial aspects of the workforce (e.g., dimensions of personality, attitudes towards the work environment or the work itself, and individual motivations), and the degree of professionalism required to perform the work (values, norms, or expected behavior patterns of the job, and team and/or organization). The organizational structure is typically characterized in terms of centralization, formalization, and complexity Bélanger et al. (2013). Centralization refers to the level and degree of formal decision-making in a work system (such as strategic, tactical, or operational). Formalization refers to the degree to which jobs or tasks within a work system are standardized. Finally, the work environment describes the relevant characteristics of the context within which the work system operates

Bélanger et al. (2013). It is critical that work systems and organizations be able to adapt to their environment. Environmental factors that positively or negatively affect work systems in organizations can be socio-economic, educational, political, cultural, or legal. For each organization and work system, these factors differ in type, quality, and importance. However, the understanding of factors affecting socio-technical systems is critical for system optimization and organizational transformation.

2.5.4. Principles of Socio-Technical Systems

It is fair to state that an organizational design refers to the constant interchange of ideas among employees at all levels, such as engineers, managers, social scientists, and financial controllers. These individuals contribute significantly to ensure that all necessary aspects are considered for organizational design but as such there is no blueprint available for ensuring that in the organization design. Cherns (1976, p. 787) highlighted the following nine principles of socio-technical systems that can be used as a checklist to aid in organizational design:

1. Compatibility: The design process must align with its objectives. If the objective of design is to create a system that is capable of "self-modification" then organizations that are "constructively participative" are needed. A necessary condition for this to occur is that people are given an opportunity to participate in the design of the job they perform.
2. Minimal critical specification: This principle requires an optimal level of specifications of tasks, jobs, or roles. According to this principle, no more should be specified than what is absolutely essential, and further, what is essential requires specification.
3. Socio-technical criterion: This criterion states that "variances, if they cannot be eliminated, must be controlled as near to their point of origin as possible" (Cherns, 1976,

p. 787). According to this principle, “self-inspection” should be part of production process so people can “learn from their own mistake.”

4. The multifunctional principle—organism vs. mechanism: Having each element of a socio-technical system with more than one function allows the organization to be “more adaptive and less wasteful” when a multitude of performances is necessary from the mechanism or the organization due to a shift in environmental demand.
5. Boundary location: This principle focuses on the boundary maintenance role on the part of supervisors, technicians, and managers. The management of boundaries between various entities becomes a resource driven conversation as opposed to territorial driven with a supervisor playing the role of a resource.
6. Information flow principle: The information flow principle requires that “information systems should be designed to provide information in the first place” where action is needed.
7. Support congruence principle: A social support system should be created to ensure that the performance of the organization is aligned with its objectives. For example, if a system is designed based on the “team operation” and “team responsibility,” then incentives and other benefits designed based on individual members’ performance would be incongruent with these objectives.
8. Design and human values: The objective of “organizational design” is to deliver a “high quality of work” that provides growth to employees without peer pressure.
9. Incompletion: This principle states that design is an iterative process and should always have a sense of continuity. There needs to be continuous evaluation and review by multidisciplinary teams to further improve the work system design.

2.5.5. Levels of Socio-Technical Systems

Trist (1981) suggests that socio-technical studies need to be carried out at three broad levels as discussed below:

1. Primary work systems: These systems include activities that are associated with "identifiable and bonded subsystems of an overall organization." They are comprised of "a single face-to-face group or a number of such groups together with support from specialist personnel and representatives from management" Trist (1981). They have a well-defined purpose, which integrates people and activities.
2. Whole organization systems: These systems include a plant, equivalent "self-standing" workplaces, and the whole corporations or public agencies. These systems persist by maintaining a "steady state" within "their environment" (Trist, 1981, p. 38).
3. Macro-social system: It includes systems in "communities, industrial sectors, and institutions operating at all levels of a society" (Trist, 1981, p. 50).

TPS and its focus are relevant to all three levels of a socio-technical system described above for their continued success. For example, the need for survival of the Japanese auto industry in post-World War II era Japan is an example of Toyota's sense of urgency, which really comes from a nationalistic view at a macro socio-technical level and a sense of community. Toyota's sensitivity to the customer with regard to pricing is unique, where the prevalent belief is reducing cost by eliminating waste at all levels of the organization. A sense of steadfastness and commitment is evidenced by the 10 years it took to instill Kanban at Toyota Motor Company, as described in Ohno (1988). Both aspects (customer focus and waste elimination) signify Toyota's focus on the company as a socio-technical system, viewing the organization as a whole and overcoming social, technical, or financial obstacles. At the lowest level of the socio-technical

system, Toyota focuses on their primary work systems and ensures success through teamwork and successful execution of JIT and autonomation. Ohno (1988) uses the analogy of a basketball team, in which he relates the skill and talent of individual players as autonomation and compared JIT to the teamwork needed to achieve an agreed-upon goal. Table 3 provides a taxonomy and mapping of lean implementation research to socio-technical levels described here. The classification was conducted from a socio-technical perspective with the purpose of examining disconnects in lean implementation and understanding the challenges in lean transformation in line with the guidelines offered by Cooper, Hedges, and Valentine (2009).

In conducting this literature review, it was anticipated that a wider selection of lean research publications that potentially could have been mapped to all three socio-technical levels. However, the output from the search was surprising in that only a small amount of research work surfaced that could be mapped to the primary work system, and even fewer research articles were identified that could be mapped to the macro-social system. This finding brings the rationality of the research trajectory in the existing body of research work in question. It supports the conclusion drawn by Yadav et al. (2010) and raises concerns about the truncated nature of lean implementation inhibiting its full potential. A lack of research focus relating to the macro-social system (less than 10% of total reviewed research articles) suggests that short-term goals drive lean implementation efforts that could change anytime with a change in leadership or in strategic focus. Our findings support the assertion that lean implementation efforts are driven by convenience as opposed to a comprehensive approach (Mohanty et al., 2007). It fails to comprehend the primary work system, whole organization system, and macro-social system contexts to complement the lean implementation effort that essentially goes against the objective of optimizing the entire complex socio-technical system. The literature review revealed that a

vast majority of prior work has focused on implementation of lean practices, application of lean principles, and the area of lean and organizational competitiveness at whole organization system levels. All of which is encouraging because of the evolutionary nature of lean. The lean concept itself is not a single-point invention but represents the outcome of a dynamic learning process that adapted practices emanating from the automotive and textile sectors (Holweg, 2007). However, a few prior research studies (included in this review) focused on macro-social system. This means that there is a tremendous opportunity to probe into organizational transformation for lean in the future.

Implementation of lean within the whole organizational system is bound to experience challenges that are influenced by both the primary work system and the macro-social system. Therefore, the success of lean implementation within the whole organizational system is subject to the successful implementation of lean principles in the primary work system and vice versa. Similarly, it is also subject to the state of lean implementation in the macro-social system that essentially drives or forces an organization to transform and adapt to changing macro level forces.

2.6. State of Lean Transformation and Challenges from a Socio-Technical Perspective

2.6.1. People Focus

According to Senge (1990, p. 4), "the organizations that will truly excel in the future, will be the ones that discover how to tap people's commitment and capacity to learn at all levels in an organization." Earlier publications on TPS clearly highlight this notion stating that people are very central to the lean transformation. Autonomation (Ohno, 1988), intense focus on standard methods designed by operators (Adler, 1993; Spear & Bowen, 1999), socialization (Adler, 1993), intense mentoring and training by leaders or supervisors (Spear & Bowen, 1999), and

continuous learning (Adler, 1993) are building blocks of TPS, which clearly emphasize the important role of human resources in lean transformation. Dibia and Onuh (2010) state that employees play a central role in socio-technical systems that are considered the most important key to lean transformation. The authors believe that lean is an interlocking set of three underlying elements: philosophical underpinnings, managerial culture, and technical tools-a triangle in which human development is at the core. Womack and Jones (1994) advocate that the needs of the individuals must be in congruence with the needs of functions and companies in order to achieve employee involvement and motivation. However, the prevailing organizational structure is often in the way due to its functional silo structure that can create a conflict between individual career goals and organizational functional views.

Instead of machines, Toyota's culture of contradictions places people at the core of the system stating that a system is always imperfect and there will always be room for improvement (Takeuchi, Osono, & Shimizu, 2008). The lean philosophy is a "hard" advancement that facilitates the organization to continuously improve the way it does business, but Toyota has also mastered a "soft" innovation that creates effective work culture across the organization. The fundamental reasoning of Toyota's success in continuous improvement efforts is because it creates these contradictions and paradoxes within the organizational system (Takeuchi et al., 2008). However, a recent study by Stone (2012a) suggests little evidence in research directed to human resource development, which unleashes human expertise through organizational development, which is a key success factor for lean implementation. Additionally, in a rush to implement lean concepts, a common misperception and irrational application of lean is reducing costs by eliminating some tasks or non-value adding activities resulting in workforce reduction

in business entities. Such practices are against the basic tenets of the lean philosophy and violate the "respect for people" principle.

2.6.2. Lack of Lean Perspective

In lean implementation, JIT is one of the pillars of lean that is needed to support the elimination of waste (Ohno, 1988). Ramarapu, Mehra, and Frolick (1995) also show that elimination of waste and production strategies are the most critical factors of JIT implementation. These authors further identify three other critical factors to implement JIT: quality control and improvement, management commitment and employee participation, and vendor/supplier participation. This clearly demonstrates that the lean implementation requires simultaneous investment on multiple fronts of any organization. Bhasin and Burcher (2006) added that, although lean is concerned with reducing waste at all levels, it is also about changing corporate culture. Other studies on lean implementation linked human performance (Genaidy & Karwowski, 2003), socio-technical aspects (Hummels & de Leede, 2000), and motivating job characteristics (De Treville & Antonakis, 2006) to lean transformations. If the lean transformation perspective is not aligned on all three socio-technical systems, the transformation effort is bound to struggle; this is especially true if the primary work system and the objectives of the whole organization are not aligned. An incoherent and often partial perspective of lean implementation on the part of the lean implementers is very common in industry (Yadav et al., 2010). The authors further state that efforts to implement one lean principle at a time in isolation would accomplish little because each principle has its own role while reinforcing others. This work further highlights that lean implementation is mostly directed at the whole organization system and primary work systems ignoring the macro organizational level because of the lack of understanding of lean principles and the fear of failure. At the macro organization level, the risk

tolerance outweighs the potential benefit of lean implementation due to the business cycle objectives, short-term financial benefits required by the boards, and shareholders of the organizations.

Marodin and Saurin (2013) identified the limitations of existing literature in addressing the generalization of lean production other than the manufacturing sector. Further, the lack of in-depth knowledge on why companies fail or succeed in their lean efforts and understanding on the complex dynamics involving the use of lean production in all areas of the company presents additional challenges. Hendrick and Kleiner (1999) point out managerial and cultural issues as the most challenging in lean production implementation, which is in agreement with Bhasin and Burcher (2006).

2.6.3. Participation of Leadership in Lean Transformation

Shingo and Dillon (1989) write that if top management does not commit to halt the machines or production lines when there is trouble, the lean system should not be adopted and stockless production should not be attempted. Spear and Bowen (1999) and Sobek II and Liker (1998) clearly articulate the importance of effective leadership in lean implementation by actively participating in continuous improvement, and providing mentoring support during the socialization process. Leaders' intense involvement with frontline workers in the process of improvement creates an atmosphere of 'trust and respect', enhances communication, 'sense of realism', and motivates people (Adler, 1993). The literature clearly emphasizes the role of the top management that ought to correct the course and lead the philosophical journey for the organizational transformation.

Table 3. Mapping of Lean Implementation Research Work into Socio-Technical Levels

Level	Classification criteria	References
Primary work system	Lean and organizational competitiveness at primary work systems	Browning and Heath (2009); Wan and Chen (2008).
	Application of lean tool box at primary work systems	Mazur et al. (2008); Losonci, Demeter, and Jenei (2011)
	Application of lean principles at primary work systems	Tucker et al. (2002). Spear and Bowen (1999).
	Application of lean rules at primary work Systems	de Leeuw and van den Berg (2011); Saurin et al. (2011)
	Application of lean practices at primary work systems	Spear and Bowen (1999).
	Lean transformation at primary work systems	
Whole organization Systems	Lean and organizational competitiveness at whole organization systems	Eroglu and Hofer (2011); Hosseini Nasab, Aliheidari Bioki, and Khademi Zare (2012); Narasimhan, Swink, and Kim (2006); Sadaghiani and Sadaghiani (2014); Shah and Ward (2007); Stone (2012b); Zanjirchi et al. (2010), Mostafa et al. (2013); Ramesh and Kodali (2012), Anand, Ward, Tatikonda, and Schilling (2009); Ballé et al. (2006); Dibia and Onuh (2010); Edmondson (2008); Emiliani (2006); Höök and Stehn (2008); Khazanchi, Lewis, and Boyer (2007); Marodin and Saurin (2013); Mohanty et al. (2007); Saurin, Rooke, and Koskela (2013); Soparnot (2011); Staats, Brunner, and Upton (2011), Spear and Bowen (1999); Staats and Upton (2011) Bonavia and Marin (2006); Cua, McKone, and Schroeder (2001); de Menezes et al. (2010);De Treville and Antonakis (2006); Demeter and Matyusz (2011); Fullerton, Kennedy, and Widener (2013); Fullerton et al. (2003); Jayaram, Ahire, and Dreyfus (2010); Kaynak (2003); LaGanga (2011); Langstrand and Elg (2012); Modi and Mishra (2011); Prokesch (2009); Shah and Ward (2003); Sila (2007); Sobek II and Liker (1998); Soltani, Lai, and Gharneh (2005); Soparnot (2011); Taylor, Taylor, and McSweeney (2013); Vinodh and Joy (2012)
	Application of lean tool box at whole organization systems	
	Application of lean principles at whole organization systems	
	Application of lean rules at whole organization systems	
	Application of lean practices at whole organization systems	
Macro-social systems	Lean and organizational competitiveness at macro social systems	Stone (2012b). Takeuchi et al. (2008).
	Application of lean tool box at macro social systems	Takeuchi et al. (2008).
	Application of lean principles at macro social systems	Takeuchi et al. (2008). Roh and Lee (2013).
	Application of lean rules at macro social systems	Driel and Dolfsma (2009)
	Application of lean practices at macro social systems	
	Lean transformation at macro social system	

For instance, when higher level executives lead the lean transformation initiative by directly participating and applying continuous improvement principles and providing respect for their people, it sends a sense of optimism and positive enforcement. Top managers should advocate and practice lean and must ensure that they understand the true meaning of lean principles and practices. However, it has been observed in several cases of lean implementation that certain aspects of lean principles and practices were selectively incorporated into existing management practices (Mohanty et al., 2007), which makes it difficult for organizational lean transformation and creates confusion among people. Emiliani (2006, p. 178) suggests, "tendency to reduce lean management to short-term cost-cutting tactics or simple tools to add to manager's tool kit increases the likelihood of confusion, lack of participation, and poor outcomes, thereby corrupting a well-thought out and potentially beneficial management system." Senior leadership must treat lean transformation as a long-term program because it demands sustained investment, a huge amount of training, continuous mentoring, a new culture, and new processes.

2.6.4. Systems Thinking or Holistic Approach

Höök and Stehn (2008) stated that problems that appear are solved with restricted or minimal diffusion without thoroughly analyzing, following a so-called shallow or first-order problem solving approach. First-order problem solving allows work to continue but does nothing to prevent occurrences of a similar problem again. In this approach, workers do not spend any more time and resources on a problem once they obtain the missing input needed to complete a task (Höök & Stehn, 2008). Second order problem solving, in contrast, investigates and seeks to change underlying causes (Tucker, Edmondson, & Spear, 2002). In general, research on problem solving stresses on defining the problem scope and selecting suitable methods rather than focusing on consequences and impacts when people at work confront these problems. They

suggested that for organizations, improvements efforts require understanding working conditions and efforts at their front line so that more attention can be paid to workers' problems while creating the suitable work environment and conditions for ensuring second-order problem solving and organizational learning (Tucker, Edmondson, & Spear, 2002). Essentially, it requires systems thinking where all socio-technical subsystems, such as human, technical, work organization, and external environment sub systems, need to be in congruence with the objective of organizational lean transformation. However, the systems thinking for lean implementation ingrained in socio-technical levels is yet to be found in existing case examples of lean implementation except TPS. Seddon and Caulkin (2007) noted that the importance of systems thinking and its applicability to lean is also important.

The adoption of lean production implies integration in the use of operations management (OM) and human resource management (HRM) practices. de Menezes, Wood, and Gelade (2010) studied the integration and evolution of operation and human resource management practices associated with the lean production concept and examined the use of seven core OM and HRM practices in British manufacturing firms. In their study they reported a lack of coherence among management practices, which is a cause of concern and validates that practices are only a manifestation of a latent philosophy. It is the integration or alignment of practices that would have the ability to achieve multiple goals and result in superior firm performance (de Menezes et al., 2010). Lin, Li, and Kiang (2009) state that a majority of continuous improvement models only focus on a specific part of the business and do not take a systematic approach to solve the problems across the entire organization. It simply emphasizes the need to approach the organizational lean transformation with a socio-technical perspective instead of just a technical

silo approach. Research work focusing on organizational commitment encompassing all the socio-technical subsystems is practically non-existent in the existing literature.

2.6.5. Understanding Organizational Artifacts

Artifacts can represent certain ideas and influence behavior through their inscriptions that people see within the organization or feel or hear when interacting inside the organization. Langstrand and Elg (2012) caution that, if not aligned with current artifacts, the newly introduced initiatives "will be mediated, filtered, and translated through the artifacts that exist within the boundaries of the organization and the resulting practice will most likely differ from the original intent." They cited the case of a traditional accounting system that is based on a well-established "push" logic where the cost of a production unit is determined by the number of units produced. In a lean system, the Kanban cards define the "pull" logic based on customer demand, the "push" logic is essentially controlled by the accounting system (Langstrand & Elg, 2012). The change process thereby becomes a trial of strength between the two action programs. Meade, Kumar, and White (2010, p. 858) highlighted existing financial practices that often lead to the inaccurate interpretation of lean implementation. The concept of cost attachment and the handling of these "attached" costs lead to the misrepresentation of performance improvements in lean implementation through inventory reduction in a manufacturing operation. The authors describe that the reduction in inventory is often considered a positive impact of lean implementation programs whereas accounting practices use "inventories, such as raw material, work-in-process, and finished goods, on the balance sheet as assets." Therefore, the current financial system will "cause a perceived decrease in financial performance of the firm for many months and possibly years if a firm works toward bringing down inventory levels" (Meade et al., 2010, p. 869). Failing to realize this issue by the organizational leadership will lead to a complete

failure of lean programs and resistance to the continuation of the program (Cunningham, Fiume, & Adams, 2003).

Further, Ballé, Beauvallet, Smalley, and Sobek (2006, p. 4) describe the fallacies of lean implementation stating that much of "western efforts to implement lean are about applying lean tools to every process." This would seem logical enough to most western thinkers assuming that this would eliminate waste, improve quality, and generate profits and revenue over time. However, it misses the true frame of mind, a well-studied concept in social science (Ballé et al., 2006). It is like implicitly considering some aspects of perceived reality as more prominent than others thereby orienting the entire problem-solving process and efforts towards those aspects. According to Ballé et al. (2006), developing a "Kaizen consciousness" is the responsibility of management, not staff "experts." On the contrary, the essence of TPS is developing "Kaizen consciousness" within each employee.

In several cases, lean implementation programs hit a road block early on because they contradict existing artifacts and, hence, are perceived as unsuccessful in the early stages of implementation (Cunningham et al., 2003; Womack & Jones, 2010). For example, the performance metrics, such as machine utilization, cost allocation, equipment efficiency, etc., may generate resistance to lean implementation and lead to the failure of implementation efforts (Kennedy & Brewer, 2005). Traditional performance indicators and management approaches prompt managers to prefer machine utilization or overall equipment efficiency over the organizational level priority. On the contrary, the TPS philosophy stresses that it is better to allow workers to be idle than to over produce or improve machine utilization (Shingo & Dillon, 1989).

