Empirical Research to Integrate National Culture in the Design of Lean Systems

A Dissertation Presented for the

Doctor of Philosophy

Degree

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Dedication

To God for his will to allow me to live and become who I am. To all the great people that has been a positive influence in my life, allowing me to reach this precise moment (you know who you are!). To my parents for their unconditional love and support through this journey called life. To my wife Samanta, who decided to share the road with me, through thick and thin... I will always love you! To my brother Hugo and his wife Daniela, for being there for me always. And to my son Leo, you brought a new spark into our lives, you and your future siblings represent the meaning of transcendence for your mom and I.

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Abstract

The focal point of this dissertation is to find the relevance that cultural difference at a societal level exercise on the design of lean systems as a strategic management practice, from the perspective of production operations involving the shop floor, support activities and management. A conceptual model derived from a thorough literature review provides the theoretical framework of the factors considered to affect the design of the lean practice, considering only human attributes such as individual competence and national culture.

The analysis of culture as a determinant factor for the success and sustainability of lean systems has been a topic of recent interest; however, most of the focus has been placed on the organizational rather than the societal environment. As a Japanese Management System, the Lean Management Practice requires a contextualization process when implemented outside of the environment natural to the Japanese culture. An analysis of the relevance of factors is compared through a case study within two different societal contexts, considering the control variable the implementation of lean systems within an organization that has worked or implanted the Lean Management Practice. . A total of 152 subject responses were collected from this organization in two different facilities within the Americas: United States, and Mexico.

The selected method for data collection is a questionnaire based on the proposed conceptual model factors. The useful sample responses for analysis consisted of 97 cases. The method of analysis is Partial Least Squares Structural Equation Modeling. The constructs were designed using three different methods, all with a starting point in Literature Review.

The model was tested at a measurement and structural level for their reliability, convergent validity and discriminant validity and predictability, as corresponded to the type of model, based on established criterion. Mediation analysis was conducted to test whether cultural dimensions influence the relationship (path linkages) between the factors. Multi-Group Analysis (MGA) was conducted to test whether there is a difference in influence of cultural dimensions between the nationalities in the study. Results demonstrated that there are significant differences of national culture among the locations sampled for validation, though mediation effects were not significant.

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Chapter 1: Introduction

1.1 Background and Motivation

The purpose of this research aims to analyze the influence of national culture on Lean systems as a strategic management practice, supporting its integration in the design and implementation of the operational system. The motivation for this project is a desire to understand the influencing factors and the achievements of successful Lean systems when replicated in a context outside of Japan, where the practice was conceived. In particular, the emphasis is in understanding the individual and cultural characteristics from the people where the adoption occurs and how these have relevance for designing an appropriate strategy of implementation, contributing to sustainable improvements.

1.1.1 Realities of Lean

Nowadays is common to find organizations that establish Lean as their operational and administrative strategy, seduced by the empirical evidence of the competitive advantages offered at a relatively insignificant cost of investment. Classic literature in the field such as (Lindberg, Voss, & Blackmon, 1998); Ohno (1988), Liker (2004) and Monden (2011) detail the superb operation and the remarkable achievements of Toyota organization-wide thanks to this practice, originally known as the Toyota Production System or TPS (for the purpose of this study, both are considered to be equivalent). Womack, Jones, and Roos (1991) compiled their benchmarking study around the world, highlighting the positive impact this management practice had in the automotive industry in general, illustrating the superiority of Toyota's operations. In the aerospace industry, Bozdogan (2010) reported that Lean, as an Enterprise System, was the best management practice to provide a holistic view of the organization, enhancing value from the supplier networks all the way through the customers. Holweg (2007) documented the story behind the dissemination of Lean, placing emphasis on the competitive advantage that Japanese manufacturing had over the western one; a gap that could be reduced, as he suggested, by implementing this management practice.

Despite the advantages presented, the implementation in diverse contexts has not always been successful. In particular, Ransom (2008) has reported Lean implementation efforts to fail 95 percent of the time, as any favorable results achieved in a short term tend to dissipate over the years. A brief review by Taleghani (2010) confirms that studies have found successful companies implementing lean in 10 percent of the cases or less.