2.6.6. Meta-Routines

A meta-routine is a standardized problem-solving procedure to improve existing routines or create new ones (Adler, Goldoftas, & Levine, 1999). Meta-routines systematize the creative process that may develop over time and exert a lasting influence on later development. Toyota's problem-solving approach starts with establishing hypotheses that can be tested, and therefore, follows a scientific method (Spear & Bowen, 1999). According to Spear and Bowen (1999), for making any changes, Toyota uses a rigorous problem-solving approach that requires detailed assessment of the current conditions and plan for improvement based on experimental tests for the proposed changes rather than just fixing the symptoms of the problem. Driel and Dolfsma (2009) emphasize that Toyota's own specific philosophy, the critical sequence of events, and the personal experience and conviction of executives helped the company to establish the meta-routine of TPS. They argue that the adoption of lean should be seen against the background of the meta-routine of "self-testing and adapting" where people are doing their jobs and helping to design the production processes. This learning of workers and managers through experimentation develops a meta-routine that is recognized as the cornerstone of a learning organization (Spear & Bowen, 1999). Toyota's problem solving itself is a very good example of their meta-routines. For example, the A3 problem-solving style ensures that it offers the structure for the users to avoid early victory and cease the problem-solving effort after the first-order problem solving. Instead they force the users to follow a very logical approach of second- or third-order problem solving if warranted. The exhaustive literature review conducted as part of this work failed to identify well-structured and dynamic meta-routines and problem-solving approaches that have been established by any other organization and that is sustainable and integrates with the day-to-day operation and learning process. This could be one of the fundamental reasons why other

companies fail to replicate Toyota's success and, hence, require a better problem-solving mechanism that is part of everyday operations.

2.7. Summary of Literature Survey

The success of Toyota in developing TPS as a lean production system is unquestionable. Moreover, Toyota has been very open, sharing its secrets of a lean production system by allowing its employees to write books and articles (Ohno, 1988; Shingo, & Dillon 1989), as well as letting researchers all over the world visit its facilities and study the unique characteristics of the production system (Sobek et al., 1998; Spear & Bowen, 1999). Despite Toyota's willingness to share this knowledge, the failure of many companies to imitate the implementation of a lean system and to sustain the benefits of lean implementation triggered the desire among researchers and practitioners to understand the secrets of TPS and reasons for unsuccessful implementation by other companies.

Previous research shows that a majority of these companies tried to implement lean mainly focusing on a few tools and practices while ignoring the organizational transformation to create a culture necessary for lean transformation. Our literature review findings have clearly demonstrated that most of these companies lacked the structured and comprehensive framework for lean transformation that can provide seamless integration of various socio-technical elements and stimulate the change process. Further, the incoherent and lack of lean perspective on the part of the lean implementers is very common in industry (Yadav et al., 2010). It is abundantly clear that efforts to implement any one lean principle or tool alone accomplishes very little because every tool has its own role and at the same time reinforces others. Implementing lean essentially requires systems thinking to realize that all socio-technical elements, such as people, technology, organization structure, and external environment, need to be aligned for organizational lean

transformation. However, the systems thinking ingrained in a socio-technical system for lean transformation is yet to be found in the existing literature.

There has been a penchant to treat lean implementation as a cost cutting strategy to gain quick but short-term gains, or another tool added to a manager's toolkit, thereby corrupting the well thought out and effective management approach. This tendency further encourages selective use of lean tools and practices into existing management practices (Mohanty et al., 2007), which makes it difficult for organizational lean transformation and creates confusion among employees. There have been several cases where lean programs suffered early termination because lean implementation efforts contradicted with existing artifacts and hence were termed failures (Cunningham et al., 2003; Womack & Jones, 2010). The issues and concerns identified here could reflect some of the fundamental reasons why other organizations have not been able to replicate Toyota's success.

In order to achieve a planned organizational transformation, it is important to establish a synergetic lean transformation framework, which requires planned and integrated development of every entity of the organization in a holistic way. Having a lean culture established within any organization ensures continuous organizational development assuring long-term sustainability. Therefore, for organizations wishing to embark on a lean journey, it is imperative for leadership to believe in the lean philosophy, initiate the lean journey, and kick off the change process by creating a conducive and cooperative work environment. Leadership must ensure that all the pillars are in place to provide structural support for the transformation process and build the foundation of knowledge that continuously feeds organizational pillars to continue the transformation process. This essentially requires a committed, visionary, and knowledgeable leadership, not only at the top but at all levels where leaders play the role of mentors, facilitators,

and coaches to help and motivate the employees. Leadership creates a transformational structure by establishing lean principles derived from a basic knowledge base built on various scientific theories and practices, which results in the sustainable, dynamic, and organic transformation of an organization.

Established lean principles help create the structure or mechanism to provide seamless integration of various socio-technical elements and stimulate the change process. These lean principles act as the nervous system of the organization to facilitate the flow of information and knowledge and hence build a very effective communication mechanism and support structure. It is important to remember that these principles rely heavily on a solid knowledge base. Without sound knowledge and in-depth understanding of basic theories and tools, lean principles are nonexistent. These lean principles should be the guiding principles for the organizational transformation that can enable and sustain the transformation process, help create a conducive work environment, and motivate the workforce. As the internal organizational environment becomes conducive to lean transformation, the human element (employees) of the organization feels motivated and empowered making the organization more robust to defy challenges from internal and external forces. The fundamental lean principles of TPS provide a clear mapping of all the entities in an organization that is critical to improve the understanding of interactions among all the entities. It integrates the technical and social elements and aspires for joint optimization of the whole socio-technical system.

More importantly, this review revealed that there is a lack of adequate research on the organizational focus on lean transformation. Therefore, there is a need for further research on the implementation of lean in an organizational context including development of a lean culture. In other words, future research should investigate the practical challenges of implementing the lean

concept by studying the interactions among various socio-technical elements in an organization, and finding the reasons for the lack of organizational commitment and participation of leadership in lean transformations. Finding of this chapter also encouraged to conduct empirical investigation of current industry practices, or lack thereof, to validate the research findings that argue that the transformation process starts with people based on fundamental scientific knowledge and theories of lean principles and practices.

CHAPTER 3. RESEARCH MODEL AND HYPOTHESES

This chapter is dedicated in providing theoretical arguments needed to conceptualize the hypothetical research model. This hypothetical model is used to evaluate whether organizational factor can predict organizational change and lean transformation particularly from an integrated socio-technical system perspective.

3.1. Conceptualization of the Hypothetical Research Model

Conceptualization of the hypothetical research model is built on the previous work of Yadav et al. (2017). Further research was conducted to gain understanding on constructs of lean, organizational change and organizational design particularly from socio-technical systems perspective and their relevance to the organizational lean transformation. A content analysis involving organizational constructs in socio-technical system perspective that refers to organizational change and lean transformation was performed in previous literary works. This search produced a list of factors that can be considered as latent constructs and their causal/reflective contribution to organizational change and lean transformation.

3.2. Organizational Factors from Socio-Technical Perspective

Organizational change, lean transformation, socio-technical system theory, open system theory and organizational development literature pointed to a set of factors including external environment, organizational leadership and structure, organizational culture, mission and strategy, organizational learning, knowledge base, innovation and adoption of systems perspective, organizational adoption to lean principles and practices, organizational engagement, job engagement, person organization fit and membership behavioral norm. It can be postulated that these factors may have reflective/causal contribution to organizational change and lean transformation.

Table 4. Implications of Socio-Technical Constructs on Organizational Lean Transformation

Socio-Technical Constructs	Organizational Change and Lean Transformation Implication Elements
External Environment Cherns (1976), Trist, E. (1981), Fok et al. (1987), Ginsberg, A. (1990), Harvey, N. (1994), Appelbaum, S. H. (1997), Niepce and Molleman (1998), Griffith and Dougherty (2001), Laracy, J. R. (2007), Stone K.B. (2012b), Carayon et al. (2015), Botla and Kondur (2018), Soliman et al. (2018), Bednar and Welch (2019), Pasmore et al. (2019).	External environment impacts organizational change requiring organizations to adapt- Burke and Litwin (1992), Yadav et al. (2017), Prakash & Kumar (2011), Canis and Webel (2013), Duggal & Budden (2012), Paez et al. (2004). External environment drives organizational learning- Pasmore et al. (2019). Technological innovation with disruption and legitimization in the macro economy influences change- Chanaron, J. (2001), Ward and Zhou (2006), Lee and Jo (2007), Bergek et al. (2013), Ghobadian et al. (2018). Variability in customer demand and incoming resources indicates external environmental impact- Shah and Ward (2007) and Steinker and Hoberg (2013). Lean organizations are better suited to deal with external variability- Liker, J.K. (2010), Soliman et al. (2018).
Organizational Leadership and Organization Structure Appelbaum, S. H. (1997), Andersen, T. K. (2016), Graen, G. B. (2009), Hazy, J. (2006), Kuntz and Gomes (2012), Paulsen et al. (2013). Ghosh and Sahney (2011), Van de Ven and Poole (2005), Alter, S. (2015), Bednar and Welch (2019), Pasmore et al. (2019), Van Eijnatten and Van der Zwaan (1998).Molleman and Broekhuis (2001), Carayon et al. (2015), Bielić et al. (2011), Thomassen et al. (2017), Botla and Kondur (2018), Šajeva, S. (2010), Majchrzak & Borys (2001), Niepce & Molleman (1998), Dankbaar, B. (1997), Das & Jayaram (2007), Baxter, G. & Sommerville, I. (2011),	Positive relationship between leadership and organizational performance based on multiple meta-analysis Knies et al. (2016), Makri and Scandura (2010), Wang et al. (2011). Understanding leadership style is useful in explaining organizational performance servant leader-Melchar and Bosco (2010. Transformational - Warrick, D. D. (2011), Lean leadership-improvement culture, self-development, qualification, Gemba and Hoshin Kanri Dombrowskia and Mielkea (2013). Organizational philosophy Toyota (2012), organizational code of conduct, Strategic leadership is enhancement over strategic management Maghroori and Rolland (1997), J. K. (2004) showed Toyota's approach to add value by developing people. Organization structure defines how an organization is designed to achieve its mission, Stone, K. B. (2012b). Robbins, S. (1990), Folami, L. (1999), Folami and Jacobs (2005) agrees that organizational structure impacts effectiveness, Dalton et al. (1980) attributed organization structure to organizational size or subunit size, span of control, flat/tall hierarchy and administrative intensity, specialization, formalization and centralization Pugh et al. (1968), Walton, E. J. (1981) and Anderson J.A. (2006). TPS rules has implications on organization structure, making people capable and responsible for improving their own work, standardization between individual customers and suppliers, pushes the resolution of connection and flow problems to the lowest possible level, Spear and Bowen (1999)

Table 4. Implications of Socio-Technical Constructs on Organizational Lean Transformation (Continued)

Socio-Technical Constructs	Organizational Change and Lean Transformation Implication Elements
Organizational Adoption to Lean Principles and Practices Oudhuis and Tengblad (2013), Kosuge, R. (2014), Soliman et al. (2018), Hadid et al. (2016). Molleman and Broekhuis (2001), Niepce and Molleman (1998), Haines, J.K. (2014), Sarker et al. (2013), Dankbaar, B. (1997), Das and Jayaram (2007), Pasmore et al. (2019), Van Eijnatten and Van der Zwaan (1998).	Lean principles have been credited for organizational transformation, performance and change, Liker, J.K. (2004), Yadav et al. (2010), Womack and Jones (1996) Lean principles are not adequately and effectively adopted in organizations, Yadav et al. (2010), Liker J. K. (2004) leading to failed outcome. Top management led efforts in implementing lean and reliance on lean principle showed success, Emiliani, M. (2006). TPS principles are something to believe in and strive for while applying appropriate tools to applicable organizational situation, Liker, J.K. (2004). Lean practice is associated with organizational performance Shah and Ward (2003), Yadav et al. (2010) Lean transformations are more successful when strategically aligned throughout the enterprise, Kyle B. Stone (2012) or synergy is capitalized in implementing lean practices collectively Shah and Ward (2003), Shah and Ward (2007). Organizations showed temporal success but failed to show sustained improvement in operational performance, Yadav et al. (2010), lean implementation needs to be viewed from a holistic socio-technical system perspective, Yadav et al. (2017) Specific organizational culture profile differentiates between unsuccessful vs successful lean plant based on their soft lean practice focus, Bortolotti et al. (2015).
Organizational Engagement, Job Engagement, Person organization Fit and Membership Behavioral Norm Cherns (1976), Choi et al. (2008), Appelbaum, S. H. (1997),Thomassen et al. (2017), Botla and Kondur (2018), Soliman et al. (2018), Molleman and Broekhuis (2001), Griffith and Dougherty (2001), Majchrzak, and Borys (2001), Niepce and Molleman (1998), Dankbaar, B. (1997), Fok et al. (1987), Pasmore et al. (2019), Van Eijnatten and Van der Zwaan (1998). Ghosh and Sahney (2011), Ghosh and Sahney (2013), Alter, S. (2015), Oudhuis and Tengblad (2013), Bednar and Welch (2019), Pasmore et al. (2019).	Organizational performance is cumulative effect of behavior of all the people Pershing, J. A. (2006), Emiliani, M. (1998) studied human behaviors from lean principle context and separated lean behavior from non- lean behavior. Organization must engage the minds of people to support and contribute their ideas to the organization for the lean journey, Liker J. K. (2004). Respect for people is one of the most critical principle that guides TPS through their organizational journey, Liker, J. K. (2004), Yadav et al. (2010) Building learning organization will remain an evasive good idea, until people in organization takes a stand, Senge (1990) Engaged employees deliver improved organizational and individual performance, disengaged employees can have a significant impact on an organization's profit, ability to retain skilled employees, Osborne and Hammoud (2017). Collective organizational engagement is an important motivational capability that influences the success of the entire organization, Barrick et al. (2015). Toyota way includes engaging team members, Leaders motivate and engage the mind of large number of associates Liker, J. K. (2004)

Table 4. Implications of Socio-Technical Constructs on Organizational Lean Transformation (Continued)

Socio-Technical Constructs	Organizational Change and Lean Transformation Implication Elements
Organizational Change and Lean Transformation Damanpour, F., Szabat, K.A. & Evan, W.M. (1989), Bielić et al. (2011), Van de Ven and Poole (2005), Botla and Kondur (2018), Hadid et al. (2016), Sundstrom et al. (1990), Molleman and Broekhuis (2001), Griffith and Dougherty (2001), Majchrzak, and Borys (2001), Niepce and Molleman (1998), Dankbaar, B. (1997), Fok et al. (1987), Das and Jayaram (2007), Pasmore et al. (2019). Ghosh and Sahney (2011), Miah et al. (2012), Alter, S. (2015), Soliman et al. (2018), Sarker et al. (2013), Bednar and Welch (2019), Kroes, P. (2012), Van Weert and Munro (2017).	Generally organizational performance takes into consideration the customers and stakeholders' satisfaction, human resources performance, definition of key performance indicators, continuous improvement, and most economic and financial indicators, all aspects integrated into the strategic management system, Draghici et al. (2014). Leadership can impact organizational outcome, Day and Lord (1988). Toyota focuses on organizational culture, organizational learning, organizational design, organizational change, organizational practice to drive performance. Organization that truly practices the full set of Toyota Way principles will have sustainable competitive advantage, Liker, J. K. (2004) Linkages of organizational routines and artifacts as a cycle where knowledge acquisition and learning competencies develop to enhance organizational intelligence, Carayannis et al. (2017) Organizations often create and employ artifacts to change their routines, Glaser, V. L. (2017). Technological artifacts influence social but social considerations form the justificatory knowledge that informs the design of technological artifacts, Sarker (2013).

3.3. Socio-Technical Constructs and Their Implications on Organizational Lean Transformation

3.3.1. Implications of External Environment on Organizational Change and Lean Transformation

Socio-technical system requires analysis from an open system concept, meaning organizations are subject to impacts from changes in various elements of external environment. The need for the understanding of the external environment and its role in influencing decisions and strategies of organizations stressed by Appelbaum, S. H. (1997). Shah and Ward (2007) along with Steinker and Hoberg (2013) mentions elements such as customers and suppliers as it helps the concept-travelling for lean in variety of applications. Shah and Ward (2002) stressed on studying environmental dynamism as part of analysis. Environmental dynamics include variable

economic condition, high uncertainty of demand, demographic attributes, political and regulatory challenges according to Baskiewicz, N. (2017) and Soliman et al. (2018), market and technological dynamism per Narasimhan et al. (2006). Burke and Litwin (1992) puts environmental impact over any other factors responsible for overhaul of company strategy and organizational change. Toyota motor company was credited by Prakash and Kumar (2011) for their success in post 1973 oil crisis period in contrast to US automakers who were struggling in the eighties by losing market share rapidly. Similarly, in the 2008-2009 financial crisis, the U.S. government was forced to provide financial support to more than 700 institutions and eventually ended up taking ownership stakes in five large companies: GM, Chrysler, GMAC (now called Ally Financial), AIG, and Citigroup according to Canis and Webel (2013), even though US Government is not known for state ownership of businesses. The impact of the 2008 financial crisis impacted cost of credit for a whole host of organizations which had implications on firm's strategic choices on future investments and such. Duggal and Budden (2012) investigated S&P 500 firms excluding financial firms to understand impact of recession on the working capital management and found that firm's ability to hold to cash became easier at the same overall cost in 2010 as opposed to 2007. Cost of capital influences organizational strategic decisions. U.S. automakers in 1925 used higher investments in overhead and technology to provide for specialization and allowed their larger production volumes to keep the impact of those cost in check while in 1930s Taiichi Ohno used his experience from textile industry and adapted for auto industry and achieved cost reduction using fewer resources to compensate for the lack of growth and mitigated the need for big capital investments described in Paez et al. (2004). Socio-technical systems principle of equifinality described by Cherns (1976) in elaborating the well-known principle of multifunctionality reminded that organization can be more adaptive and less

wasteful under variable environmental demand by performing same function in different ways by using different combination of elements in line with Pasmore et al. (2019) who explained that additional variety in work design furthers individual and organizational learning and essentially helping organizational adaptation to change. Molleman and Broekhuis (2001) used the principle of requisite variety by Ashby, W. R. (1969) to stress that organization should have enough means to transform inputs into desired output by exploiting internal variety to beat external environmental variety. Soliman et al. (2018) has characterized lean organizations with increased functional diversity resulting from multifunctional workers, quick set up and mass customization and reiterated that lean organizations are prone to have fewer external suppliers a view presented by Liker, J.K. (2010) due to their long-term relationship and thereby keeping the environmental risk at minimum. In line with Appelbaum, S. H. (1997) this research work stresses that organizations need to be aware of their own strength and weaknesses and the factors in the environment, their specific characteristics that influences organizations work. Subramanian et al. (1993) cited contingency theorists and noted that organizational performance is subject to organization's ability in corresponding its strategies, structure, and processes to its environment and suggested environmental scanning as a process that organization uses to collect information from environment to utilize for strategic management purposes. Their work suggested relationship between environmental scanning and organizational performance after studying some Fortune 500 organizations. Environmental scanning as a concept was presented by Aguilar (1967) that allows management of the benefit of relevant information about events taking place outside of the organization helping to guide the direction of the company and its future course of action. This research work postulates that measurement items associated with variability in customer demand and variability in incoming resources such as financial support, raw materials

and labor market should suffice to measure the latent construct of External environment (ξ1). A common factor model is described in Figure 1. External environment (ξ_1), a latent construct that can affect organizational change and organizational lean transformation. External environment is indicated or measured by items/questions associated with variability in customer demand (X1) and items/questions associated with variability in incoming resources (X2). Factor loading or correlation between factor and indicator is described by λ and δ as the error term for each of the indicators in Figure 1.

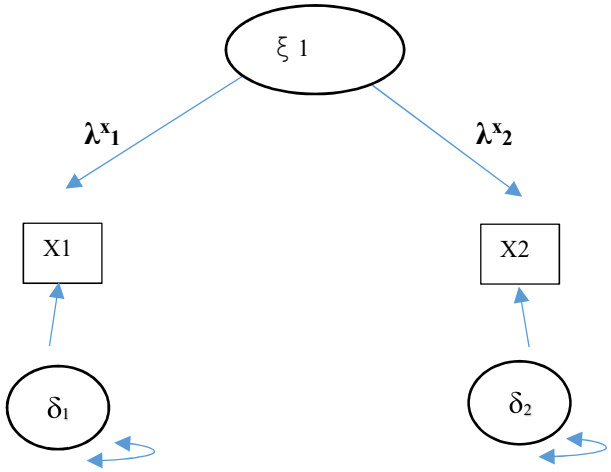

Figure 1. Common Factor Model for External Environment.

3.3.2. Implications of Organizational Leadership and Structure on Organizational Change and Lean Transformation

Organizational leadership and structure is a critical socio-technical construct that drives organizational performance, growth and ensures eventual survival of the organization in a turbulent external environment. Leadership in general has been studied thru the lens of individual capacity of role player/occupant or leadership traits in the past research work. Among such, Wang et al. (2011) associated influence of senior leadership like the role of CEO on attitudes of middle managers and influence its ability to drive organizational performance. TPS views middle

managers as a change agent described in Liker, J.K. (2004). Camuffo and Wilhelm (2016) reported Toyota's own challenges in having enough properly developed change agents during the period of 2000 to 2010. Leadership at the top has also been credited as an antecedent to organizational innovation in high tech organizations by Makri and Scandura (2010). Overcoming extra ordinary circumstances such as Toyota's success led by Toyoda Kiichiro was reported by Ohno (1988). In contrast, external intervention in GM management took place in 2009, where senior executive corps, given its internal corporate culture of being bureaucratic and, out of touch with consumer preferences were removed to ensure organizational transformation. In this research, leadership is considered as a socio-technical construct of organization that can be learned and adjusted and drive employee engagement as it can be thought of as a service that people in organization "buy" or "don't buy" in line with Kim and Mauborgne (2014). As former Ford president Joe Henrichs summed up in Auto News (2020), his letter to Ford employees, leadership is about service. Organizational leadership needs to apply socio-technical perspective while driving change for performance improvement. Failures has been described in mechanization attempts in coal mines by Trist (1981) or a new ERP system described by Andersen, T. K. (2016). Andersen, T. K. (2016) reported a laissez faire attitude by management where expert and experienced segment of work force often gets engaged in the development and deployment of new technical system without including the larger population of users. This signifies abdication of leadership system, engagement and the social aspects of the organization risking joint optimization. Continuous improvement and respecting people were presented at the highest sphere in lean implementation. It requires problem solving behavior of people who are motivated to improve which requires support from social system per Liker, J. K. (2004). Articulating organizational philosophy (reason or purpose for existence/ why an organization

exists). Toyota in 2001 -Toyota way articulated its philosophy- "Seeking Harmony between People, Society and the Global Environment, and Sustainable Development of Society through Manufacturing" mentioned in Toyota Motor Company (2012). Apple's 2011 three-point call – "Empathy, Focus and Impute" marketing philosophy are some of the examples. For Toyota the organizational philosophy becomes the code of conduct for everything they do. The philosophy becomes the background for Toyota's guiding principle. Philosophy a word with Greek origin philosophia is translated as "love of wisdom". It is a social construct; human is at the core of this construct who carries wisdom and passes on to next generation. Organizations, once they articulate their organizational philosophy and continue to seek wisdom to perfect the organizational purpose, it becomes organizational DNA. Figure 2 shows reflection of Toyota's philosophy.

Figure 2. Reflection of Toyota's Philosophy (Courtesy: Toyota Motor Company, 2012).

Maghroori and Rolland (1997) viewed strategic leadership as an enhancement over strategic management. They defined strategic leadership as "the art of balancing organizational mission with internal structures, processes, and policies; and furthermore, keeping the organization's mission aligned with the realities of the external environment." Liker, J. K. (2004)

described Toyota “a process-oriented company and this focus is built into the company DNA, and managers believe in their hearts that using the right process will lead to the results they desire”, this is a living example of stable strategic leadership at all levels of the organization at Toyota Production System. Organizations invests in systems for work processes and appropriate procedures to accomplish tasks with minimum resources such as time and effort. Systems are a vital part of employee engagement in ensuring people doing the right thing, essentially making it easy to do the hard right as opposed to do easy wrong-a human behavior that is a testament of work climate and organizational culture of host organization. Zhang and Chen (2013) described developmental leadership behaviors as developing subordinate leaders in influencing their work-related skill and facilitating personal growth of subordinates by coaching mentoring and feedback. This learning process helps subordinate leaders with a sense of self-determination, supervisor identification, and organizational identification. Holistic mentoring and coaching were proposed by Hollywood et al. (2016) to meet the organizational demand for innovation, sustainable performance, productivity and a constant engagement in the process of change. One of Ralph Nader’s comment on leadership in Nader, R. (2015) is that "The function of leadership is to produce more leaders, not more followers." It involves perpetual learning and expanding capacity of the organization by developing more leaders. Developing people requires instilling steadfast commitment to organizational philosophy at various levels of the organization, front line shop floor leadership to the board room leadership. Liker, J. K. (2004) emphasized on Toyota’s approach to add value to the organization by developing people and partner. This approach inspires development of exceptional value by developing exceptional people and team that believes in organization’s philosophy. These leaders not only grow as a leader but understands thoroughly the work, teaches others and lives by the company philosophy. Kets de

Vries and Korotov (2010) viewed organizational leadership as an intricate complex web of leaders who possess a range of capabilities and experiences necessary and these capabilities are distributed throughout the organization as opposed to a single point intervention from one individual leader. Organizational leadership is viewed and characterized by Waal, André. (2007) as trust between all levels, integrity-lead by example, coaching, inspiring, growing leader from within and decisive decision making to stimulate change and accomplish extraordinary results. Thus, values based and technical leadership needs to focus on cultivation of leadership. Cultivation of leadership benefits from proper organizational structure.

Organizational structure is perceived by Burke W. W. (1992) as an "arrangement of functions and people into specific areas and levels of responsibility, decision-making, authority, communication, and relationships to assure effective implementation of the organization's mission and strategy." Past research work Dalton et al. (1980) and Anderson J.A. (2006) reported lack of strong agreement on organizational structure influencing organizational performance. However, Robbins, S. (1990), Folami, L. (1999), Folami and Jacobs (2005) in agreement that organizational structure impacts the effectiveness of the organization. Hierarchical and rigid bureaucratic organization under the premise of Taylor's principle is considered outdated due to the rapid changes in technology and environment stated in Yadav et al. (2010) and Liker, J. K. (2004). Toyota production system practices learning bureaucracy to spread teaching and learning while encouraging commitment and innovation per Adler (1993) and Yadav et al. (2010). Regarding structure, Liker, J. K. (2004) referred to enabling bureaucracy while describing NUMMI adoption of TPS, where technical structure consisted of rules and procedures coupled with social structure leading to organic structure. Various dimensions were described in past scholarly work Dalton et al. (1980) propelled the idea of

distinguishing two aspects of organization structure: structural versus Structuring. Structural refers to size or subunit size, span of control, flat/tall hierarchy and administrative intensity. Structuring refers to specialization, formalization and centralization. Structuring perspective has also been examined by others like Pugh et al. (1968), Walton, E. J. (1981) and Anderson J.A. (2006). Specialization is defined by the division of labor in the organization, the distribution of official duties among several positions per Pugh et al. (1968), specialization essentially means complexity which can be divided in horizontal differentiation, vertical differential and spatial differential. Formalization is defined by the extent of work and tasks that is performed in the organization are standardized, essentially defining the extent of organizational actions being regulated by rules, routines and procedures. Centralization defines decision making points in an organization. Successful lean organizations like Toyota are characterized by high degree of specification, and structure without promoting command and control per Spear and Bowen (1999), empowered employees, rules and procedures as enabling tools and hierarchy supporting organizational learning per Liker J. K. (2004) and Yadav et al. (2010). Terms associated with Toyota organizational structure are matrix organization structure in engineering, work group structure in manufacturing shop floor. The stages of forming team development are orientation, dissatisfaction, integration and Production. Low formalization and low vertical differentiation have been associated to implementation of JIT, a lean construct in Koufteros and Vonderembse (1998). Lean organization structure essentially is characterized like an organism that follows its core values and is flexible to adapt in its journey to perfecting the organizational mission. Presence of equivocal vision gives employees and work groups the freedom and autonomy to develop their own goals while top managers can clearway any obstacles and prepare the ground for self-organizing groups or teams mentioned in Nonaka I. (2007). This research work

postulates that organizational leadership and structure can be predicted by items associated with focus areas in values based and technical leadership, cultivation of leadership and organizational structure. A common factor model is described in Figure 3. Organizational leadership and structure (η_1), a latent construct that can affect organizational change and lean transformation and can be described by items/questions associated with values based and technical leadership (Y1), items/questions associated with cultivation of leadership (Y2) and items/questions associated with organizational structure (Y3). Factor loading or correlation between factor and indicator is described by λ and ε as the error term for each of the indicators in Figure 3.

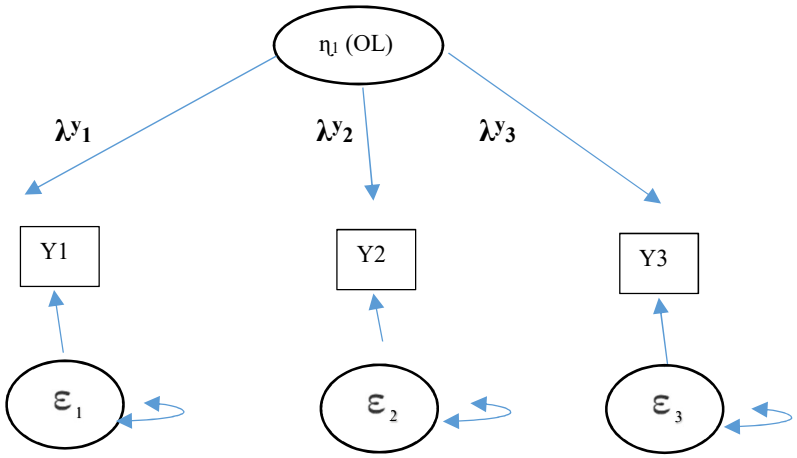

Figure 3. Common Factor Model for Organizational Leadership and Structure.

3.3.3. Implications of Organizational Culture, Mission, and Strategy on Organizational Change and Lean Transformation

Organizational culture is so important to organizational functioning and survival that it cannot move forward with goals, objectives or activities in desired fashion until organizational strategy and culture is aligned. Achieving goals objectives and organizational activities must be viewed and practiced in agreement with core values with desired behaviors must safeguard required practices. Peter Drucker is famous for his comment "Culture eats strategy for breakfast"

referring to incongruence between strategic focus and organizational reality. Organizational culture is defined by Schein E. H. (1990) as "what a group learns over a period of time as that group solves its problems of survival in an external environment and its problems of internal integration". Based on his definition, culture can be followed as a shape or influence of basic assumptions in organization and it can be invented, discovered or developed by a given group, it allows to cope with external challenges and secures integration internally based on experience and validates the assumptions that have worked in the past and articulates sharing those assumptions with new members for continuity of organizational learning. It can be characterized by level of cooperation between work groups, openness on issues, empowerment and employee engagement and positive organizational culture is associated with organizational performance. Organizational culture impacts organizational learning, employee motivation and employee productivity per Joseph and Dai (2009). Conceptualization of organizational culture can be performed based on the espoused attitudes, beliefs and ethics of the associates of the organization. Marcoulides and Heck (1993) reported that these attitudes can be predicted by organizational values, organizational climate and task organization. Waal, A (2007) associated employee empowerment, establishing strong meaningful core values and drive for organizational performance with high performing organization. Association between organizational culture and employee's commitment showed that the content of culture mediates between leadership behaviors and normative commitment of the followers within the organization. Particularly transformational leadership which mediates both affective and normative commitment of the associates promoting positive work values and consequentially employees show emotional attachment to the organization showed in Simosi and Xenikou (2010). Organizational culture has been associated with lean transformation in various literature. One of the most prominent factors

for lean journey is organizational culture along with leadership says AL-Najem et al. (2012). Dombrowskia and Mielkea (2013) stressed on improvement culture to achieve lean culture. Liker, J. K. (2004) gave Toyota the credit for devising Toyota way by implementing various lean tools that actually originated from their organizational philosophy based on their understanding, people and human motivation but ultimately originated from its ability to cultivate leadership, teams, and culture, to devise strategy, to build supplier relationships, and to maintain a learning organization. Many organizations identify organizational core values to define behavioral code for individuals that they are expected to believe and abide by as part of being something bigger, such as organization. Even though there is no universally adopted list of core values, most organizational core value revolves around trust, integrity, accountability, customer service, continuous improvement and respect for people and other related traits. Organizations instill a sense of collective way of living a work life.

Employee empowerment is positively related to performance and work-related attitudes such as job satisfaction, organizational commitment and job involvement summarized by Fernandez and Moldogaziev (2013). Employee empowerment allows organizational members to take responsibilities of decision making to achieve their job objectives and achieve internal and external customer satisfaction. Employee empowerment signifies mutual trust between leader and follower. Toyota takes the bottom up management and employee empowerment seriously by using standardized work including stop production when defect surfaces and delve into solving problem instead of higher authority approval per Liker, J. K. (2004). Organizations strive to communicate their identity, product, market and their methodology or technology when describing their mission. It incorporates specifics about the organization that makes it unique and describes organization's hope of achievements, aspirations, organizations business, markets and

customer domain presented in Tanković, A. Č. (2013) and Alkhafaji, A., (2003). Wide ranging variation is reported in organization's mission Cady et al. (2011). While differentiating between two large automotive company Toyota and Ford Liker, J. K. (2004) highlighted deeper purpose of Toyota's mission which has three parts; Contribute to the economic growth of the country in which it is located (external stakeholders), contribute to the stability and wellbeing of team members (internal stakeholders) and contribute to the overall growth of Toyota. A well-defined mission can act as an organizational control system to reach desired organizational behavior. The concept of strategy originated in army Tanković, A. Č. (2013) strategy's components include a long-range view, the preparation of resources, and planning for the use of those resources before, during, and after an action. The term has expanded far beyond its original military meaning. Market and economy are the context in which strategy is generated and includes various organizational activities and organizational orientations which change and develop together with business activity. Strategy adapts to the new situation in the market. Strategy is characterized by communication of compelling purpose or vision to all in and outside of the organization, curious audience. It establishes connection between organization's strength and market's opportunities ensure effective resource management by coordinating activities directed to reasonable and submitted achieving success and develops capability to adapt and react in new market conditions Huff et al. (2009). Liker, J. K. (2004) attributes Toyota's success ultimately on its ability to cultivate leadership, teams, and culture, that devise strategy, to build supplier relationships, and to maintain a learning organization. Burke and Litwin (1992) viewed mission and strategy from two perspectives, one- it is something top management believes and communicates, two-what employees believe is the central purpose of the organization. Having a written mission and

strategy is important to organizational effectiveness. They went on to agree with Porter (1985), linking strategy with external environment, organizational structure and organization culture.

Organizational culture, mission and strategy (η_2), is a latent construct that can affect organizational change and organizational lean transformation. Items/questions associated with organizational core values (Y4), items/questions associated employee empowerment (Y5) and items/questions associated organizational mission and strategy (Y6) is postulated to predict the latent construct Organizational culture, mission and strategy (η_2). A common factor model is described in Figure 4. Factor loading or correlation between factor and indicator is described by λ and ε as the error term for each of the indicators in Figure 4.

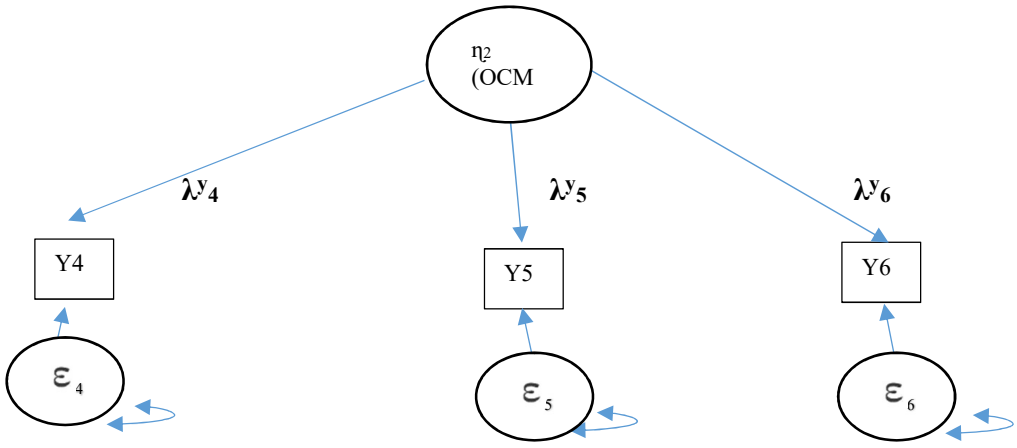

Figure 4. Common Factor Model for Organizational Culture, Mission, and Strategy.

3.3.4. Implications of Organizational Learning, Knowledge Base, Innovation, and Adoption of Systems Perspective on Organizational Change and Lean Transformation

From a socio-technical perspective, one must be concerned about all levels of the organization when it comes to learning, development of knowledgebase and innovation. Senge, P. M. (1990) commented, "Organizations learn only through individuals who learn. Individual learning does not guarantee organizational learning. But without it no organizational learning

occurs." Senge also articulated the need for teams learning as it is the basis for being the microcosm of organizational learning allowing skills and insights to propagate throughout the organization and establish a standard for learning. Learning is essential part for innovation, and it depends on knowledge base of the organization per de Weerd-Nederhof et al. (2002). Nonaka, I. (1999) described four patterns of knowledge creation 1. From tacit to tacit, which takes place in the form of socialization, like between mentor and mentee or apprentice. 2. From explicit to explicit, an act of sorting, recategorizing, decontextualizing and combining discrete pieces of explicit knowledge into explicit knowledge, called combination 3. From tacit to explicit, an act of externalization of the knowledge and sharing it explicitly with all. Japanese companies are credited for doing a great job in this type of learning and middle managers act like knowledge engineers in this regard. 4. Explicit to tacit an act of internalization which is deeply related to actions. Toyota production system stresses heavily on organizational learning and innovation. The highest level of Toyota way is organizational learning as Toyota places individual accountability on learning and growing while continuously solving root problems, any problem solving that helps its ability to build in quality and satisfy customer mentioned in Liker J. K. (2004). Toyota views standardization and innovation as two sides of same coin and transmits individual and team innovation into organizational learning. The desire of perfection brings innovation and new way is developed and the new way must be standardized and practiced across the organization until a better method is discovered by next innovation. When companies imitating TPS are figuring out Kanban systems or when to trigger Kanban, Toyota takes it as a challenge to create learning organization that is engaged in finding ways to reduce number of Kanban and eliminate the inventory buffer. This fits the criteria of a Nonaka's knowledge creating company, it "is as much about ideals as it is ideas," organizations recreate the world

according organizational vision fueled by innovation according to Nonaka, I. (1999). Organization benefits from adopting a system perspective when pursuing learning, innovation and development of knowledgebase. General systems theory in 60s and 70s was founded by Ludwig von Bertalanffy and J. G. Miller, Bertalanffy, L. V. (1968) and Miller, J. G. (1978). Organizational researchers pursued the organism concept to the system theory. Gastil, R. D. (1975) summarizing the work of Kuhn, A. (1974) writes "all organisms, including human, have detector, selector, and effector functions (DSE)" and organizations also have same functions, even though the functions may be performed by different persons. Gastil's summary also articulates Kuhn's perspective on organizations that pursues rationale self-interest like individuals but at a higher level attaining the rational goals of some or all the person involved more efficiently. Recurrent experiences positive or negative towards attainment leads to adapted response or policies for individuals and organizations respectively. From an open system concept Bertalanffy, L. V. (1968) mentions that it may pass from a lower to higher state of order owing to conditions of the system and a feedback mechanism and can reactively reach a state of higher organization owing to learning. Both primary and secondary regulations play a role in seeking higher level of organization in organism. Continuous transition of primary regulations to secondary regulation takes place in open system as open system actively seeks higher level of organization with higher level of order. Bertalanffy, L. V. (1968) also mentions that primary regulations are evolved in the dynamics of open system and secondary regulations are applicable to feedback. Eventually during development of system, increasingly organisms become mechanized. It's the ability of the organism to see the consequences of their actions and it's the ability to see connections between situations. From organizational perspective, as more knowledge is achieved with simplification and standardization it becomes a way of life for all

involved functions. It's not just the ability to understand consequences but to connect antecedents of the situations being analyzed and the ability to change towards designed intent of the system or achieving rational self-interest. Lean system or TPS can be understood as an organism that understands, evaluates, acts and improves these webs of situations from an input, process and output of the system understanding the interconnectedness and interdependences between the elements of the system and environment. Seddon and Caulkin (2007) suggested system thinking in understanding lean. Socio-technical system is an open system, from an open system perspective organizational change is better studied from a wholeness; organization as a "whole" system, it is one of the property of system per Bertalanffy, L. V. (1968). This concept acknowledges struggles between elements within a system. Liker, J. K. (2004) suggested to understand lean as an entire system that must permeate an organization's culture instead of giving birth to a technical system with application of tools. Thus, lean system as an organism need to have a systematic structure built with necessary sub systems. Both social and technical system is intended to work as a "whole" instead of individual elements. Describing Toyota's uniqueness Liker, J. K. (2004) mentions all elements of the organization functioning together as a system. Elaborations of Kuhn's system defines each of the detector, selector, and effector (DSE) functions. Once organization adopts the system thinking and view themselves as "whole" and seeks organizational transformation and change, then it becomes a repository of living functional system comprised of interactions between various sub system, individuals and groups. Communication has been highlighted as one of the critical factor for organization change and transformation by Buschmeyer et. al. (2016). Communication occurs between detector functions while transactions occurs between selector functions per Kuhn, A. (1974) and Gastil, R. D. (1975). Detector is engaged in exchanging communication between systems. Selector is engaged