Failure factors range from attitudinal perspectives to technical approaches. From a managerial point of view, the focus in short term gains, the constant batch reduction pressure (uncovering unreliable processes), and continuous changes, lead to a loss of motivation (Sawhney & Macias de Anda, 2017) in the people involved with the practice implementation. In addition, most managers desist when some "counter-intuitive truths" emerge such as: idling a machine and workers, accumulating inventory to level-out the production schedule, substituting overhead for direct labor, and using manual processes over IT and automation (Liker, 2004). Both perspectives suggest that the interpretation of these effects are highly influenced by the perceptions and the consequent attitudes of the people involved in the system towards the Lean efforts.

1.1.2 The Role of Culture in Lean

Lean is widely selected as a management practice as it offers a measurable set of principles with associated tools (Pakdil & Leonard, 2014), which should agree not only with the goals of the organization (Cottyn, Van Landeghem, Stockman, & Derammelaere, 2011), but also with the societal traditions and norms of the people. Success in sustaining Lean is determined to a large extent by the *"hybridization"* (Liker, Fruin, & Adler, 1999) with the context of where it is being implemented.

A hybrid implementation of Lean may require different approaches according to the context. Lean was created in Japan (Holweg, 2007). However, the relevance or influence of the Japanese societal culture has encountered conflicting or inconclusive opinions for transplantations or replication in different contexts. People have beliefs, values and motivations (paradigms) influenced by their social environment, customs and traditions. Inherently, those elements become part of their work and may have an effect in their understanding, acceptance and practice of Lean (!!! INVALID CITATION !!!).

Culture represents the "shared motives, values, beliefs, identities, and interpretations or meanings of significant events that result from common experiences of members of collectives that are transmitted

across generations." When the previous definition is applied to the context of geopolitical boundaries, it is considered as a *national* or *societal* culture, where the commonalities reside in "language, ideological belief systems, ethnic heritage, and history." (House & Global Leadership and Organizational Behavior Effectiveness Research Program, 2004)

A debate without resolution in operations management is the convergence (values are mostly standard across contexts) versus divergence (values differ among diverse contexts) theories of organiational practices (Al Ariss & Sidani, 2016; Kwon, Farndale, & Park, 2016), which suggests that purely universal practices do not exist. A possible explanation is that variations of culture at the societal level may moderate the outcomes of these practices (Robert, Probst, Martocchio, Drasgow, & Lawler, 2000).

In the field of Lean, the literature does not reflect sufficient depth regarding the cultural challenges encountered in the implementation of the practice within different contexts (Kattman, 2012; Muniz Jr, Batista, Batista Jr, & Loureiro, 2013; Sanches Frutuoso Silva, 2013; Wagner, 2011). Moreover, literature provides diverse perspectives and definitions of the Toyota culture (Bhasin, 2015; Liker & Hoseus, 2010; Marksberry, 2011), where most address it at an organizational level, missing the discussion of the influence that the Japanese one had in its development (Kull, Yan, Liu, & Wacker, 2014; Wiengarten, Gimenez, Fynes, & Ferdows, 2015).

The handful of researchers in Lean that have considered societal culture, only mention its philosophical importance, but still fail to explain the factors that address the challenges for implementation, operation and sustainability. John Krafcik (1988), who coined the name of "Lean Production", highlighted the importance of culture and parentage of the facility over the technological capacity or geographical location for facility performance, not providing any further details. Kristjuhan (2010) and B. Rathinam (2010) proposed that it is necessary to understand localized artifacts by emulating behaviors that reflect the attitudes natural to the Japanese culture of work and management to guarantee sustainable continuous improvement, without a clear description of such attitudes. Liker and Hoseus (2008) approached the problem from two perspectives: Toyota's culture is "unique to Toyota" but also "a reflection of Japanese culture", leaving a proposition that each company should develop its own culture aligned with its own contextual characteristics.

Considering that societies indeed differ, there is a clear opportunity to fill the gap of establishing how the cultural differences that exist between the people in different regions affect the implementation of this practice. Perhaps, culture might influence the perceptions that employees and management have about the different activities that comprise the framework of Lean (Bäckström & Ingelsson, 2015; Bouville & Alis, 2014; Frahm, 2016; Jayamaha, Wagner, Grigg, Campbell-Allen, & Harvie, 2014; Kull et al., 2014;

Mazzoleni, 2014; Pakdil & Leonard, 2014; Sawhney & Macias de Anda, 2017; van der Merwe, Pieterse, & Lourens, 2014; Wiengarten et al., 2015).