in exchanging material based on the established rules that system uses in decision making process. Both communication and transactions are interactions between systems and these are alternative modes of interaction per Kuhn. Transaction is simply a market like exchange of goods based on effective preference and bargaining power where established rules come to play. Rules can be changed based on feedbacks. Individuals and groups will prefer to attain goals primarily through communication or transaction if it is warranted, and dominant coalition as a last resort per Kuhn. The concept of dominant coalition is simply a form of majority rule when communication and transaction fails between entities then rules of the dominant coalition exerts its rule. It can be Government rule that all individuals and organization must follow examples can be rules on insider trading, intellectual property or rules regarding EEOC. Effector function provides the resources or means for making transactions happen. Gastil, R. D. (1975) described that organizations or super level organizations are ways to relate effector functions to achieve purpose. Effector function requires flexibility or more freedom to achieve the purpose or goal. Critical aspects of organization are accuracy and speed of information flow, material flow, service flow and decision flow based on established rules or updating of rules based on feedbacks and learnings. Systems have feedback, it uses feedbacks as a signal to adjust actions towards achieving common goals and get better at it as an individual, group and organizational level. Kuhn, A. (1974) and Gastil, R. D. (1975) is in congruence with the concept originated from open system and cybernetics with Bertalanffy, L. V. (1968) who extended system dynamics involving receptor, control apparatus and effector. Communication and transaction can have variability. This variability in detector and selector functions can hinder effectiveness of effector function in organism. TPS heavily relies on standardization and antithesis to standardization is variability and it is even worse when it comes to system level variability. Lack of feedback in the

form of accurate, timely and complete information, and flexibility to achieve goals can lead to organizational distress. Lee et al. (1997) cautioned one such phenomena is bullwhip effect. Bullwhip effect is a cyclical boom and bust behavior of demand described by Klug, F. (2013), leading operating supply chain in causing a complex dynamic involving swing both in rate of production and stock level, where variability in production rate and stock level in the supply chain tends to be higher in upstream then downstream. Lee et al. (1997) identified forecast update, order batching, price fluctuation and shortage gaming are among the reasons for bullwhip effect. Klug, F. (2013) credited Burbidge (1958) for "batch of one" concept while referring that one-piece flow concept of that is preached and practiced in TPS. Ohno used American supermarket concept to view earlier process as a kind of store and perfected Kanban and pull system along with leveling the process in accordance with takt-time to operationalize the concept of elimination waste by optimizing information flow, material flow and avoid bullwhip effect by achieving accurate Just in time (JIT) information and material flow. The feedback mechanism supports organizational learning, integration and optimization of output of all sub systems. The system is watching the permeable boundaries and exchanges with environment for variations as an organism. TPS exerts its functionality with pull system, one-piece flow system, visual system, Kanban system, a system of reducing variability, a system of product development, a budget control system, a system of experimentation along with validation before making changes to manufacturing system, continuous learning system, personnel subsystem, environmental heath safety management system, a system of standardization that develops systems and procedure and, a belief and value system of learning by doing. System engages in iterative processes over time using feedbacks to drive organizational change and transformation. New information in TPS is generated from both first

order and second order problem solving and leads to primary or secondary regulations for system functions to adhere while driving towards its desired direction. This research work hypothesizes that a problem solver function is imbedded in every detector, selector, and effector function as system mechanism functions. Thus, organization change and transformation must adopt the construct of whole system to understand, explain and drive organizational change. A concept of learning organization presented by Senge (1990) and used by Liker J. K. (2004) in describing TPS/ lean systems sometimes referred to as workplace systems that builds quality in these systems. A culture of delivering value in the form of quality, cost, service level and satisfaction works in tandem with technical system developing high value-added flow benefiting from systematic structure. People work dedicatedly to grasp the situation and ensure that everyday everybody is engaged eliminating waste and create value exhibiting goal directed behavior. Control mechanism is directed with designed system intent and continuously updated based on feedbacks and learnings. It important to pay attention to techniques, methods, rules and machines, however it is more important to have the rational self-interest identified and grow the capacity and capability of the organization by improving detector, selector and effector functions. As system translates feedbacks and learnings to new information new norm converting more organism to new mechanism, it creates capacity for change by continuously changing to stay true to the intent of the system and facilitating continuous organization change and transformation. All functional system in TPS is aligned in seeking perfection and facilitating organizational change and transformation as needed for long term organizational sustainability.

Organizational learning, knowledge base, innovation and adoption of systems perspective is identified as a latent construct (η_4). Items/questions associated with commitment to organizational learning and innovation (Y7), items/questions associated with extent of problem

solving using scientific method (Y8) and items/questions associated with rational self-interest of the system (Y9) is postulated to predict the latent construct organizational learning, knowledge base, innovation and adoption of systems perspective is identified as a latent construct (η_4) in this research. A common factor model is described in Figure 5. Factor loading or correlation between factor and indicator is described by λ and ε as the error term for each of the indicators in Figure 5.

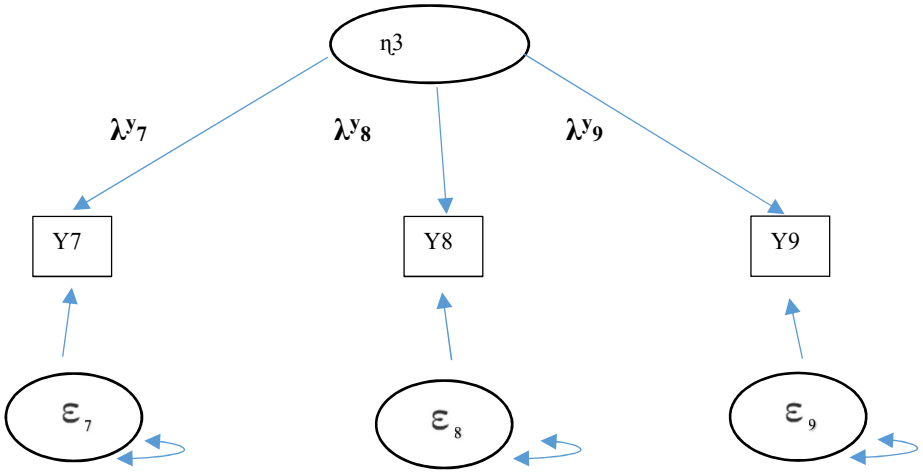

Figure 5. Common Factor Model for Organizational Learning, Knowledge Base, Innovation, and Adoption of Systems Perspective.

3.3.5. Implications of Organizational Adoption to Lean Principles and Practices on Organizational Change and Lean Transformation

Principles are a very important construct of social and psychological analysis. Borrowing from literature, American author Jon C. Maxwell writes, "Policies are many, principles are few. Policies will change, principles never do." TPS/Lean system being a socio-technical system per Shah and Ward (2007) is expected to comply with the principles of socio-technical system as described in Cherns (1976) and explained in Yadav et al. (2017). TPS/Lean principles and lean management practices go hand in hand. Many TPS principle evolved from TPS practices. Lean

principles can be considered as the operating principle for the socio-technical system, where organization is seeking lean transformation without regard to internal or environmental realities. Organizations seeking lean transformation must comprehend and use lean principles to operationalize their management practices.

The basis for TPS is absolute elimination of waste, two pillars that support the objective is JIT (Just in Time) and autonomation noted in Ohno (1988). Organization needs system level focus to reach JIT and autonomation. To achieve organizational outcomes (Toyota, 2014) TPS seeks two critical features: responsiveness and flexibility mentioned in Yadav et al. (2017). JIT cannot be achieved without instilling the automatic error proofing, i.e. autonomation. Application of TPS principle of Jidoka ensures that organization is not pushing defects down the line. Nehzati et al. (2014) studied responsiveness and flexibility in multisite production context. Their work defined flexibility as the capacity to absorb disturbances and variability from internal and external environment. Responsiveness has been associated with speed or rapidness with which a production or supply chain adjust its outputs to an external request per Nehzati et al. (2014) such as customer request of higher volume or rush order. It requires flexibility to create responsive system from organizational perspective. Principles of TPS as in Ohno (1988), Womack and Jones (2000), and Liker J. K. (2004) offer a foundation for driving organizational change and transformation. It is important for this research to identify the constructs that best explains the adoption of lean principles. lean organizational cognitive system and organizational responsiveness and flexibility are such constructs.

First, organizational cognitive system must be based on lean principles that is continuously transforming the organization. To maintain integrity and control mechanism, organizations must follow logical steps or practices in all its functional sub systems. Lean

principles must be ingrained in those codes of logic to ensure system is giving it all to drive value for customers as in Toyota (1998). Foundational elements of lean principles as in Liker, J. K (2004) are that the management decisions must be based on long term philosophy even at the expense of short term financial goals. It is built on a culture of stopping and fixing problem to build quality into product and services, using only reliable and thoroughly tested technology. People and processes of the organization produce leaders who thoroughly understand work of the organization to live by the organizational philosophy and teaches others to live the same way by developing exceptional people and teams that follows the organization's philosophy by ensuring respect for external partners and suppliers by challenging and helping them improve continuously, fix root causes and drive organizational learning, make decisions slowly by consensus by thoroughly considering all options yet implement rapidly. Organization becomes a learning organization through relentless reflection (Hansei) and continuous Improvement (Kaizen). These principles become code of conduct when defining or deploying any organizational management practice and the system transforms to an organizational lean cognitive system. Organization then computes value, observe value streams identifies obstacles to flow, defines rational for pull and continuously improve by synthesizing all information thru analysis of structured and unstructured facts in adherence with lean principles.

Second, organizational responsiveness and flexibility, that is focused on absorbing or eliminating variability regardless of the origination of disturbances either internal or external as well as successfully respond to external variability. Organizational responsiveness can be best understood by examining three aspects 1. Organizational inertia from Hannan and Freeman (1984), 2. Organizational flexibility from Aaker and Mascarenhas (1984) and Ginsberg and Buchholtz (1990), and 3. Isomorphism from Ginsberg and Buchholtz (1990). Inertia is described

as “correspondence between the behavioral capabilities of a class of organizations and their particular environments” described in Hannan and Freeman (1984) and Ginsberg and Buchholtz (1990). Aaker and Mascarenhas (1984) stressed on the term strategic flexibility referring to organizational flexibility and defined as the ability of the organization to adapt to substantial, uncertain, and fast-occurring environmental changes that have a meaningful impact on the organization’s performance.

Finally, isomorphism, a socio-logical construct that emphasizes organizational tendencies toward conformity and legitimization, these adoption increases the probability of organizational survival per Zucker, L. G. (1987) and Ginsburg and Buchholtz (1990). Lean principles that must be adopted as code of conduct of the construct of organizational responsiveness and flexibility are creating a continuous flow bringing problem to surface, use pull systems to avoid overproduction, level out the workload (Heijunka), standardized tasks are the foundation for continuous improvement and employee empowerment, use visual control so no problems are hidden, go and see for yourself to thoroughly understand the situation (Genchi Genbutsu) described in Liker, J. K. (2004). Toyota’s organizational flexibility comes from their scientific experimentation and ability of being a learning organization. Their nature of problem that they are solving dictates how the organization needs to be structured, Spear and Bowen (1999) mentions that different organizational structures coexists happily at Toyota. They apply all their learning to solve problems for the customers.

According to Patton, M. Q. (2018), evaluating concrete practices is how the overarching principles are evaluated and field of knowledge is defined. Lean management practices must be in accord with the lean and socio-technical principles. Three organizational lean management practice constructs that are of paramount interest are organizational lean cognitive practices,

organizational practices based on elimination of waste and organizational practices based on feedbacks. Organizational lean cognitive practices are those that ensures organizational survival and philosophy. Essentially addressing reason for existence and doing everything the way organizational philosophy dictates. These includes practices related to respect for people, developing people, leadership and, organization. Also, instill organizational culture that creates organizational learning mechanism with relentless reflection and scientific experimentation to drive continuous improvement in achieving organizational excellence in all areas. These ensures quality is built in the product or services that organization offers and, ultimately achieve highest level of satisfaction in all stakeholders with mutual value propositions.

Organizational practices focusing on elimination of systemwide waste while adhering to JIT and autonomation principles. Practices involving level loading production lines, operating a pull system, ensuring continuous flow processing, establishing standardized work with all 3 of its elements: Takt time, working sequence and standard in-process stock are used religiously. Also, developing and utilizing multi skilled workers and work groups to mitigate the risk from external demand fluctuation and adjustments in takt times ensuring smooth flow described in Toyota (1998). Other practices such as TPM, SPC, SMED, flow, pull, supplier JIT are all battling variability and devising means to absorb or eliminate the effect from it. Organizational practices based on feedbacks are important both from general systems theory in Bertalanffy (1968) and socio-technical systems in Shah and Ward (2007). TPS/lean is a socio-technical system in Shah and Ward (2007). Organizational dynamics dependent on feedbacks play a very key role in communicating between individuals, groups, departments and organizations. It contributes in the process of organizational subsystem interplay and intra-play between two organizations such as relationship between suppliers and customers. Source of feedbacks includes both external and

internal, if properly used feedbacks can enrich organizational learnings, creating new rules and transform behaviors of the organizational members. The intent of creating flow in TPS is to create rapid impersonal immediate feedbacks besides teamwork as employees and teams need feedback on how they are performing by using continuous measurement in shop floor discussed in Liker, J, K (2004). A reliance on feedback and advice is a major mode of communication when it comes to employee development, product development and promote organizational learning between employees and leaders at various levels of organizational hierarchy. Shah and Ward (2007) reported 3 underlying constructs that describes importance of feedbacks in the form of supplier feedback that reduces supplier variability, help supplier development, customer involvement, employee involvement and continuous flow. Toyota management process is built on setting thought-provoking goals jointly with their subordinates and are obsessive about measurement and feedbacks, which transforms to their policy deployment or "Hoshin kanri" process stated in Liker, J. K. (2004). TPS/Lean decision points are handled with care with feedback loops, where, value stream maps offer guidance on current system and feed backs shows the gap between current state and future/desired state. Feedbacks are used in the form of accurate, timely and relevant information while seeking flexibility and to achieve goals. Scientific experiments are conducted in accordance with "how to improve" rule in Spear and Bowen (1999). Shah and Ward (2003) reported studying likelihood of implementing 22 lean practices and reports empirically validating 4 bundles of interrelated and internally consistent synergistic practices: just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management (HRM). Similar coherent synergistic approach in lean practice was suggested in Stone, K. B (2012b) and was directed at shah and Ward (2007). Adoption of lean principles and practices on organizational level should produce

combined effect of lean organizational cognitive system, proper responsiveness and flexibility, organizational lean cognitive practices, organizational practices based on elimination of waste and organizational practices based on feedbacks. These are in line with the socio-technical principles of socio-technical criterion, the multifunctional principle, boundary location, information flow principle. This research finds that socio-technical system principles of compatibility, minimal critical specification, information flow and incompletion of Cherns (1976) is in congruence with lean principles Womack (1996), Liker, J. K. (2004) and Yadav et al. (2010). Organizational change and lean transformation requires organizational adoption to lean principles and practices.

Organizational adoption of lean principles and practices (η_4) is a latent construct. Items/questions associated with focused areas in lean principles for the organizational cognitive system (Y10), items/questions associated with lean practices for the organizational system (Y11) and items/questions associated with organizational responsiveness and feedback (Y12) is postulated to measure organizational adoption to lean principles and practices ($\eta 4$) in this research. A common factor model is presented in Figure 6. Factor loading or correlation between factor and indicator is described by λ and ε as the error term for each of the indicators in Figure 6.

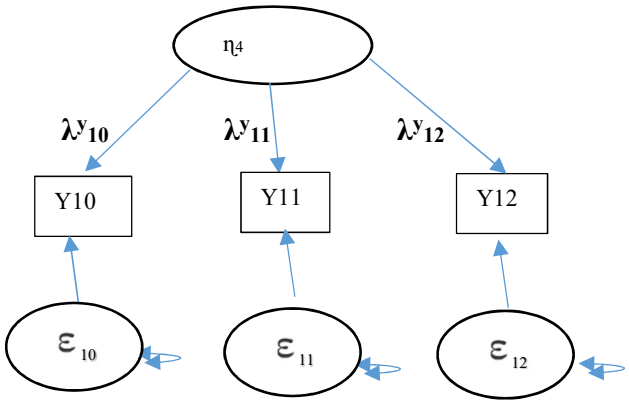

Figure 6. Common Factor Model for Organizational Adoption of Lean Principles and Practices.

3.3.6. Implications of Organizational Engagement, Job Engagement, Person Organization Fit, and Membership Behavioral Norm on Organizational Change and Lean Transformation

Employee engagement as a critical construct has been studied in previous works including Kahn, W. A. (1990), Frank et al. (2004), Saks, A. M (2006), and Mahon et al. (2014). Which, at times referred to as connecting of organizational member selves to individuals work role or emotional and intellectual commitment to the organization reflecting variable active psychological state of employees in Mahon et al. (2014) in line with Kahn, W. A. (1990) and Saks, A. M. (2006). Rothbard, N. (2001) viewed role engagement in two components; attention and absorption in a role. Mental ability and duration of time one is consumed in thinking about the role refers to attention and being engrossed in a role refers to the absorption or intensity of focus in the role. Thus, employee engagement in organization needs to be viewed in two perspectives, job engagement or work role and organizational engagement or the role of being an organizational member per Mahon et al. (2014). Saks, A. M. (2006) studied employee engagement in the form of job engagement and organizational engagement and their antecedents and consequences. This work suggests meaningful differences between job and organizational engagement in terms of individuals psychological conditions leading to and consequences of

both form of engagement. Perceived organizational support and procedural justice both predicted organization engagement and characterized organizational engagement of having stronger predictive usefulness than job engagement towards organizational outcomes thus, relating to organizational change and transformation. Saks, A. M. (2006) associated job engagement with "sustainable workload, feelings of choice and control, appropriate recognition and reward, a supportive work community, fairness and justice, and meaningful and valued work." Andrew and Sofian (2012) associated higher organizational productivity of lean organization with characterization of talented, supportive, co-employees, higher employee engagement where whole organization works together, learns together and helps each other.

Socio-technical system theory and lean principles and practices can contribute to organizational engagement. Which involves organizing work in a way such that it is compatible to the interest of the organization, leading to participatory work design process and employee involvement per Appelbaum, S. H. (1997). Individuals' needs such as high quality of work life, congruent Human Resources Policy (HRM) and unbiased execution of those policies can help organizational engagement. TPS requires people development through coaching, learning, socialization, job enrichment with opportunity for scientific experimentation, team work, team leader accountability, leader's catalytic role of problem solving and instilling long term company philosophy in associates. These sets the stage for organizational change by driving behavioral change, standardized routine of behavior and standardized work routine and goal setting perpetually create positive personnel development. Positive organizational congruence preserves organizations against the deviant behavior. Employee engagement in TPS/lean is not used as a control mechanism but as a collective ownership in Toyota way. Camuffo and Wilhelm, M. (2016) reported Toyota's own experience with challenges of organizational engagement

including turn over, absenteeism and inability to follow people development requirement and inability to pass defect free products to customer.

Ünal and Turgut (2015) reported strong contribution of person organization fit to organization engagement. Compatibility between an employee and the organization is measured by the degree of congruence in their mutual interest and is defined as person organization (PO) fit, that can manifest in multitudes of ways. These include value congruence, goal congruence, needs supplies fit and demands ability fits in Argyris (1957), Kristof (1996), and Hoffman and Woehr (2006). Hoffman and Woehr (2006) found varying degree of relation of PO fit to behavioral outcomes such as turnover, task performance and organizational citizenship behavior. Organizational HRM policy based on lean principles can help organizational behavioral outcomes aided by proper onboarding, training, empowering and offering secure stable future for the organizational associates and eventually improve the PO fit. Camuffo and Wilhelm, M. (2016) reporting of Toyota's failure to follow Toyota way showed organizational policies short sightedness can influence the PO fit leading to unintended behavioral outcomes between 2000-2010. Positive contribution to person organization fit has been attributed to pre-and post-employment socialization between mentee and mentor by Chatman, J. A. (1991). Sekiguchi and Huber (2011) stressed that P-O fit has a stronger association with work attitudes and belongingness to organization.

The behavioral norms of organizational members in Toyota production system is shaped by long-term philosophy, priority in quality and customer satisfaction, developing people and continuously solving problems for both internal and external organizations. Socio-technical system theory and lean systems literature puts people at the center of analysis. Organizations do not change its behavior until people in the organization change their behavior. Organizational

performance is the output of the organizational function particularly a cumulative effect of behavior of all the people in it. Human performance has been identified by those valued results produced by people working within a system by Pershing, J. A. (2006). Analysis of system must include relationships of individuals besides the elements of the system. Many TPS tools and principles were born out of focused behavior of Toyota leaders that learned to map value added and non-value-added acts of the organizational members and the systems. Ohno's war against waste in the form of buffer, over/early production avoided suboptimal behavior of losing motivation for continuous improvement. Continuous flow, 5S, and Andon system is used to drive sustaining behavior modification through recognition and speedy feedback. thoroughness, organizational learning, collective reflection, consensus and due process in decision making is very important for Toyota. Quality of decision is equally important as the process of decision making, practically pushing to pay attention in process instead of results as the belief is due process will yield the results according to Liker, J. K. (2004). The change process brings people closer to desired behavior from all hierarchy within an organization, including senior leaders of an organization to frontline leadership. Emiliani, M. (1998) separated lean behavior from fat behavior (non-lean). Buschmeyer et al. (2016) shed light on need for employees need for behavioral adjustment in driving organizational transformation. Their empirical study suggests that behavior at individual and organizational level can be influenced impacting organizational transformation and change. They concluded that personnel development and goal setting are two variables that drives behavioral change both at individual and organizational level and advised that specific attentions are needed when developing guidelines for personnel and goal setting mechanism in organizations. Recent days agile enterprise systems are used in helping organizations in shaping personnel development and goal settings. Emiliani, M. (1998) argued

that waste elimination is not a focus area in research when it comes studying human behavior in organizations. He went on to map lean principle and human behavior and advised in specifying value in human interactions and seeing it from a customer supplier lens brings a very different perspective then a self-serving and self-preserving mindset. Understanding individual and group behavior from a value stream perspective allows one to understand value added behavior, non-value-added behavior and some unavoidable non-value-added behavior. Standardized behavioral routine and standardized work can help shape lean behavior. Desired organizational outcome is hypothesized to correlate with desired behavior particularly people in leadership capacity while achieving organizational engagement that is based on lean principles. Shantz et al. (2013) showed that the design of a person's job prompts his or her engagement with the job, which in turn, both increases task and citizenship performance, and decreases the frequency of deviant behaviors. Organizational engagement, job engagement, person organization fit and membership behavioral norm (η_5), is a latent construct. Items/questions associated with focused areas in Organizational engagement (Y13) and items/questions associated with Job engagement (Y14) is postulated to predict the latent construct Organizational engagement, job engagement, person organization fit and membership behavioral norm (η_5) in this research that can predict organizational change and lean transformation. A common factor model is presented in Figure 7. Factor loading or correlation between factor and indicator is described by λ and ε as the error term for each of the indicators in Figure 7.

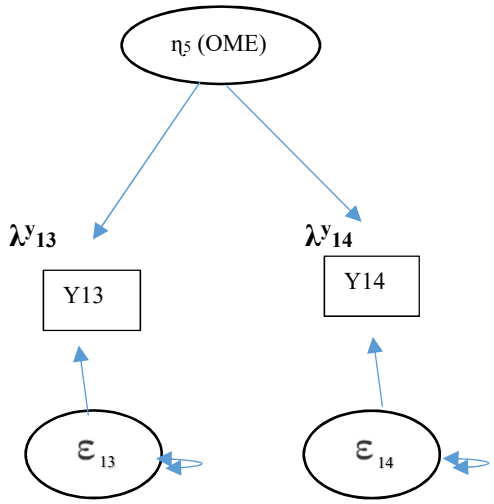

Figure 7. Common Factor Model for Organizational Engagement, Job Engagement, Person Organization Fit, and Membership Behavioral Norm.

3.3.7. Implications of Organizational Change and Lean Transformation and Associated Item Focus

Haveman, H. A. (1992) studied the impact of organizational change on organizational performance and failure rate. This study found that the adjustments in organizational structures and activities proves beneficial to short term financial benefit and long-term survival chances. Stone, K. B. (2012b) states that lean transformations appears to have seen higher level of success when the transformation was aligned strategically and the scope addressed the whole enterprise. Organizational change with the intent of implementing lean in the organization is organizational lean transformation. Little work addressed the organizational change from lean transformation in past research work. Organizational change, in general, has been studied from various perspectives, including ecological, political theory, meso-institutional, and structural contingency theory. The central tenet of organizational ecology is that organizations are subject to strong inertial forces. Opposite to organizational inertia and stability is organizational change. Beside ecological theory, Hage, J. T. (1999) studied political theory, meso-institutional theory and structural contingency theory of organizational change and made connections between changes

in organizational form emphasizing organizational innovation. Political theory takes the opposing view of structural contingency and stresses on dominant coalition that once in power, remains in place despite of organizations facing major contingencies and hence explains some firms not responding to environmental changes. Institutional theory stresses the importance of professional associations, foundations, socialization agents as source of change in organizational form according to Hage, J. T. (1999). Hannan, M. T. and Freeman, J. (1977) suggests population ecology of organizations must attempt to study the distributions of organizations across environmental conditions and the limitations on organizational structures. Essentially survival under unfavorable condition is subject to organizational forms and, its ability to survive potentially with excess capacity (or lack thereof) or high levels of professionalism.

Organizational forms appeared as a common factor in these analyses. In terms of the definition, Knudsen, T. and Eriksen, B. (2002) built on the previous definition of organizational form defined by Romanelli, E. (1991). Their definition of organizational forms is "a collection of members, a collection of channels through which the members can pass information or control to each other, and a set of dynamic rules that help define the flow of information or control and thus help define their decision rights." Donaldson, L. (1995) strongly favored structural contingency theory and Soylu, A. (2008) argued that "Population ecology theory has yet to show the existence of population-level organizational adaptation, whereas structural contingency theory has shown individual organizational adaptation of organizational structure." Structural contingency theory essentially suggests adapting to the environmental needs that the focal organization belongs to and let the organization meet requirements of efficiency, innovation or anything it must do to survive and prosper per Donaldson, L. (1995) in line with Hage J. and Aiken M. (1970). Donaldson, L. (1995) also invokes Christensen et al. (1978) in referring to the

adoption of new strategy on the part of organization's management. The strategy of the organization being reflective of not only environment but also managerial statement of organizational objectives built on comparative advantage of the focal organization. And, continues that these strategies coupled with extant organizational resources lead in adopting levels of size, technology, diversification and other factors. Donaldson, L. (1995) called each of these factors contingency variable in line with past research. Design of organization was cited as strategic variable and enhancements in organizational form was advised to be undertaken for sustained competitive advantage by Daft, R. L. and Lewin, A. Y. (1993). They recommended organizations that are flexible, capable to adapt and create change and harness both human and technological sources with global scope. Hage, J. T. (1999) in providing overview of organizational change mentions changes in organizational form particularly a movement towards organic form with the emphasis on organizational innovation. Burns, T. and Stalker, G. M. (1961) described the contrast between mechanistic and organic system. Mechanistic management system is suitable for dealing with stable condition. Whereas, organic system is more appropriate for changing conditions.

Organizational forms alone cannot explain the organizational change, however organizational forms, in concert with proper organizational change context, appropriate change content, driven with proper organizational change process, reliance on proper strategic variables, flexible organization structure, required organizational innovation and utilizing proper interface within and beyond organizational boundary can help drive the change. In case of organizational lean transformation, the organizational change content must be based on lean principle and the organizational change process must be based on lean practice applicable to establish proper

organizational meta routines and artifacts that will develop organizational capacity guided by lean leadership in the subject organization.

Devos et al. (2007) studied the concurrent impact of the content related variables, context related variables and process related variables of organizational change and found that they have significant influences independently of each other. In this work, “non-threatening nature” of organizational change was used as one example of content-related variable. Essentially, characterized by the nature of congruence between individual interest and organizational motivation in the change process. Context-related variable was exemplified by trust in upper management and finally example of a process-related variable was described by the opportunity to participate in the change process. Some of the challenges of organizational lean transformation was cited as lack of trust in organizational intent of lean transformation or lack of trust in management or lack of proper knowledge about the content of the change directed for organizational lean transformation in Toyota (1998), Yadav et al. (2010), Nahm, A. Y., and Lauver, K. J. (2012). Hannan, M. T. and Freeman, J. (1986) discussed dynamics of boundaries in organization space and impact of technological influence in creating organizational forms besides social influence. It claimed simultaneous processing of selection and institutional aspects in organizational life creating appropriate structure and rules in the backdrop of theory of organizational discontinuity. Organizational discontinuity often tied with revolutionary, chaos, disorganization and less attractive path in organizational change per Deeg, J. (2009). Who used three characteristics of need for discontinuity 1. Decreasing average lifetime of organization, 2. Limitation of success to a short period, 3. declining economic potential of organization and described the complementary aspect of apparent duality of evolutionary and revolutionary nature of change. This work proposes re evolutionary change process to accommodate the tension

between structure and action taking place by simultaneous presence of evolutionary and revolutionary forces.

Adler et al. (1999) studied the efficiency/flexibility tradeoff in organizational contextual factors of trust and training. This work presented that "range of organization design alternatives is not one-dimensional spectrum from organic to bureaucratic/mechanistic but two-dimensional matrix contrasting high versus low extent of bureaucracy on one dimension and high versus low levels of trust on the other dimension." Adler et al.'s work credited four mechanisms in NUMMI. First, routine for changing other routines, i.e., meta-routines, enabling the efficient performance of non-routine tasks. Second, contribution to non-routine tasks by workers and suppliers took place while routine production work. Third, temporal separation between routine and non-routine work was maintained so worker can switch them sequentially. Finally, organizational form allowing for partitioning such that differential sub units could work on routine and non-routine in parallel. NUMMI presented exceptional capability for both first order and second order learning and flexibility of transitioning non-routine work to route work. Leadership played a key precondition in providing the context of harnessing trust and investment in training. Thus, transferring the obligation on improvement to associates and partners instead of acting with mechanistic control.

Structure of work and shared accountability for customer satisfaction has surfaced in various research work. Division of labor drives the efficiency aspect of work distribution and associated economic benefits that is associated with work structure in Havemen et al. (2007). Drive for economic efficiency by studying division of labor was dominated by both Taylor and Ford as discussed in Janoski, T. and Lepadatu, D. (2014). Ford essentially exploited division of labor by reconstructed automotive assembly processes in simple task in proper sequences in

search for efficiency. Division of labor also has a social aspect such as potential alienation of employees with a machine-like perspective of human endeavor. Such risk is high when employees don't have opportunity to contribute to the change but live a work life of clocked presence at work with producing pre- determined output defined by the experts. Havemen et al. (2007) referred pessimistic view of Karl Marx on division of labor. Toyota needed to respond to the flexibility of market by developing flexible methods. Toyota requires workers to be multiskilled and their method relied on flexing multi skilled human capacity by allowing takt time to dictate the flow matching the pace of the customer demand. Just in time, standardized work, building quality in production processes, elimination of waste, level loading, ability to respond to varying takt time and continuous improvement are all part of shared accountability in satisfying customer demand per Toyota (1998). This shared accountability between team leader, individual worker and the small teams that they belong to are a very distinguished form of work dynamics that ties efficiency with effectiveness of organization and function more as organic form of organization. Petkova, I. (2015) in line with Dyer and Nobeoka (2000) characterized Toyota's identity as organic type and change was viewed as a change in organic whole and suggested that organizational learning and new knowledge must be practiced throughout the organization. At Toyota, employees function as empowered and motivated members of the organization instead of being a cog in the machine of capitalistic society as feared by Karl Marx in Havemen et al. (2007) and Jasińska, J. (2018).

Haveman, H. A. (1992) stressed on existing competencies and preferred that related new activities to be closer to original domain referring to product diversification effort under sudden environmental pressure. These organizational competency is a form of organizational capacity of change. Soparnot, R. (2011) studied organizational change from a content, context and process

perspective. Findings from this research work states that change capacity is as much linked to its process as it is on context. Organizational learning acts as a mechanism to regenerate learning dimensions in cohort with the content and context. Organizational capacity for change is an important aspect for organizational change. Judge, W. Q. and Douglas, T. (2009) viewed this capacity as something that allows organizations to adjust to changing situation sooner and more effectively in comparison to competitors. Improving organizational capacity for change is an enabler to long term organizational survival. Competences of employees and organizations both are relevant to organizational change in Jasińska, J. (2018). Enhancing organizational member's understanding about change, conceptualizing and selecting proper approaches to change, business complexity and socio-technical uncertainty has been identified as analyzing capacity for organizational change in Buono, A. F. and Kerber, K. W. (2010). People are trusted with their jobs and encouraged to find a better way, prepared associates to abandon old ways and carry the spirit of continuous improvement in Toyota production system per Toyota (1998).

Lean transformation has been associated with superior organizational performance. Shah and ward (2003) associated manufacturing cycle time, scrap and rework cost, labor productivity, unit manufacturing costs, first pass yield, and customer lead time to address three highly related underlying aspects: product lead time, product cost and conformance to customer quality. Gross margin variance, inventory turn variance and warranty variance were studied by Stone K. B. (2012b) to measure organization's leanness to postulate link between organization's leanness and financial performance. Richard et al. (2009) studied financial performance, product market performance and shareholder return. Their work included measurement of organizational performance from objective measures of accounting measures, financial market measures, mixed accounting/financial market measures and survival. Their work also discussed fully subjective

measures and quasi-objective measures. Organizational performance is subject to multidimensionality mentioned in Shah and Ward (2003), Richard et al. (2009), and Camuffo and Wilhelm (2016). The dimensionality of performance, i.e., establishment of rationale for using certain performance measures to certain research context was called important in Richard et al. (2009). In the context of lean transformation, Camuffo and Wilhelm (2016) mentions the stream of research focusing on complementarities and performance landscape. Organizations usually track organizational performance as a validation to desired timely achievement targeted by all stakeholders. It reflects the extent of goal achievement in organization's workforce, capital, marketing and fiscal matters in Marcoulides, G. A. and Heck, R. H. (1993), individual and organizational indicator of effort and achievement in Burke, W. W. and Litwin, G. H. (1992). Prevention of unnecessary waste drives efficiency in cost factors but other factors such as scarce resources of capital, clients and manpower are valued resources for organization that require effectiveness per Seashore, S. E. and Yuchtman, E. (1967). They defined effectiveness as the ability of the organization to exploit its environments in the acquisition of scarce valued resources as well as the sustaining and functioning of the organization. Both performance measures of efficiency and effectiveness were of simultaneous importance in Bartuševičienė, I. and Šakalytė, E. (2013). Toyota Production System stresses on driving out inefficiencies and ensures effectiveness in its organizational system but does it without being overly organic by having a viable enabling standard in continuously improving repeatable processes in Liker, J. K. (2004). Camuffo and Wilhelm, M. (2016) did a retrospective analysis of Toyota on its failure to live up to the lean/TPS principles and practice. Toyota's inability to match internal organizational growth to match desired market growth between 2000-2010 was criticized. These include failure to built-in quality to its products, inability to stop production when needed to

stop, inability of developing people, leadership and organization, failure in allowing decentralized decision making and standardized behavioral routines, cost based supplier management instead of value based decisions and lacking complementary human resource practices and policies. Which, Toyota had to accept responsibilities of failure and correct their course. Organizational change and lean transformation (η_6) is a latent construct in this research. Items/questions associated with focus area lean organizational form (Y15), items/questions associated with content context and process of change (Y16) and items/questions associated with organizational performance (Y17). A common factor model is described in Figure 8. Factor loading or correlation between factor and indicator is described by λ and ε as the error term for each of the indicators in Figure 8.

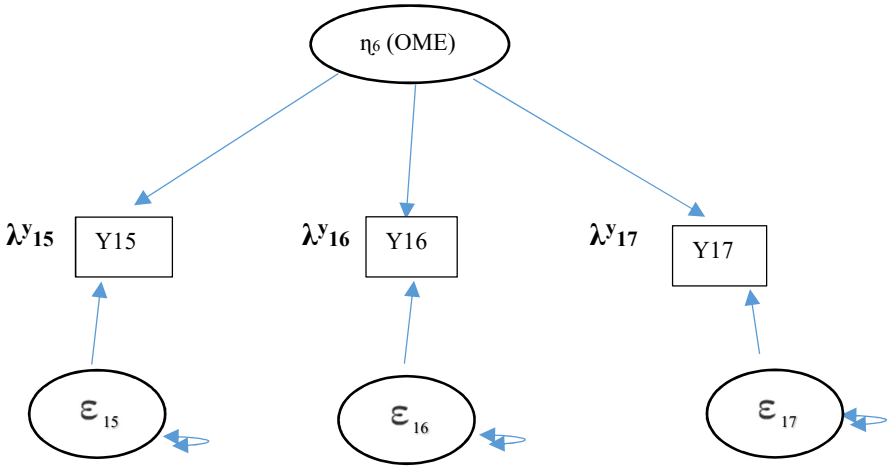

Figure 8. Common Factor Model for Organizational Change and Lean Transformation.

3.4. Research Hypothesis

Based on the implications of socio-technical factors on organizational change and lean transformation this research work postulates that organizations should prioritizes joint optimization of social and technical factors for overall system optimization. From a socio-technical system perspective all the six factors can be hypothesized to predict the seventh factor, which is organizational change and lean transformation. When discussing lean transformation, it

is imperative to look into existing engineering management and organizational science literature in order to understand the organizational barriers and the ways to overcome those barriers for the successful implementation of lean. For example, through their empirical research Hambrick and Mason (1984) demonstrated that organizational outcomes, such as strategic choices and the effectiveness of an organization, reflect the "values and cognitive bases" of their top management or other influential people in an organization. Further, Brown and Duguid (1991) argue that the traditional view of considering organizational work, learning, and innovation as separate activities should shift towards a unified view of these activities in order to truly improve or transform an organization. More importantly, researchers in both engineering management and organization science suggest that organizational transformation should be managed as a structured process to advance the learning from the individual level to an organizational level (Huber, 1991). Experimental outcome of following hypothesis contributes to the study of organizational change and lean transformation from socio-technical perspective and answer all three research questions originally posed in this research.

Hypothesis 1: External Environment can positively predict organizational change and lean transformation.

Hypothesis 2: Organizational leadership and structure can positively predict organizational change and lean transformation.

Hypothesis 3: Organizational culture, mission, and strategy can positively predict organizational change and lean transformation.

Hypothesis 4: Organizational learning, knowledge base, innovation, and adoption of systems perspective can positively predict organizational change and lean transformation.

Hypothesis 5: Organizational adoption to lean principles and practices can positively predict organizational change and lean transformation.

Hypothesis 6: Organizational engagement, job engagement, person organization fit, and membership behavioral norm can positively predict organizational change and lean transformation.

CHAPTER 4. RESEARCH METHODOLOGY

This chapter specifics the methods used to conduct research that aims to develop a model for organizational change and lean transformation from socio-technical perspective. The design elements of research (i.e. unit of analysis, key respondent, target sample frame, sample size, and survey administration) is described first. Following section provides measurement items and their underlying structure. Final section contains the method used for measurement and structural validation.

4.1. Research Design

4.1.1. Unit of Analysis and Unit of Observation

It is important to define the unit of analysis and unit of observation for this study. The unit of analysis used in this research is individual professional opinion and the respondents were asked to share their thoughts with respect to organizational context in their professional experienced formed through being part of various organization that they have been part of or provided leadership in organizational change, lean implementation, organizational development.

4.1.2. Target Respondent

Target participants in this research are professionals, who has been in industry playing various responsible roles including Board of Director, CEO, COO, VP, MD, Senior director of operations, VP Technology, Technical director, Director of Operations, Director of HR, Director of Sales, General Manager, Plant Managers, Senior operations executives and Senior staffs at Plant level of various functionalities including HR managers, Production Manager, Lean Mfg. Manager, Engineering manager and financial Controllers.

4.1.3. Target Sample Frame

The population of interest in this research work are participants in North America and Europe who given their current or former roles in the industry has been in situations where they have experienced or provided leadership in organizational development, lean implementation, strategic deployment or has been tasked for organizational change and organizational performance improvement. Most participants were selected from across the industry/ sector that includes manufacturing, financial, technology, health care service and publicly traded business organizations. Participants in this research for both phases of EFA and CFA came with working experience in Large Cap corporations, Mid Cap, large public service Institutions (Federal Government) and some Small Cap Private equity companies. Given the characteristics of the population professional contacts, LinkedIn Network and professional references were used to recruit the participants.

4.1.4. IRB Approval/Exemption

This research involves human participation and thus required Institutional Review Board (IRB) evaluation. A request for IRB exemption was submitted to IRB at North Dakota State University (NDSU) along with a copy of questionnaire. Upon review IRB at NDSU determined the exemption status of protocol No. EN21047, "Study of Organizational Change and Lean Transformation from Socio-technical Perspective." Relevant documents are furnished in the appendices in this research.

4.1.5. Data Collection

The survey was built using Qualtrics at NDSU with the intent of collecting data electronically. Qualtrics had built-in features of multiple channels, including social media, emails, personal links and anonymous link for distribution of the survey among the participants.

This research employed a five-point agreement based Likert method for development of questioners.