An important implication is that, regardless of the context, its sustainability of Lean depends on an understanding beyond the tools as a daily routine driven by, and a reflection of, the behavior of the group, hence, the culture. Practitioners need to find the balance between a customized and a standardized implementation, for what is needed to understand national culture dimensions (Abrahamsson & Isaksson, 2012). Failure to understand and appreciate the culture, particularly in a societal level (country and region), might lead to unsustainable Lean practices (Wincel & Kull, 2013).

Therefore, the conceptual hypothesis is that the success and sustainability of the practice has a strong influence of national culture, especially in the cases where its operation is not organic or natural with the context. Examples of such cases are subsidiaries outside of Japan or a non-Japanese organization (Liker & Meier, 2013). The suggested starting point in any Lean implementation is the understanding of the Toyota culture, in order to explain the ties between the influence of work culture and national culture (Ahmad, 2013).

1.1.3 Research Opportunities

The relationship between Lean management practices and culture in the selected literature (detailed in section 2.3) proposes several opportunities. Two clear propositions provide ground for discussion, following the debate of convergence vs. divergence (introduced in the previous section). One is the influence of culture at the national level (divergence) on the management practice. The second is no distinction or influence of culture between the organization and the external environment (convergence) actually exists. The current evidence provides mixed conclusions, opening the door for further analysis and a conciliatory theory.

Divergent propositions - Some studies favor that the environment and policies existing in a geographical area may have a significant effect on the success of implementation and operation for Lean management practices by either being conducive or detractive. For example, an implementation in Germany was favored by the heavily regulated environment, facilitating the success of Lean at a multinational organization (Friel, 2005); on another end, some implementations in China failed because the practice was not combined with local culture, and just tried to imitate Japanese practices (Lixia & Bo, 2010).

Convergent propositions - Some other studies have drawn conclusions that national culture is irrelevant and independent to the success of Lean. For example, a study in 23 countries determined that the culture of the organization was predominantly important, but national culture had no effect (Netland, Mediavilla, & Errasti, 2013). A similar study with a Japanese multinational found no significant differences between the headquarters in Japan and its subsidiaries in UK (Miroshnik & Basu, 2014).

A cohesive proposition - A third group identifies that culture exercises influence, but just some of the constructs (factors) among current developed theories of national culture would be relevant for analysis, having other with no relation with Lean management practices. For example, Wong (2007) used Confucian dimensions to assess adaptive features of Lean only from the perspective of short versus long term orientation. Wincel and Kull (2013) used the Global Leadership & Organizational Behavior Effectiveness (GLOBE) study for societal culture, where they found that only four of the nine cultural constructs proposed influence Lean. Yokozawa and Steenhuis (2013) identified factors beyond cultural theory constructs such as employees' eagerness to Lean and discipline at work.

On a different perspective, from a sociological standpoint, defining the characteristics of culture is a complex task. Development and classification of common factors that define the differences among groups is particularly challenging. Cultures are nested at multiple levels: national, industry, organizational, professional and work (Liker et al., 2008; Sasaki & Yoshikawa, 2014; Taras, Rowney, & Steel, 2009; Wagner, 2011). Constructs should reflect a single level of analysis, hence the challenge on creating reliable measures that reflect the influence in Lean management practices.

The following is a summary of the research opportunities and challenges identified in the literature:

- Confirmation of influence of national culture versus organizational culture (Naor, Linderman, & Schroeder, 2010) and it's interaction (Wincel & Kull, 2013).
- Identification of factors of influence outside of Japan with focus in emerging countries (Glaser-Segura, Peinado, & Graeml, 2011; Wallace, 2004)
- Use of constructs (scales) beyond Hofstede's six-dimensional framework (Netland et al., 2013), including factors not developed before (Yokozawa & Steenhuis, 2013) to investigate their relationship to the specific practices of lean (Pakdil & Leonard, 2017).
- Longitudinal studies (Netland, 2016; Netland et al., 2013).
- Configuration of a taxonomy of problems identified for internationalization of lean (Bortolotti & Boscari, 2016) and other contingencies (Netland, 2016) such as the institutional context (Friel, 2005).

- Development of a readiness model (AL - Najem, Dhakal, Labib, & Bennett, 2013) and systematic implementation of Lean practices (Lixia & Bo, 2010) with cultural emphasis.
- Adapt training practices in Lean based on culture (Love, 1997).