4.1.6. Sample Size

Statistical power is the estimation of the sample size that is appropriate for power analysis stated in Kyriazos (2018). Current research work used factor analysis techniques for measurement instrument development and testing of hypothetical *a priori* model. There is a lack of consensus that exists in operations literature on an exact number of responses needed for applying the Structural equation modeling (SEM) techniques for testing a SEM model per Schumacker and Lomax (2004) and Mitchell (1993). Kyriazos (2018) described N: q rule, i.e. the number of cases (N) to the number of estimated parameters (q). Thus, in case of CFA this ratio for CFA can range from 5 to 10 cases and in this research the CFA data set complies with Bentler and Chou (1987) Bollen (1989), and Kyriazos (2018). Given the professional profile of the participants, a wide-ranging participation was found to be a hurdle in this research.

In case of CFA, the proposed model had 9 items at the most per latent construct. Exploratory factor analysis in current research involved receiving 41 responses. After screening 33 of those valid responses were included for EFA, 8 responses were subject to missing data. Bootstrapping technique was used in R to improve the estimates and provide confidence interval of the estimates to overcome the lack of the statistical power in EFA phase. Confirmatory factor analysis (CFA) in current research includes receiving 51 responses. CFA in this research complied with the guideline. After screening 47 of those valid responses were included for CFA. This research excluded 4 responses with missing data.

4.1.7. Data Analysis

The data analysis centered around the assessment of the structural (underlying factors or subscales) and psychometric (reliability and validity) properties of organizational change and lean transformation. The conventional methods were performed using exploratory factor analysis. It ensured content validity, convergent validity and nomological validity. Since this research could not identify any of the previous measurement scale as a suitable fit for measuring organizational change and lean transformation from socio-technical perspective, it took it upon itself to create a measurement model for testing the validity of the hypothetical model. Survey was conducted with original 57-item questionnaire for EFA and second round of survey was conducted using a completely different population of participants for CFA.

4.2. Construct Measurement

This research work opted for creating a new measurement scale for validating the hypothesis. None of the existing measurement instrument in existing work appeared to have the proper orientation to answer the research questions posed in this research. Process for scale development in this research was followed from Robinson, M. A. (2017) particularly in the process of administering preliminary item and initial participant feedback before finalizing EFA survey items.

4.2.1. Questionnaire Development

4.2.1.1. Administer Preliminary Items

Once the hypothetical model was created, a list of 113 items were produced to predict 7 latent constructs that had the potential to be included in the EFA item list. An expert panel of 3 reviewed the item list and considering the practical limitation of required sample size and the

required time it might take the participants a further review was conducted to reduce the number of items to 57.

4.2.1.2. Implement the Participant Feedback

Feedback provided by the preliminary item review by 3 expert participants were taken into consideration. Some modification in word selection and verbiage clean ups were done to ensure the integrity of the intent of the item design without reducing number of items.

4.2.1.3. Initial Survey Questionnaire

Feedback from the expert panel and theoretical findings were used for further analysis. Finally, based on the theoretical domain and operational domain assessment on the organizational factors described in hypothetical model development, a list of 57 items were selected for measuring 7 latent constructs for conducting exploratory factor analysis (EFA). These constructs include 1. External environment ($\xi 1$), 2. Organizational leadership and structure (η_1), 3. Organizational culture, mission and strategy (η_2), 4. Organizational learning, knowledgebase, innovation and adoption of systems perspective ($\eta 4$), 5. Organizational adoption to lean principles and practices (η_5), 6. Organizational engagement, job engagement, person organization fit and membership behavioral norm (η_6) and 7. Organizational change and lean transformation (η_7).

4.2.2. Measurement Items

4.2.2.1. Latent Construct: External Environment ($\xi 1$)

This construct is primarily focused on measuring variability in customer demand and incoming resources that organization needs for normal operating condition. This construct is measured by 6 items described below:

Q2: Organizations must have systems for understanding and tracking changes in customer demand to be able to respond to the market condition.

Q3: Economic and environmental conditions can have an impact on market demand requiring adjustments by the organization.

Q4: Market demands can be influenced by natural catastrophes or technological breakthrough that might influence consumer behavior requiring organizational change.

Q5: The Organization's direction can change depending on the availability of cash.

Q6: The availability of required skilled workers can influence decisions of organization with respect how and where it does business.

Q7: The organization's strategy may change if raw materials become constrained or governmental regulations change.

4.2.2.2. Organizational Leadership and Structure (η_1)

This construct is primarily focused on measuring values based technical leadership, cultivation of leadership and organizational structure. This construct is measured by 9 items described below:

Q8: Organizational leadership should display moral behavior and personal commitment to earn respect in followers to drive the organization's lean vision into action.

Q9: Organization leadership must make principled decision with integrity regardless of short term temptation to create value for customers or shareholders.

Q10: Respect for technical leadership, in a lean organization, is earned through disciplined long self-development that is built on knowledge of functional expertise on products and processes.

Q11: Organizational leadership must understand the motivation of people to be able to build and develop a learning organization.

Q12: It is important to promote leaders from within the organization to build a strong lean culture.

Q13: Leadership development is a means to maintain consistency of organizational purpose.

Q14: The organizational structure should favor distributed leadership with smaller span of control over a leadership structure based on cost models.

Q15: The organization must balance the need for deep technical specialization with general lean operational knowledge based on the complexity of its products, processes and services.

Q16: Low centralization built on organizational learning reflects empowerment and trust in the ability of the associates in a lean organization.

4.2.2.3. Organizational Culture, Mission, and Strategy (η_2)

This construct is primarily focused on measuring organization's focus on their set of core values that it identifies with, employee empowerment, organizational strategic choices and strategic leadership. This construct is measured by 9 items described below:

Q17: The leadership of the lean organization must build a culture that promotes "built in quality" as a core principle for sustainable business success.

Q18: Striving for perfection should emanate from every day activity of all associates in lean organization.

Q19: The organization must adopt a "set of values" that associates can identify with to get engaged with organization.

Q20: Associates must be empowered to handle job related problems including the authority to stop production when a nonstandard event takes place such as a defect or machine malfunction.

Q21: A high degree of coaching and mentoring is necessary to ensure associates understand their work roles to be successful in organizational lean transformation.

Q22: The organization must allow associates to come up with new practical ideas to drive improvement and create new standard for work in a lean organization.

Q23: Organizational strategic plan must be in line with long term mission and understood by all associates to be able to relate/ align with overall direction for timely execution.

Q24: Operational excellence practices consistent with lean principles can be used as a vehicle for achieving milestones by strategic leadership in lean organizations.

Q25: Organizational mission and strategy must not only focus on cost reduction in value stream but also on top line growth as part of organizational change.

4.2.2.4. Organizational Learning, Knowledge Base, Innovation, and Adoption of Systems Perspective (η3)

This construct is primarily focused on measuring Commitment to organizational learning and innovation, extent of problem solving using scientific method and Rational self-interest of

the system from overall open system perspective. This construct is measured by 9 items described below:

Q26: In lean organizations, leadership must be personally engaged in promoting organizational learning by using scientific principles.

Q27: A lean organization must build systems to encourage professional development of employees including the importance of teamwork to achieve the right culture.

Q28: Lean organizations use socialization to promote knowledge sharing between various roles of employees.

Q29: A lean organization must have a standardized approach such as a set of best practice tools that best suits solving problems.

Q30: Problem solving must be based on a scientific approach using facts from direct observation of the problem with a quest to ask "why" for identifying root causes.

Q31: A deliberately thorough attempt must be made always to investigate all possible options of problems and solutions without short cuts risking reoccurrences of the problem.

Q32: Striving for highest level of customer satisfaction using feedback to mobilize resources is the best strategy for organizational development.

Q33: It is in the best interest of the organization to be the best in what they do by learning from the best and to create knowledgebase to be used for reference and planning.

Q34: The organization must rely on knowledgebase to drive innovation in creating product, processes and systems in a coherent way for organizational change.

4.2.2.5. Organizational Adoption to Lean Principles and Practices (η4)

This construct is primarily focused on measuring adoption of lean principles and practices as part of the organizational cognitive and organizational management practices built on organizational responsiveness using feedback mechanism. This construct is measured by 9 items described below:

Q35: A long-term purpose based on the creation of value for all stakeholders is required to articulate a sense of overall direction.

Q36: The organization must continuously improve and evolve as to how products or services are created up and down the entire value stream.

Q37: The organization should eliminate waste throughout the system by developing exceptional people built on reflections from past organizational learning and standardized work.

Q38: Everyday work practices should be built around developing capability of delivering products or services with quality exactly as the customer requires.

Q39: The organization should have step by step standard work guidelines for every job in terms of quantity and sequence based on a continuous flow or customer pull.

Q40: The organizational human resources practices must ensure respect for people even in economic down turn by properly utilizing them as valuable resources instead of easy head count reduction practices.

Q41: The organization must establish day-to-day practices to reduce/absorb variability in demands keeping all forms of inventories at desired level without adding undue burden on cash flow.

Q42: People in the organization must use feedback mechanism to detect variances against the target standard and solve the problems immediately at the source of the variation.

Q43: The organization must empower its people at all levels to do the right thing including shut down production regardless of short term consequences.

4.2.2.6. Organizational Engagement, Job Engagement, Person Organization Fit, and Membership Behavioral Norm (η5)

This construct is primarily focused on measuring organization engagement, job engagement and person organization (P-O) fit that drives standardized behavioral norms at organizational level. This construct is measured by 6 items described below:

Q44: Offering long term job outlook and the ability to actively participate in improving one's job is a way to engage employees for organizational lean transformation.

Q45: To motivate and engage large numbers of people to work together toward a common goal is one of a lean organization's top priority.

Q46: The organization must establish standardized behavioral routines by mentoring and coaching to engage the minds of people to support and contribute their ideas to the organizational change.

Q47: The organization must establish role clarity and recruit with the goal to drive engagement and improvement.

Q48: The organization must recruit the best fit for the job and challenge them to grow in the job by constantly allowing them to solve problems.

Q49: The organization's daily life must promote policies that are designed to gain employee satisfaction by continuously improve their performance.

4.2.2.7. Organizational Change and Lean Transformation (η6)

This construct is primarily focused on measuring organizational performance, lean organizational form, content context and process of organizational change. This construct is measured by 9 items described below:

Q50: A flexible organizational structure using standardized rules of engagement among its members is indicative of a lean organization.

Q51: The organization's human resources policy should be designed to promote a multi-skilled work force to maximize flexibility in meeting changing demands for a required expertise.

Q52: A team of multi-skilled workers led by capable team leader relying on standardized work and organizational learning is the basis for level of autonomy in lean organization.

Q53: Lean transformation strategies must include plans to mitigate any outcomes that may seem threatening to the organizational members.

Q54: The context of organizational change such as trust in management will help the manifestation of organizational lean transformation.

Q55: The change process must be clear in terms of situation, actions, outcomes and ownerships for successful organizational lean transformation.

Q56: Built-in quality resulting low variance in warranty related cost drives higher level of customer satisfaction will drive market growth.

Q57: Short lead time to market and high turns in inventory for better cash flow are drivers of organizational performance of a lean organization.

Q58: Organizational performance of a lean organization is visible in high gross margin and high return on capital invested.

4.3. Hypothetical Research Model

A graphical representation of the hypothetical research model is presented in Figure 9 below.

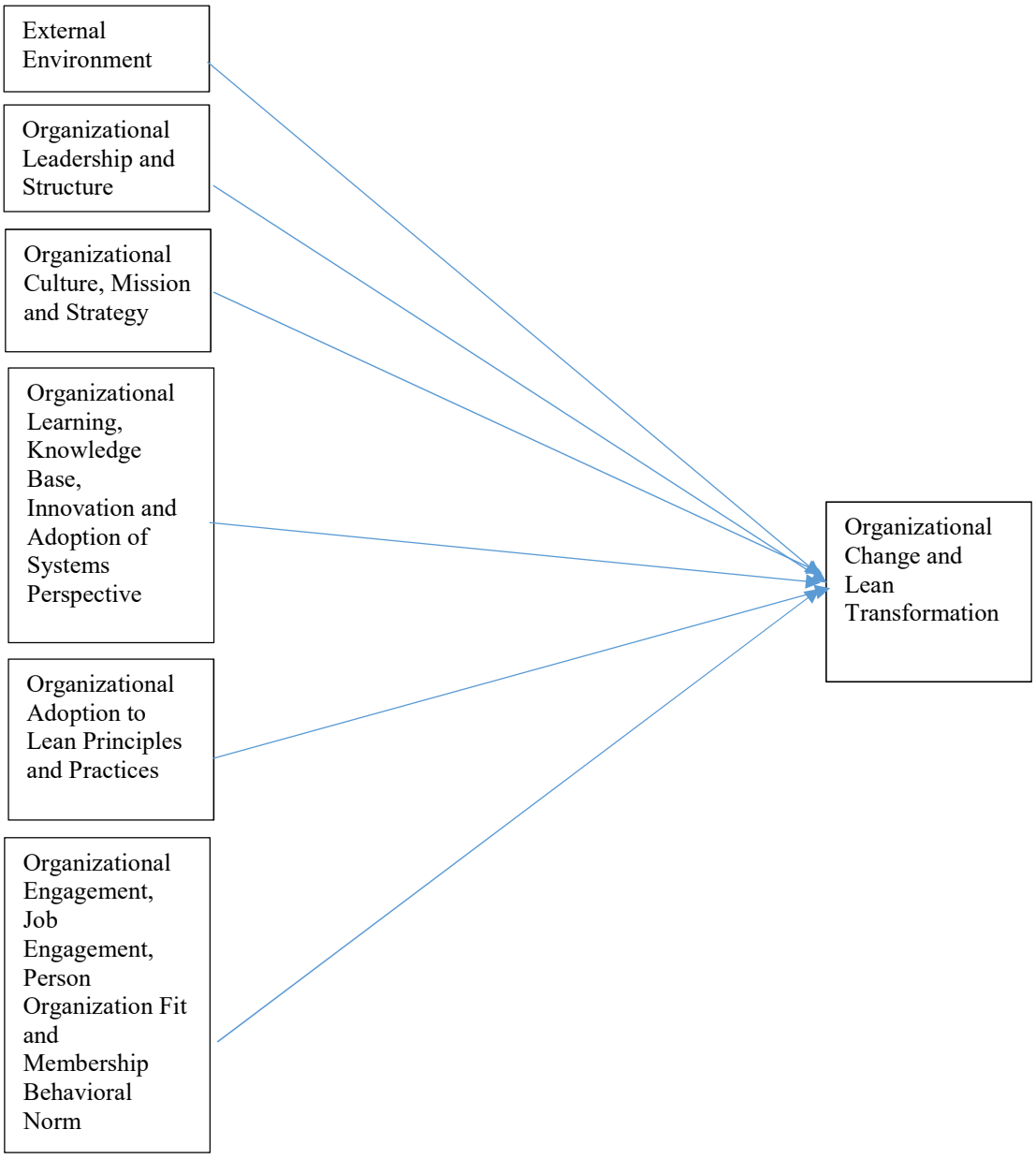

Figure 9. Hypothetical Research Model for Organizational Change and Lean Transformation.

4.4. Data Validation Plan

Measurement validity was evaluated by checking for reliability, convergent validity and discriminant validity and structural validity was tested by hypothesis testing in this research work.

4.4.1. Computer Software

In this research work, Package R i386 4.02, R studio and AMOS 26 were used for data analysis.

CHAPTER 5. RESULTS

This chapter encompasses the results of the data analyses pertinent to this research. More specifically, it contains the results from the exploratory factor analysis (EFA) and results from the confirmatory analysis (CFA). The EFA helped with identifying items with minimum factor loading that would qualify for being part of CFA survey item. A Path Analysis was performed in IBM SPSS AMOS V26 Grad pack and assessed the predictions with the model. Estimates were produced with ML estimation. Current research evaluated the model for convergent, discriminate, and nomological validity and reliability. Finally, this research identified significant latent constructs and the extent of model fit.

5.1. Steps for a Scale Creation and Validation

5.1.1. Item Generation and Evidence of Content Validity

Rigorous theoretical study presented in Chapter 3 was supported by multiple steps including expert consultation, feedback from pilot participants of the survey items in Chapter 4. These steps were taken in the item generation process to ensure content validity. Content validity refers to the degree that the instrument covers the content that it is supposed to measure.

5.1.2. Convergent Validity

First step to convergent validity is to purify the items with EFA, i.e. to eliminates low loading items defined as above 0.32 in Tabachnick and Fidell (2012). Then, conduct Confirmatory factor analysis (CFA), is a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs.

5.1.3. Steps of Structural Validity

a. Path analysis to test hypotheses

   i. Assess the model fit for the calibration (training) sample.

ii. Confirm the model structure with the validation sample.

5.2. Exploratory Factor Analysis (EFA)

EFA dataset of 33 valid response per item appeared somewhat small for Structural Equation Modeling (SEM) purposes. In agreement with Streiner, D. L. (2006) this research has *a priori* hypotheses about which items or variables are grouped together as manifestations of an underlying construct. A decision was made to conduct EFA for each latent construct/factor separately. And this approach produced meaningful findings. Description of theoretical manifestation *of a priori* hypothesis has been described in Chapter three for all latent factors under study in this research. Bootstrapping technique was employed to better asses the accuracy of the estimates.

5.3. Analysis of Preliminary-Item Data

Preliminary-item data included response on all 57 items indicating combined 7 latent constructs. If an item failed to meet the minimum factor loading (i.e. 0.32 or at least 10% overlapping variance), then it was removed from the latent variable. A tabular presentation for each latent factor with corresponding factor loading and commonalities are furnished below (Tables 5 to 11). A bootstrapping procedure was utilized to show the possible range of each estimate. It was observed each latent factor gained percentage of variance explained and offered usability of the data set.

Table 5. Retained External Environment Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
1. Q3	.42	.50 (.00, .78)	.18	.30 (.00, .60)
2. Q4	1	.87 (.41, .1.0)	1.0	.79 (.17 .1.1)
3. Q7	.34	.40 (.00, .65)	.16	.19 (.00, .42)
4.				
5.				
6.				
7.				
8.				
Eigenvalues	1.62	1.65 (1.25, 1.97)		
% of Variance Explained	43.25%	55.09% (41.8, 65.79)		
Coefficient α_{Total}	.58 (.22, .78)			

Note. Values in parentheses are 95% confidence intervals.
Factor loading below 0.3 for point estimate has been excluded

Table 6. Retained Organizational Leadership and Structure Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
9. Q10	.63	.58 (.22, .97)	.40	.37 (.04, .93)
10. Q11	.31	.28 (.00, .65)	.10	.13 (.00 .40)
11. Q12	.50	.48 (.00, .76)	.25	.28 (.00, .59)
12. Q13	.60	**.63 (.00, .92)**	**.35**	.45 (.00, .85)
13. Q14	.60	.61 (.07, .84)	.37	.40 (.01, .70)
14. Q15	.34	.32 (.00, .71)	.12	.15 (.00, .50)
15.				
16.				
17.				
Eigenvalues	2.27	2.35 (1.72, 2.98)		
% of Variance Explained	26.32%	39.09% (28.62, 49.73)		
Coefficient α_{Total}	.56 (.28, .75)			

Note. Values in parentheses are 95% confidence intervals.

Table 7. Retained Organizational Culture, Mission and Strategy Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
18. Q17	.36	.35 (.00, .72)	.13	.18 (.00, .52)
19. Q18	.55	.54 (.09, .82)	.30	.33 (.01 .67)
20. Q19	.52	.52 (.00, .84)	.27	.33 (.00, .70)
21. Q21	.55	**.56 (.13, .79)**	**.30**	.34 (.04, .64)
22. Q22	.45	.45 (.00, .77)	.20	.25 (.00, .60)
23. Q23	.40	.40 (.00, .66)	.16	.19 (.00, .44)
24. Q24	.76	**.71 (.44, .99)**	**.57**	.53 (.19, .97)
25. Q25	.67	.65 (.21, .93)	.44	.45 (.05, .86)
26.				
Eigenvalues	3.03	3.15 (2.23, 3.75)		
% of Variance Explained	29.81%	39.37% (27.81, 46.90)		
Coefficient α_{Total}	.76 (.60, .85)			

Note. Values in parentheses are 95% confidence intervals.

Table 8. Retained Organizational Learning, Knowledge Base, Innovation, and Adoption of Systems Perspective Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
27. Q26	.57	.58 (.00, .80)	.33	.37 (.00, .64)
28. Q28	.36	.34 (.00, .76)	.13	.19 (.00 .56)
29. Q29	.55	.56 (.00, .70)	.30	.33 (.00, .49)
30. Q30	.67	**.63 (.27, .90)**	**.45**	.43 (.09, .82)
31. Q31	.56	.56 (.05, .83)	.32	.35 (.01, .68)
32. Q32	.59	.56 (.24, .83)	.34	.34 (.06, .69)
33. Q33	.48	**.50 (.00, .79)**	**.23**	.30 (.00, .62)
34. Q34	.64	.62 (.00, .84)	.42	.42 (.02, .71)
35.				
Eigenvalues	3.18	3.3 (2.24, 4.2)		
% of Variance Explained	31.51%	41.30% (27.94, 52.58)		
Coefficient α_{Total}	.76 (.58, .87)			

Note. Values in parentheses are 95% confidence intervals.

Table 9. Retained Organizational Adoption to Lean Principles and Practices Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
36. Q38	.59	.65 (.21, .88)	.35	.45 (.04, .77)
37. Q39	.57	.56 (.23, .87)	.32	.34 (.06 .77)
38. Q41	.73	.71 (.33, 1.0)	.53	.53 (.11, 1.0)
39. Q42	.53	**.55 (.00, .81)**	**.28**	.34 (.00, .66)
40.				
41.				
42.				
43.				
44.				
Eigenvalues	2.10	2.17 (1.53, 2.60)		
% of Variance Explained	37.15%	54.28% (38.34, 64.98)		
Coefficient α_{Total}	.64 (.34, .78)			

Note. Values in parentheses are 95% confidence intervals.

Table 10. Retained Organizational Engagement, Job Engagement, Person Organization Fit, and Membership Behavioral Norm Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
45. Q45	.66	.66 (.37, .83)	.44	.45 (.13, .69)
46. Q46	.60	.59 (.31, .82)	.36	.37 (.10 .68)
47. Q47	.62	.63 (.26, .82)	.39	.42 (.07, .67)
48. Q48	.70	**.71 (.41, .90)**	**.50**	.52 (.16, .81)
49. Q49	.63	.63 (.14, .83)	.39	.42 (.02, .69)
50.				
51.				
52.				
53.				
Eigenvalues	2.65	2.69 (2.10, 3.11)		
% of Variance Explained	41.4%	53.82% (41.95, 62.30)		
Coefficient α_{Total}	.75 (.62, .84)			

Note. Values in parentheses are 95% confidence intervals.

Table 11. Retained Organizational Change and Lean Transformation Items After Exploratory Factor Analysis

	Original Factor Loadings		Communalities	
Items	Original	Bootstrap	Original	Bootstrap
54. Q50	.77	.76 (.52, .91)	.60	.59 (.27, .83)
55. Q51	.80	.80 (.58, .94)	.64	.65 (.34 .89)
56. Q52	.62	.61 (.27, .80)	.38	.39 (.07, .65)
57. Q53	.34	.35 (.00, .65)	**.11**	.15 (.00, .42)
58. Q54	.56	.56 (.19, .76)	.31	.33 (.04, .57)
59. Q55	.45	.45 (.17, .64)	.20	.21 (.03, .41)
60. Q56	.48	.48 (.00, .81)	**.23**	.28 (.00, .65)
61. Q57	.67	.68 (.45, .84)	.45	.47 (.20, .71)
62. Q58	.50	.50 (.17, .70)	.25	.26 (.03, .48)
Eigenvalues	3.74	3.85 (2.85, 4.60)		
% of Variance Explained	35.22%	42.83% (31.64, 51.13)		
Coefficient α_{Total}	.81 (.71, .88)			

Note. Values in parentheses are 95% confidence intervals.

5.4. Summary of Retained Items After Exploratory Factor Analysis

A summary of items presented in Table 12 for a list of retained items. Parallel analysis scree plot was produced for each latent factor to discern number of factor present in the analysis. A general guideline of factor loading above 0.32 was used for retaining items with the exception to one item Q11 per Tabachnick and Fidell (2012).

Table 12. Summary Table for Items Retained After EFA

Factor	Retained items	Excluded items	Reason for excluding an item	% of Variance explained	% of Variance explained (Bootstrap)
External Environment *(*ξ1*)*	Q3 Q4 Q7	Q2 Q5 Q6	Factor loading<0.32	43.25%	55.09%
Organizational Leadership and Structure (η_1)	Q10 Q11 Q12 Q13 Q14 Q15	Q8 Q9 Q16	Factor loading<0.32 *Q11 loading was .314 exception due to a priori theory*	26.32%	39.09%
Organizational Culture, Mission and Strategy (η_2)	Q17 Q18 Q19 Q21 Q22 Q23 Q24 Q25	Q20	Factor loading<0.32	29.81%	39.37%
Organizational Learning, Knowledge Base, Innovation, and Adoption of Systems Perspective (η_3)	Q26 Q28 Q29 Q30 Q31 Q32 Q33 Q34	Q27	Factor loading<0.32	31.51%	41.30%
Organizational Adoption to Lean Principles and Practices (η_4)	Q38 Q39 Q41 Q42	Q35 Q36 Q37 Q40 Q43	Factor loading<0.32	37.15%	54.28%
Organizational Engagement, Job Engagement, Person Organization Fit, and Membership Behavioral Norm (η_5)	Q45 Q46 Q47 Q48 Q49	Q44	Factor loading<0.32	41.4%	53.82%
Organizational Change and Lean Transformation (η_6)	Q50 Q51 Q52 Q53 Q54 Q55 Q56 Q57 Q58	None	Factor loading<0.32	35.22%	42.83%

Note. Each EFA utilized an oblique (i.e., Direct Oblimn) rotation.

5.5. Evidence of Convergent and Discriminant Validity and Reliabilities

Measurement model was purified using CFA. CFA, performed on all remaining items for each individual latent construct, preceded testing of the full path analysis (Anderson & Gerbing, 1988). This process produced seven different measurement models with adequate fit. The modification indices did not suggest any subdimensions underlying the construct. The standardized residual covariance matrix indicated that all items behaved in a similar manner (i.e., value less than |1.96|) and all standardized item loadings were higher than 0.5, suggesting convergent validity (Anderson & Gerbing, 1988). In addition, within-construct variance was compared with between-construct variance. In most cases, the average variance extracted (AVE) for each construct was higher than the squared structural link shared by constructs; AVE was also higher than 0.5, suggesting partial evidence of discriminant validity (Fornell & Larcker, 1981). Finally, the reliability of the all constructs was assessed (Table 13).

Table 13. Evidence of Convergent and Discriminant Validity and Reliabilities

		r^2						
Construct	AVE	1.	2.	3.	4.	5.	6.	7.
1. EE	.701	**.681**	.185	.472	.574	.257	.556	.470
2. OLeadership	.526		**.654**	.573	.456	.572	.509	.474
3. OCulture	.528			**.748**	.691	.530	.723	.725
4. OLearning	.567				**.782**	.516	.694	.662
5. OAdoption	.606					**.691**	.635	.555
6. OEngagement	.636						**.770**	.637
7. OChange	.605							**.823**

Note. Statistics are from the Validation sample ($N = 47$). Reliabilities are bolded along the diagonal of the table and are calculated as Coefficient Omega. All pairwise comparisons support evidence for discriminate validity. AVEs were calculated with all factor loadings above .5, which is evidence of convergent validity.

5.6. Hypothetical Research Model

A hypothetical model (Please see Figure 9 in Chapter 4.) was produced in IBM SPSS AMOS V26 Grad pack for organizational change and lean transformation. As per the research

design with retained list of items. Fourteen items were excluded from the original model leaving 43 items for further exploration in the final survey.

5.7. Structural Validity

This research tested the new scale for evidence of Nomological validity in line with Cronbach and Meehl (1955) and Churchill (1999). As Cronbach and Meehl (1955) pointed that the logic of construct validation takes place when investigator believes that his or her instrument reflects a particular construct. Testing for nomological validity in this research ensured that the measurement scale for organizational change and lean transformation is measuring the construct properly.

Based on previous research, each latent variable should be positively correlated with Organizational Change in Yadav (2017). In addition, a theory-grounded link between all latent variables was included in the model as in Yadav (2017). Path analysis (performed using AMOS) showed adequate fit for the structural model (Table 16; Byrne, 2010).

Overall, three of the six constructs correlated in a manner predicted by theory, providing initial evidence for nomological validity (Table 14). Specifically, external environment positively predicted Organizational Change ($\beta = 0.197$, $p < .039$), as did organizational leadership and structure ($\beta = 0.433$, $p < < .001$and XXX ($\beta = 0.261$, $p < .042$).

Table 14. Hypotheses for the Structural Model Establishing Nomological Validity

Hypothesis	Model			
	Calibration Sample		Validation Sample	
	β	*p*-value	β	*p*-value
1. EE → OChange	0.099	.508	0.197	**.039**
2. OLeadership → OChange	0.004	.997	0.433	**< .001**
3. OCulture → OChange	0.427	**.019**	-0.363	**.015**
4. OLearning → OChange	0.204	.245	0.261	**.042**
5. OAdoption → OChange	0.193	.226	0.189	.138
6. OEngagement → OChange	0.006	.997	0.450	.405

Note. An arrow (→) denotes the specified direction of the relationship in the model. Bold indicates *p*-values that are less than .05. Calibration sample had $N = 33$ and Validation sample had $N = 47$.

Table 15. Summary of Hypothesis Tests

Hypothesis	Supported
Hypothesis 1: External Environment can positively predict organizational change and lean transformation	Yes
Hypothesis 2: Organizational leadership and structure can positively predict organizational change and lean transformation	Yes
Hypothesis 3: Organizational culture, mission and strategy can positively predict organizational change and lean transformation	Not supported significance was wrong direction
Hypothesis 4: Organizational learning, knowledgebase, innovation and adoption of systems perspective can positively predict organizational change and lean transformation	Yes
Hypothesis 5: Organizational adoption to lean principles and practices can positively predict organizational change and lean transformation	No
Hypothesis 6: Organizational engagement, job engagement, person organization fit and membership behavioral norm can positively predict organizational change and lean transformation	No

Note: Chapter 6 will elaborate on the outcomes of the hypothesis and potential short comings for mixed results.

5.8. Model Fit Indices

Model fit indices referring to both calibration model and validation model shows good model fit for the proposed mode.

Table 16. Table of Fit Indices for the Initial and Final Structural Models for Both Samples

Model	X^2(df)	CMIN	CFI	RMSEA	MFI	AGFI	SRMR
Calibration	1.111 (1)	1.111	.999	.059	.998	.730	.055
Validation	.138 (1)	0.138	1	.000	1	.976	.014

Note. Models are Path Analysis with Reliabilities. An asterisk (*) denotes a significant (i.e., $p <$ .05) X^2 statistic. CMIN refers to X^2/df.

5.9. Refined Model for Organizational Change and Transformation.

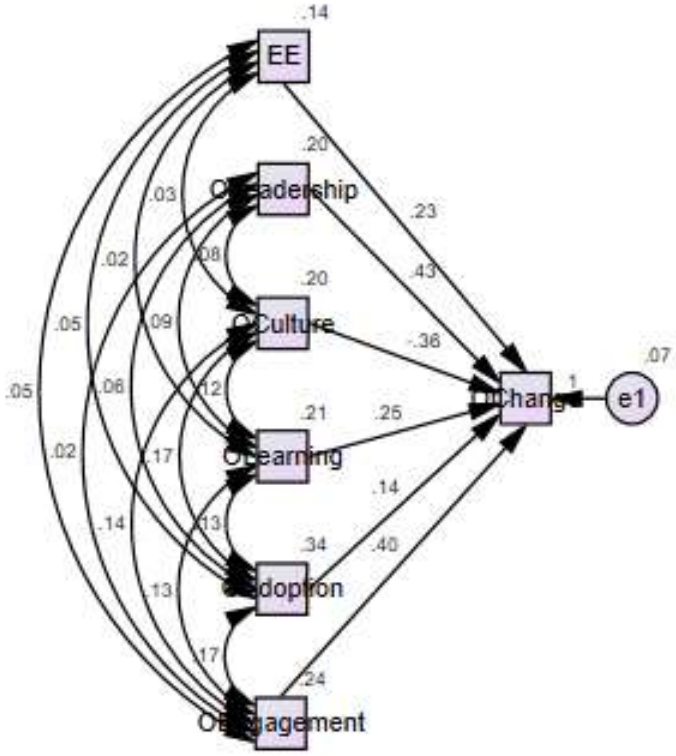

Figure 10. Refined Model for Organizational Change and Lean Transformation.

CHAPTER 6. SUMMARY AND CONCLUSION

This chapter encompasses the results of the data analyses pertinent to this research. More specifically, it contains the results from the exploratory factor analysis (EFA) and results from the CFA and nomological validity.

6.1. Key Findings

The key findings of this dissertation are presented with respect to the four research questions posed in Chapter 1:

1. What are the challenges of organizational lean transformation?
2. What are the organizational constructs from socio-technical system perspective that are relevant to organizational change and lean transformation from socio-technical perspective?
3. What organizational constructs has significant effect on organizational change and lean transformation from socio-technical perspective?
4. To what extent the organizational constructs can predict organizational lean transformation and organizational change?

6.1.1. Key Finding 1

This research provides a better understanding of a system level perspective on lean implementations, thereby identifying the missing links and their root causes. The findings in Chapters 2 and 3 made case that organizational lean transformation needs to be approached from a socio-technical perspective. Organizational change and lean transformation can be achieved through consideration of challenges at all levels of socio-technical systems involving all subsystems of the socio-technical system. Socio-technical factors in organizational context must

be viewed in an organizational development perspective as opposed to sole focus on localized efficiency improvement project. Effectiveness and efficiency both must be optimized.

6.1.2. Key Finding 2

Based on the systematic evaluation of existing work in organizational change, organizational development, lean transformation, socio-technical system and open system theory a set of factors were identified that are relevant to organizational change and lean transformation. A detailed mapping of these factors is discussed in Chapter 3 of this research. Table 12 in Chapter 5 documented list of factors and their corresponding item lists that were found to be relevant.

6.1.3. Key Finding 3

Based on the nomological validity assessment, Table 13 shows the significant factors that can predict organizational change and lean transformation. These factors are

1. External environment can positively predict organizational change and lean transformation.
2. Organizational leadership and structure can positively predict organizational change and lean transformation.
3. Organizational learning, knowledgebase, innovation and adoption of systems perspective positively predict organizational change and lean transformation.
4. Organizational culture, mission and strategy has significant impact on organizational change and lean transformation.

6.1.4. Key Finding 4

Table 15 in Chapter 5 documented the fit indices of the hypothetical model and the final structural model.

6.2. Overall Conclusions

6.2.1. Organizational Change and Lean Transformation is a Predictable Process

It is possible to overcome the challenges of organizational change and lean transformation by focusing on socio-technical factors from organizational context. Seeking joint optimization is a function of organizational design intervention. This intervention is better executed if individual and synergistic efforts are focused on the significant factors. It can be achieved by staying vigilant on variability in customer demand and variability in incoming resources such as financial resources, raw material, labor and other resources. System must be resilient and responsive to address these variabilities experienced by the organization.

Organizational leadership and structure can play a key role in organizational change and transformation. Organization must stay focused on values based leadership by respecting technical leadership and functional expertise on product and processes of people within the organization. Leadership must understand the motivation of people to be able to motivation of people to be able to build and develop a learning organization. Leadership also must stay focused on cultivating leadership by instilling organizational core values and maintaining constancy of organizational lean culture and philosophy. This research also found the significance of organizational structure that should be supportive of organizational change and lean transformation in line Liker, J. K. (2004).

Finally, this research validated the significance of staying focused on organizational learning, knowledgebase, innovation and adoption of systems perspective. This focus can be achieved by ensuring leadership being engaged in the organizational learning process, promoting appropriate culture of knowledge sharing, socialization for distribution of knowledge that is based on scientific principles and facts. Organization must also focus on a standardized approach

on promoting best practices, promote direct observation of problem solving and require a deliberate thorough attempt to investigate all possible options before change however push for change as quickly as possible once the new way is found. Also, standardize the new way until the next better way is discovered. Organization must also prioritize highest level of customer service as part of their strategy and mobilize resources to achieve the strategic goal. Organization should also seek expert knowledge and innovation to improve product, processes and systems in a coherent way. This research work failed to find the significance of adoption of lean principles and practices in this research. As this factor did not meet the *p* value threshold for significance in this research. It could be due to small sample size or lack of attention of this construct in the industry. This research did not find the significant effect of organizational engagement, job engagement, person organization fit and membership behavioral norm. It could be that the item selection process failed to capture appropriate items for this construct. Finally, organizational culture, mission and strategy also did not meet the significance threshold. It could be also due to item selection process or sample size limitations. All these finding validated prior findings that lean implementation is a transformational process, therefore, requiring organizational level support and changes (Pearce & Pons, 2013). The transformation process is better served if it is approached with a socio-technical perspective.

6.2.2. Implications of Top Leadership Support on Organizational Change

The outcome of this research showed that organizational leadership and structure play a significant role in organizational change and lean transformation. The other factor that showed significance is the organizational learning, knowledgebase, innovation and adoption of systems perspective. Both factors require significant sponsorship from senior leadership per Senge (1990) and Liker, J. K. (2004).

6.3. Contributions of Research

This dissertation makes several contributions to the field of organizational change, organizational development, lean transformation and socio-technical system theory.

- Provide a meaningful framework for organizational development and organizational intervention to support organizational change and lean transformation from socio-technical perspective for future researchers, academics and practitioners.
- Developed an instrument for measuring organizational change and lean transformation from socio-technical perspective that can be used making comparative assessment between organizations or category of organization based on SIC code.
- Bring attention in the gap/challenges to lean implementation in organizational context.

This research provided a set of priorities for organizational change and lean transformation particularly the importance of organizational leadership and structure as well as the importance of organizational learning, knowledgebase, innovation and adoption of systems perspective. It laid the importance of environmental scanning given the predictability of external environment on organizational change and lean transformation. More importantly this research has developed a model for organizational change and lean transformation that can predict organizational change and lean transformation. Practitioners in organizational change and lean transformation as well as researchers and academics will benefit from this work in terms of using the findings as a practical guideline.

6.4. Limitations of the Study

The target participant group in this research were in a senior role in organizational context making them less accessible and required longer waiting period for responses for both the EFA sample and the CFA sample. Thereby the sample size ended up being somewhat small.

Path analysis is a form of structural equation modelling (SEM) and SEM requires a large data set. This research produced meaningful contribution with small data set aided by bootstrapping technique. First, one limitation of this study remains that smaller sample size for EFA may have missed some significant factor in this research. With larger data set a Full Information Likelihood (FIML) model could have been produced to gain item specific insights.

Second, this study was conducted across various types of organizational domains for larger participation from the industry. Besides manufacturing, there are some participants in this research that participated from financial service and public/state and federal agencies type organizations. These organization generally lacks prevalence of lean perspective. Thus, there is a potential for improvement in this work by ensuring participants from organizations with higher level of prevalence of lean perspectives.

Third, this research could not capture the negative contribution of organizational culture, mission and strategy on organizational change and lean transformation. This research attributes this short coming to limited sample size and presence of some potential confounding effect in item selection process.

6.5. Suggestions for Future Research

This research provided a stepping stone in the direction of studying organizational change and lean transformation from a socio-technical perspective. Future researchers can

- Test the organizational change and lean transformation from socio-technical perspective framework presented here in specific organizational set up and validate with organizational intervention in longitudinal study for some duration of time.
- Study each latent factor separately to identify granular perspective from each item in organizational context and conduct a FIML Model.

- Test the organizational change and lean transformation from socio-technical perspective framework presented here with longitudinal study in different organizations and learn differences between various organizational domains.
- Some research participants in this research expressed that the instrument used in this research can be used as an assessment tool for organizational effectiveness or conduct gap analysis between organizations of similar nature in terms of common domain.

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APPENDIX A. SUPPLEMENTAL FIGURES

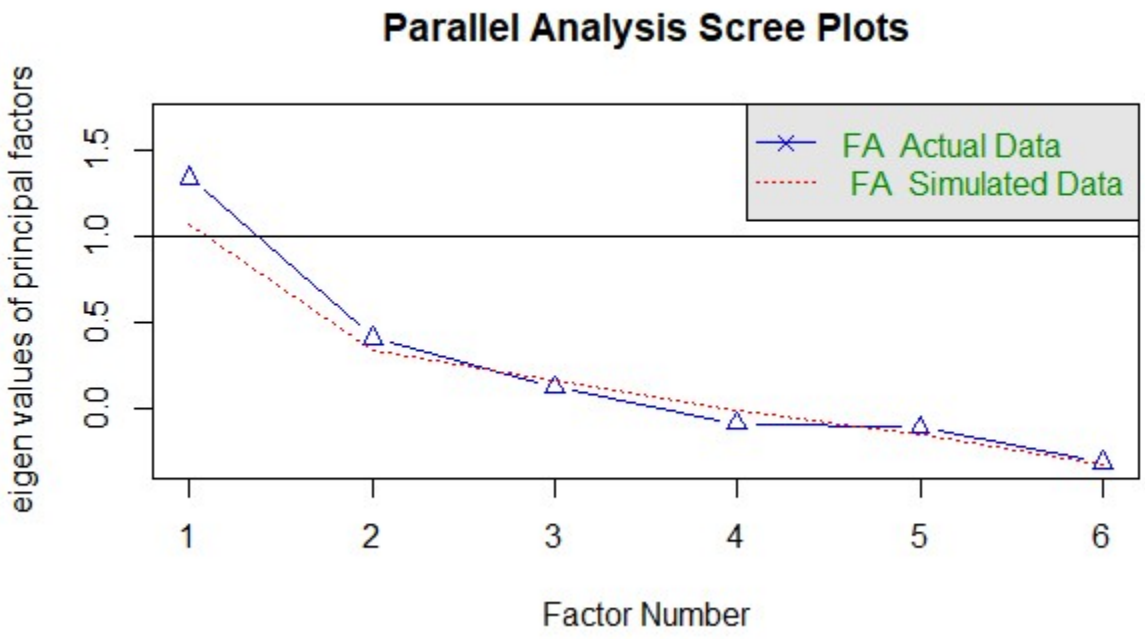

Figure A1. Unidimensionality of External Environment.