1.2 Problem Statement

This research investigates Lean from the perspective of the dichotomy "universality-locality" of the practice, placing people at the center of sustainable management practices. As proposed in Section 1.1, Lean practices fail to sustain, where among all possible explanations, it is due to the lack of implementation knowledge, which hypothetically includes the lack of understanding of the practices and integration of national culture as the context (Figure 1). In essence, to address this opportunity, the specific objectives of this research are:

- Definition and evaluation of the influence of national culture on Lean via the personal requirements for success.
- Determination of the differences between cultures for the development of a strategy to approach the practice-culture fit.

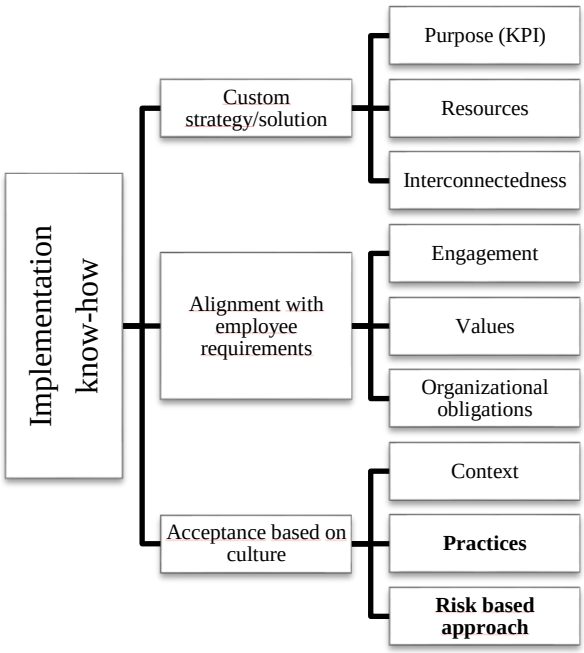


Figure 1 Elements for implementation know-how

The practicality intent of these objectives is providing practitioners and academicians with a better understanding of the role of culture in the sustainability of Lean, when it is the chosen management practice during strategic management planning.

Concluding from the opportunities in the previous section (1.1.3), the suggested logic for this research follows a sequential set of actions to be addressed, as illustrated in Figure 2 .

Conceptual Lean model - Determination of a consensual definition of Lean (Shah & Ward, 2007) that considers a homogeneous model for a standard interpretation regardless of contextual factors such as geographical location or size of an organization. This model should be aligned with three specific principles (Sawhney & Macias de Anda, 2014): reduction of lead time, reduction of variation and improvement of the quality of life of the people involved in the system implementation.

Methodological approach - Sequential requirements for successful implementation, as there are both hard (technical) practices and soft (human) interactions that have to be developed in order to achieve a sustainable evolution of the system (Bhamu & Singh Sangwan, 2014; Čiarnienė & Vienažindienė, 2014).

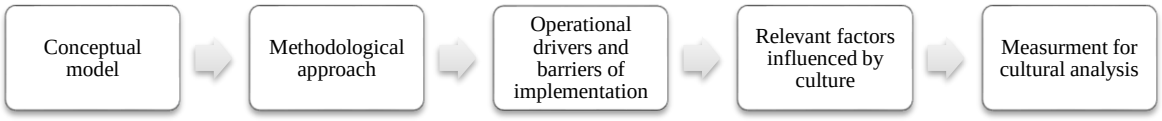


Figure 2: Opportunities identified for research

Operational drivers and barriers of implementation - The challenge is to identify what are the most relevant items that are affected in the operation of lean systems when a new implementation is deployed in regards to the well-being of the organization (Marodin & Saurin, 2015a).

Relevant factors influenced by culture - As addressed from the perspective of continuous flow (one of the main goals of lean) and organizational requirements, not all concepts and practices in Lean would be affected by culture at a societal level (Frahm, 2016). Part of the academic challenge is to develop good scales to assess cultural aspects that consider meaningful factors.

Definition of cultural analysis - The last opportunity is to understand and appropriately address the measurement of culture. Values and culture are inherently soft characteristics of the organization, but a genuine appreciation of them is mandatory for a successful implementation of Lean (Womack & Jones, 2003), hence the importance of the definition of an adequate framework and tool for analysis. The instruments available to measure culture are distinct and comprehensive. Their validity is still questioned by the interpretation of their results. Utilizing a proper instrument could expand not only in the understanding of this particular strategy but in any other area for improvement as a valuable tool to test methods adopted from different contexts.

1.3 Limitations

The limitations in this study are a derivation of the complexity behind understanding culture. In particular, this approach looks at the accessibility to generate relevant information: the opportunity to address adequately a measurement method that captures data that is statistically valid and conceptually meaningful for the purpose of this study.

In respect to the chronology of the study, the design of this research is cross-sectional, which implies that the data is registered at the moment of the study on a specific population, with no subsequent analysis over the same population. Most studies performed in the area of Lean (95.51 percent) are cross-sectional, due to the difference in cost and time compared to longitudinal studies (Jasti & Kodali, 2014). In this particular case, this happens for two reasons: the availability of time to perform the study, and the nature of the confidentiality of data (responses should be anonymous to observe the confidentiality of the subjects).

A second identified limitation is the number of countries involved in the study (two) for the validation of the theory. Ideally a larger number of countries is suggested to perform a platform for cultural comparisons (G. H. Hofstede, Hofstede, & Minkov, 2010). However, results provided for the comparison within two countries that are culturally distant can be used in the research of operations management (Kogut & Singh, 1988) to provide conclusions that differ in their management practices, such as Lean.

Another element that is both advantage and limitation is the comparison of a single organization for the case study validation within different processes. As an advantage, it serves as a control for the influence of organizational culture, which is not the research intention in this study. In the opposite context, several studies use as control variables size of plants, age of plants, existence of union representation and type of production process (Raja, 2011), suggesting to have more facilities under study and using the heterogeneity of the operations for comparison.

In the number of variables involved in the study, the use of a relatively small number of cultural constructs may show a narrow dimensionality to the whole concept of national culture (Tsui, Nifadkar, & Amy Yi Ou, 2007). However, most of the studies in the field focus in a few number of variables in order to create a robust set of clear differentiators within the factors considered.

1.4 Approach

1.4.1 Question 1

Does national culture mediate personal requirements and lean practices?

The strategic management planning process has the purpose to align goals with the environmental and organizational conditions, where many studies fail to address the impact of national culture, which "could be a crucial variable mediating this process"(Rafferty & Tapsell, 2001). Shook (2010) suggests: "to change a culture, it is necessary to define the actions and behaviors they desire and then design the processes that will reinforce those behaviors." Such behaviors should reflect alignment with the requirements for implementation and operation of a successful Lean practice.

The opportunity emerges for understanding the specific behaviors that connect with cultural dimensions in order to establish a uniform scale for comparison between the different societal contexts. Cultural analysis explains how a given cluster of values and beliefs would make sense out of diverse attitudes people show and the practices they employ (Sawhney & Macias de Anda, 2017). This perspective incorporates cultural variation in the perception of task improvement providing valuable insights in the implementation know-how, a "people-oriented" approach identifying the elements that drive or block change. Therefore, dissecting the elements and identifying the corresponding factors of influence from a national culture perspective becomes an essential body of knowledge for the successful implementation and sustainability of lean efforts (Saurin, Rooke, & Koskela, 2013; Wiengarten et al., 2015).

To answer this question, the particular actions of this research address the following:

- Definition of personal attitudes and competencies required (hereafter identified as "requirements") for a successful lean implementation.
- Definition of national culture constructs relevant to establish differences among societies.
- Definition of a framework for lean implementation.
- Definition of a framework to establish causalities within requirements, national culture and lean implementation.
- Identification of a model and a methodology for the analysis of the relationships between personal requirements and the lean framework, mediated by the national culture constructs.

1.4.2 Question 2

If mediation occurs, are there any differences moderated at the country level?

Literature provides cases (illustrated in chapter 2) where successful or failed implementations occur within a specific context. This suggests that indeed some of these cases have a certain influence from the surrounding contingencies, which would affect differently in both the easiness and acceptance of particular elements of the practice. For example, there are certain cultures where people inherently prefer collective interactions, while others are more independent (Moorman & Blakely, 1995; Papamarcos, Latshaw, & Watson, 2007; Power, Schoenherr, & Samson, 2010; Wiengarten et al., 2015). Lean proposes teamwork as an essential element of the practice, which evidently would be counterintuitive for independent cultures, while it could provide the "quick-wins" in the collectivistic ones. Understanding these cultural differences becomes crucial in the strategic approaches and mechanisms utilized to promote teamwork within organizations becoming "lean".

To find these differences, the actions are:

- Definition of an assessment to quantify the culture gap among the different contexts.
- Integration of the assessment in the defined model to look for relevant differences.
- Validation of the model for the development of a localized strategy of implementation and operation through a case study.

1.5 Methodology

The plan for this research comprehends five stages: literature review, statistical model and data collection instrument, data collection, statistical analysis, and results, discussion and conclusions (as depicted in Figure 3).

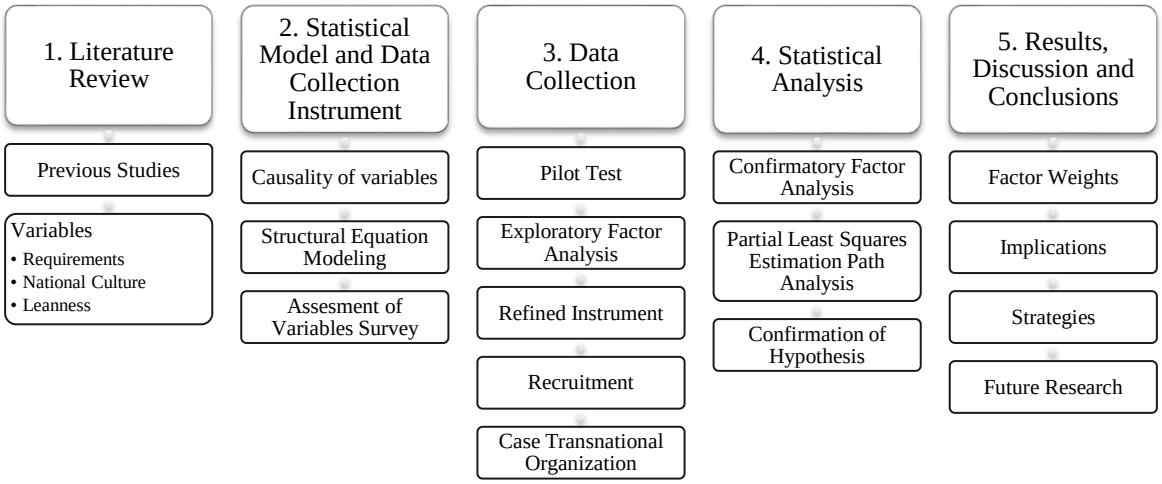


Figure 3 Methodology

1.5.1 Literature review

This section is a fundamental step to construct the theory that supports the framework of this study. The focus is in three areas: national culture, lean and the influence of national culture, and the factors for successful implementation of lean.

The approach to measure culture considers multiple instruments, as proposed by Taras et al. (2009). To remain in observance of good research practices, this project explores the studies with the strongest validation and most popularly used in operations management literature. The factors are a select number of constructs proposed in the Global Leadership & Organizational Behavior Effectiveness, or GLOBE(House & Global Leadership and Organizational Behavior Effectiveness Research Program, 2004), Values Survey Module(G. H. Hofstede et al., 2010), and Trompenaars-Hampden International Studies (Trompenaars & Hampden-Turner, 2012). The procedure for selection of constructs is furtherly explained in chapter 3.

The second part, Lean and the influence of national culture, includes a selection of current literature that addresses the discussion in section 1.1.3, convergent vs. divergent studies related with the influence of national culture in the Lean Management Practice. Selected studies provide the arguments for the research opportunities.

The last part of identifies factors and measurement instruments for Lean as well as the behaviors that are expected from the associates dealing with each one of the lean practices (Bangre, 2017). The focus of the measurement instruments for Lean is the diversity of assessments existing in literature with their respective purpose. The behaviors identified are derived from risks for the failure of lean, which are comprehensive and across three areas: process management, management support and shop floor associates involvement (Marodin & Saurin, 2015a).

1.5.2 Statistical Model and Data Collection Instrument

This research is a hybrid model, with simultaneous descriptive and analytical characteristics. The analytical method selected is Structural Equation Modeling (SEM), with foundation in the descriptive theory from literature. This statistical method has been widely used in the area of operations management with the study of manufacturing practices to find the relationships among different variables (Vinodh & Joy, 2012), and how they are affected by mediating factors (Preacher, Zhang, & Zyphur, 2011). Therefore, this model is intended to represent the characteristics that reflect the skills and behaviors (competencies) needed for people participating in lean, inducing the mediating variables of national culture (Figure 4), to understand their influence through comparison of the groups in the case study.

The instrument to collect the data that supports the path analysis of the model is a questionnaire on the concepts of the model. The questionnaire development followed common procedures in survey research, taking as a reference documented studies for each of the concepts and refined through statistical analyses, which will be explained in Chapter 3.

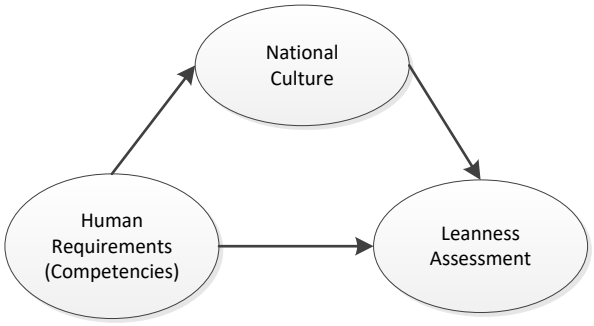


Figure 4: Conceptual Structural Equation Model for Mediation of National Culture on Lean Systems

1.5.3 Data Collection

A case study serves for the validation of the Structural Equation Model. The characteristics required to meet the purpose of this study are the analysis of a transnational organization that has implemented the lean management practice, with operations in at least two countries, and satisfying the sample size required for statistical validity (furtherly described in chapter 3).

The context of the North American Free Trade Agreement (NAFTA) provides a fertile ground for this research. The development of Lean as a new practice for competitive advantage, the opening of domestic markets to foreign competition, globalization of manufacturing within local companies, the role of offshore manufacturing mainly as a source of improved ways of manufacturing, and the accelerated political development derived from economic clusters like NAFTA (Lindberg et al., 1998) create a rather peculiar international context for competitiveness.

Within NAFTA, manufacturing presents a set of characteristics that represent challenges and opportunities for competitiveness, specifically in the comparison of U.S. and Mexico. In a perspective from labor, U.S. is more conducive of "labor management cooperation schemes" characteristics of lean production, where in Mexico labor leaders follow an "uncritical endorsement of structural adjustment in lean production" (Moody, 1995). This suggest that the influence that the cultural structures provide within the treaty built to enhance the region display clear differences beyond the economic development, in context of the interpretation and execution of manufacturing strategies. Hence, the inquisitive analysis of comparing the sustainability of Lean practices within these countries.

Some studies document that in assessing the level of Lean within the automotive industry, Mexican facilities displayed a superior level over their U.S. counterparts within the same company (Shaiken, 2001, in addition to other case where the subsidiary in Mexico was used as a benchmark, receiving the Shingo Prize {Nael, 2003 #748).

The organization recruited operates within NAFTA, having facilities in East Tennessee and in the northeastern border on the Mexican side. This company has worked implementing Lean, including current visible operation of some of the tools offered by the strategy. The data was collected via web-based survey, available to participants in a separate room within their facilities. A total of 152 employees participated in the survey anonymously, having the option to withdraw or refrain consent, deriving in a participation rate of 82 percent. The survey consisted on 99 questions. Demographic details, characteristics of the sample and other statistics are furtherly explained both in chapters 3 and 4.

1.5.4 Statistical Analysis

The analysis of the responses for the refinement of the Structural Equation Model follow Exploratory Factor Analysis to determine the explanatory variable. The development of the *a priori* model through the testing of Factor Analyses, will determine if the model could be considered confirmatory (Kline, 2011). Following the Confirmatory Factor Analysis, the process followed is Multi-Group Analysis (MGA) {Henseler, 2011 #780}, testing for the group difference between U.S. and Mexico of the indirect effects of national culture (mediation) in the relationship (path) of the human competencies as requirements of Lean (independent variables) and the leanness of the organizations in each respective country (dependent variables).

The estimation method utilized in the model is Partial Least Squares (PLS). The software used for PLS-SEM is SmartPLS 3 (Ringle, Wende, & Becker, 2015). The assumptions of the model and the sample size fit better for PLS, where Maximum Likelihood (ML) methods suggests a larger sample size, and present a constrained approach. However, the tests for construct validity and measurement model use a combination of both methods, in aims to decrease PLS-SEM bias (Joseph F. Hair, Ringle, & Sarstedt, 2011). The conclusion of the analysis explores the hypothesis testing for both, mediation within the respective group effects with MGA.

1.5.5 Results, Discussion and Conclusions

The opportunities addressed provide a model to use as a reference in assessing sustainability of Lean, and comparing facilities across organizations implementing or operating this strategy. The development of future work would enhance the model, as longitudinal studies should provide a solid platform to explain the transition from the influence of national to organizational culture. This implicates analysis of a larger and diverse subset of countries, organizations, and participants. The model can be enhanced by these results as variances across larger groups reflect on better loadings for factor analysis in the relevance of variables. This would not discriminate the variables that within a dichotomous comparison of groups seem irrelevant, as they can display a pattern within a specific cluster of cultures, different from the other clusters.

1.6 Expected Outcomes

In summary, the opportunity is to provide a better understanding of how diverse production schemes fit and adapt per national culture, hypothetically relevant in the success of the Lean management practice. This research aims to identify the models, approaches and factors significant for the sustainability of the practice, supporting the academic field with an empirical study in favor of divergent propositions, which will also assist managers and practitioners as they face these challenges.

This project will provide a consensual framework of Lean and a list of the factors that define the desired set of behaviors. The approach will establish the connections based on precedence to implement different aspects of Lean as defined by the scope of the initiative, supporting its sustainability, based on the geographical location of the implementation effort, and the attributes identified within their people.

Finally, this approach intends to provide a reference framework for managers to evaluate the strengths and weaknesses of the national culture when implementing lean management practice, providing focal points for development of training efforts to enhance the culture transitioning into a favorable one conducive of continuous improvement and reflective of competitiveness.

1.7 Organization of the study

This document follows the structure of the research methodology presented in section 1.5. Following this Introduction, chapter 2 (step 1) provides a literature review of prior work related to this project, as well as a characterization of the relevant elements that determine the framework of measurement for both, culture and lean. Chapter 3 (steps 2 and 3) describes the methodology in detail. It explains the rationale for the determination of the statistical model and the stages for the design of the survey instrument, along with the specific hypothesis. Consequently, this chapter explains the requirements for statistical validity, the process for recruitment of subjects, the implementation of the survey. Chapter 4 (step 4) presents the analysis and results, addresses the characteristics of the collected data, with a stepwise explanation of the results for each stage of the statistical analyses, the refinement of the model and the relevant links (paths) of causality within the factors and their corresponding hypothesis. Lastly, chapter 5 (step 5) discusses the results, implications, conclusions and future research.

Chapter 2: Literature Review

2.1 Introduction

As previously discussed, the Lean management practice is a system with a measurable set of principles and associated tools that must be aligned with the goals pursued by the organization, but also in line with the traditions and norms, hence the culture of the people from that place. This research focuses on the argument that the initiative's success is determined in high degree by the surrounding environment (with its cultural values). In this sense, academia has the task to provide the foundation for practitioners on how Lean affects performance and what elements affect both. On the judgement of some researchers, this has not received enough attention (Netland, Ferdows, & Sanchez, 2015).

Lean practitioners need to develop critical thinking skills as their purpose is to design systems that effectively address the needs and expectations of the customers, both internal and external. However, people involved in the organization should meet a diverse set of requirements when the Lean management practice is the operating strategy. Therefore, the importance to identify their competencies and values, but more important is to understand the culture where these come from. This chapter presents relevant research in national culture and its measurement, select publications in both convergent and divergent propositions of the influence of national culture on Lean through empirical results, and the factors for successful implementation of Lean with corresponding instruments.

This literature review was conducted as a non-structured comprehensive search on two search engines: Google Scholar and the University of Tennessee Library Resources. The first search comprehended previous work in this topic utilizing keywords in the format as Boolean operators: *(lean*) (cultur*) (manuf*) and (country)*; and *(lean*) (sociotechn*) (nation*) (cultur*)*. A semantic identification of documents synthesized the results. These keywords and operators also served for searches in Scopus and Web of Science. When a relevant title was identified, the subsequent step was to conduct a full document search within journal databases such as Science Direct (Elsevier), Emerald, Taylor & Francis, Sage, JStor and Wiley Periodicals. Related works and references guided finding additional resources. The collection of documents was discriminated identifying those that were considering management practices under study with the names of Continuous Improvement, Toyota Production System (or TPS), Lean and Kaizen. The results yield papers, thesis, dissertations, books and book chapters.