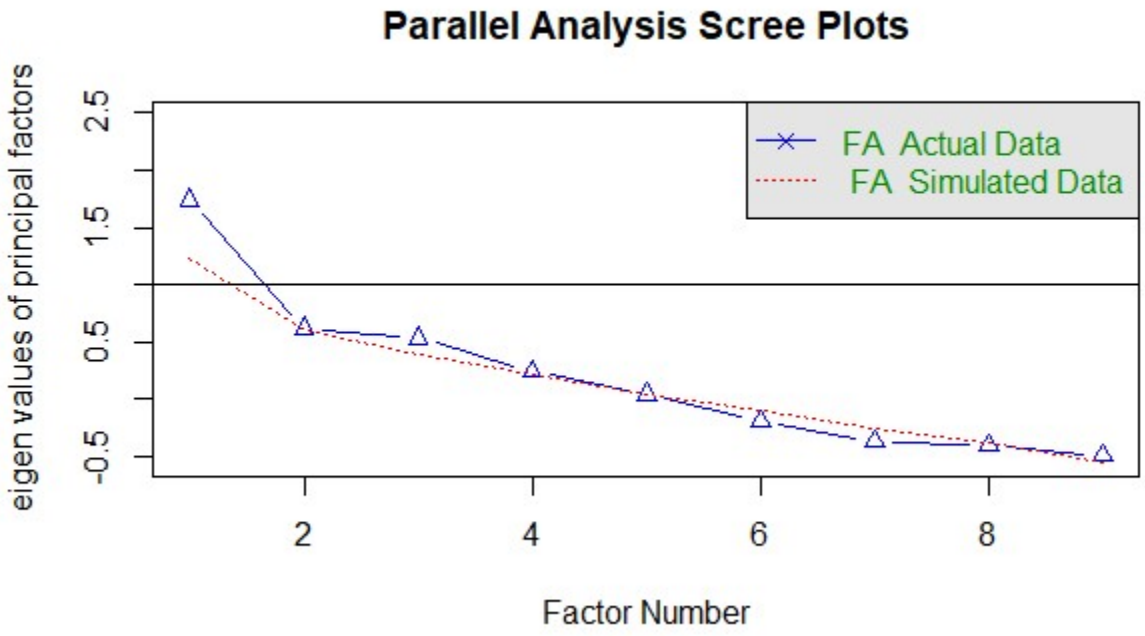

Figure A2. Unidimensionality of Organizational Leadership and Structure.

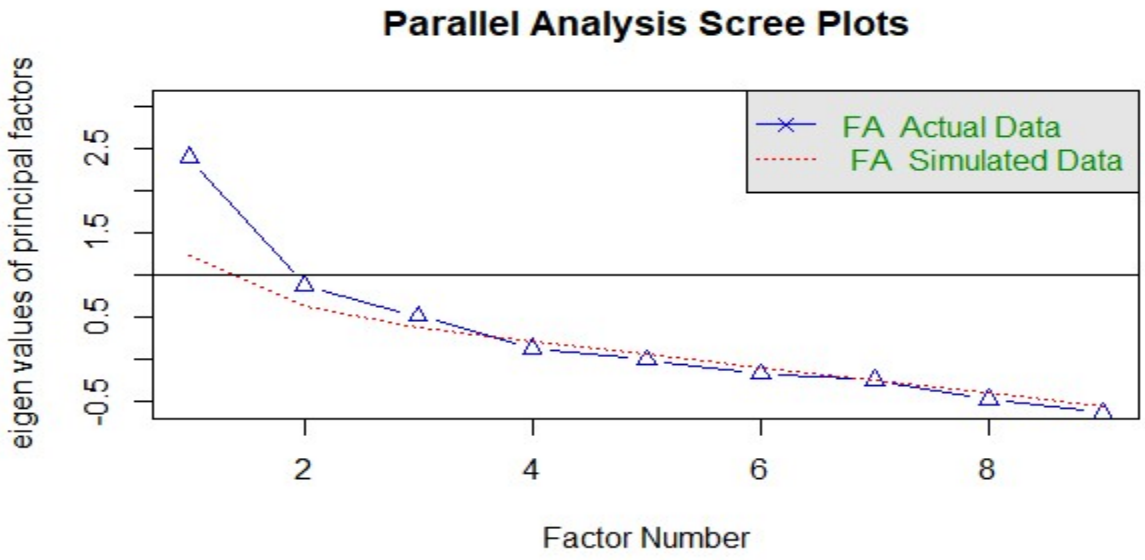

Figure A3. Unidimensionality of Organizational Culture, Mission, and Strategy.

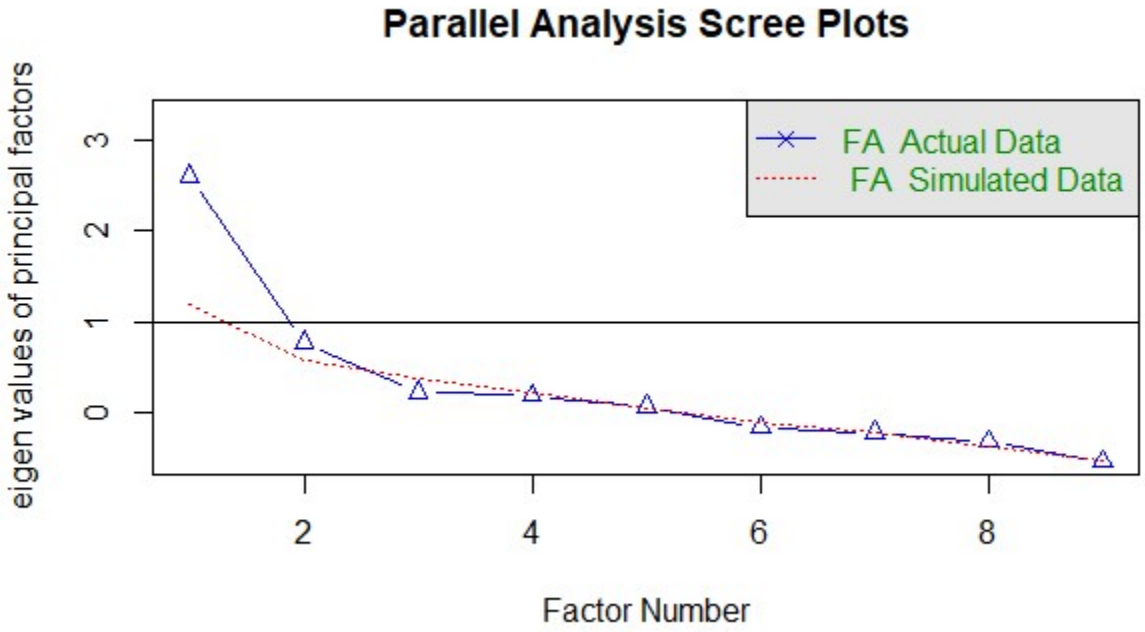

Figure A4. Unidimensionality of Organizational Learning, Knowledge Base, Innovation, and Adoption of Systems Perspective.

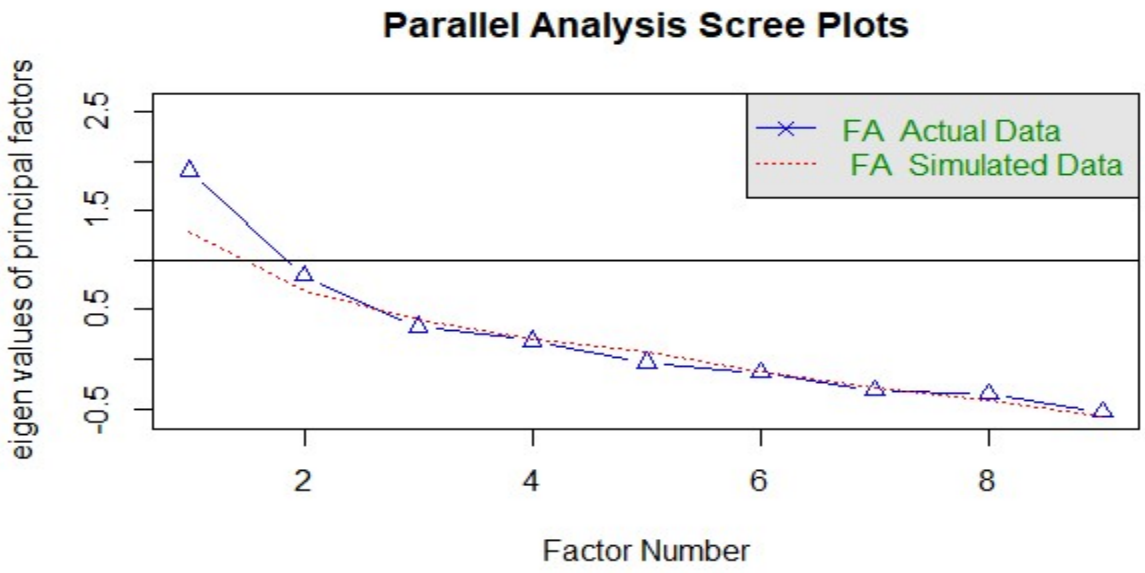

Figure A5. Unidimensionality of Organizational Adoption of Lean Principles and Practices.

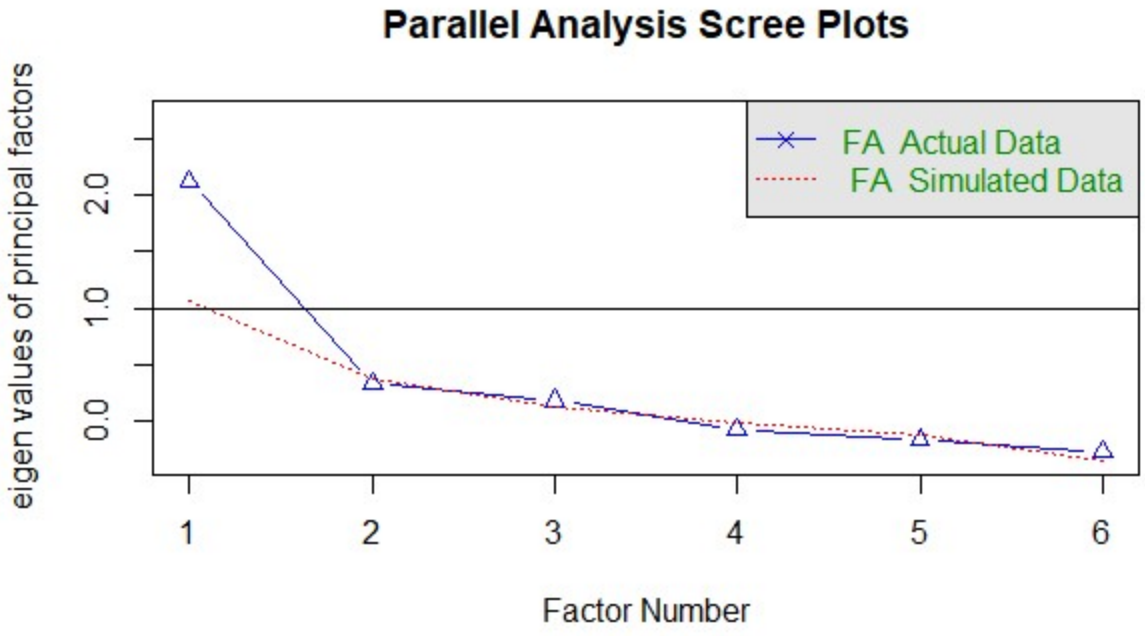

Figure A6. Unidimensionality of Organizational Engagement, Job Engagement, Person Organization Fit, and Membership Behavioral Norm.

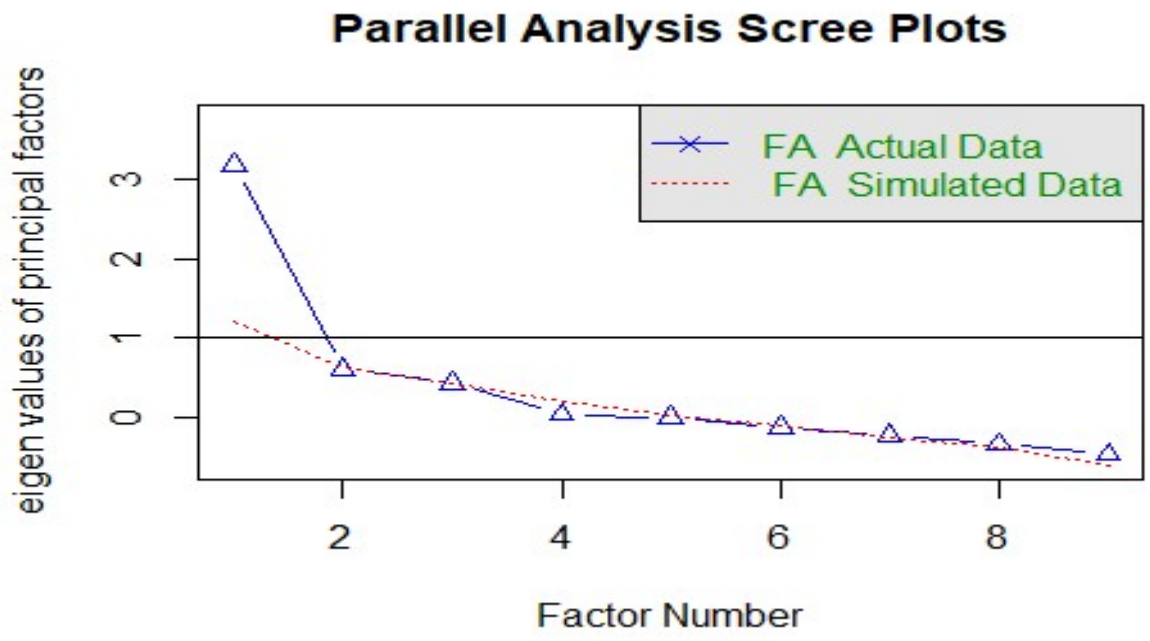

Figure A7. Unidimensionality of Organizational Change and Lean Transformation.

APPENDIX B. SURVEY QUESTIONNAIRE

Questionnaire:

1. Note: Q1 was simply an opening statement to participants, did not include any survey questions.
2. Organizations must have systems for understanding and tracking changes in customer demand to be able to respond to the market condition.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

3. Economic and environmental conditions can have an impact on market demand requiring adjustments by the organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

4. Market demands can be influenced by natural catastrophes or technological breakthrough that might influence consumer behavior requiring organizational change.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

5. The Organization's direction can change depending on the availability of cash.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

6. The availability of required skilled workers can influence decisions of organization with respect to how and where it does business.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

7. The organization's strategy may change if raw materials becomes constrained or governmental regulations change.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

8. Organizational leadership should display moral behavior and personal commitment to earn respect in followers to drive the organization's lean vision into action.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

9. Organization leadership must make principled decision with integrity regardless of short term temptation to create value for customers or shareholders.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

10. Respect for technical leadership, in a lean organization, is earned through disciplined long self-development that is built on knowledge of functional expertise on products and processes.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

11. Organizational leadership must understand the motivation of people to be able to build and develop a learning organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

12. It is important to promote leaders from within the organization to build a strong lean culture.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

13. Leadership development is a means to maintain consistency of organizational purpose.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

14. The organizational structure should favor distributed leadership with smaller span of control over a leadership structure based on cost models.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

15. The organization must balance the need for deep technical specialization with general lean operational knowledge based on the complexity of its products, processes and services.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

16. Low centralization built on organizational learning reflects empowerment and trust in the ability of the associates in a lean organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

17. The leadership of the lean organization must build a culture that promotes “built in quality” as a core principle for sustainable business success.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

18. Striving for perfection should emanate from every day activity of all associates in lean organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

19. The organization must adopt a "set of values" that associates can identify with to get engaged with organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

20. Associates must be empowered to handle job related problems including the authority to stop production when a nonstandard event takes place such as a defect or machine malfunction.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

21. A high degree of coaching and mentoring is necessary to ensure associates understand their work roles to be successful in organizational lean transformation.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

22. The organization must allow associates to come up with new practical ideas to drive improvement and create new standard for work in a lean organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

23. Organizational strategic plan must be in line with long term mission and understood by all associates to be able to relate/ align with overall direction for timely execution.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

24. Operational excellence practices consistent with lean principles can be used as a vehicle for achieving milestones by strategic leadership in lean organizations.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

25. Organizational mission and strategy must not only focus on cost reduction in value stream but also on top line growth as part of organizational change.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

26. In lean organizations, leadership must be personally engaged in promoting organizational learning by using scientific principles.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

27. A lean organization must build systems to encourage professional development of employees including the importance of teamwork to achieve the right culture.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

28. Lean organizations use socialization to promote knowledge sharing between various roles of employees.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

29. A lean organization must have a standardized approach such as a set of best practice tools that best suits solving problems.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

30. Problem solving must be based on a scientific approach using facts from direct observation of the problem with a quest to ask "why" for identifying root causes.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

31. A deliberately thorough attempt must be made always to investigate all possible options of problems and solutions without short cuts risking reoccurrences of the problem.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

32. Striving for highest level of customer satisfaction using feedback to mobilize resources is the best strategy for organizational development.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

33. It is in the best interest of the organization to be the best in what they do by learning from the best and to create knowledgebase to be used for reference and planning.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

34. The organization must rely on knowledgebase to drive innovation in creating product, processes and systems in a coherent way for organizational change.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

35. A long-term purpose based on the creation of value for all stakeholders is required to articulate a sense of overall direction.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

36. The organization must continuously improve and evolve as to how products or services are created up and down the entire value stream.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

37. The organization should eliminate waste throughout the system by developing exceptional people built on reflections from past organizational learning and standardized work.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

38. Everyday work practices should be built around developing capability of delivering products or services with quality exactly as the customer requires.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

39. The organization should have step by step standard work guidelines for every job in terms of quantity and sequence based on a continuous flow or customer pull.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

40. The organizational human resources practices must ensure respect for people even in economic down turn by properly utilizing them as valuable resources instead of easy head count reduction practices.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

41. The organization must establish day to day practices to reduce/ absorb variability in demands keeping all forms of inventories at desired level without adding undue burden on cash flow.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

42. People in the organization must use feedback mechanism to detect variances against the target standard and solve the problems immediately at the source of the variation.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

43. The organization must empower its people at all levels to do the right thing including shut down production regardless of short term consequences.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

44. Offering long term job outlook and the ability to actively participate in improving one's job is a way to engage employees for organizational lean transformation.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

45. To motivate and engage large numbers of people to work together toward a common goal is one of a lean organization's top priority.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

46. The organization must establish standardized behavioral routines by mentoring and coaching to engage the minds of people to support and contribute their ideas to the organizational change.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

47. The organization must establish role clarity and recruit with the goal to drive engagement and improvement.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

48. The organization must recruit the best fit for the job and challenge them to grow in the job by constantly allowing them to solve problems.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

49. The organization’s daily life must promote policies that are designed to gain employee satisfaction by continuously improve their performance.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

50. A flexible organizational structure using standardized rules of engagement among its members is indicative of a lean organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

51. The organization's human resources policy should be designed to promote a multi-skilled work force to maximize flexibility in meeting changing demands for a required expertise.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

52. A team of multi-skilled workers led by capable team leader relying on standardized work and organizational learning is the basis for level of autonomy in lean organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

53. Lean transformation strategies must include plans to mitigate any outcomes that may seem threatening to the organizational members.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

54. The context of organizational change such as trust in management will help the manifestation of organizational lean transformation.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

55. The change process must be clear in terms of situation, actions, outcomes and ownerships for successful organizational lean transformation.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

56. Built-in quality resulting low variance in warranty related cost drives higher level of customer satisfaction will drive market growth.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

57. Short lead time to market and high turns in inventory for better cash flow are drivers of organizational performance of a lean organization.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

58. Organizational performance of a lean organization is visible in high gross margin and high return on capital invested.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree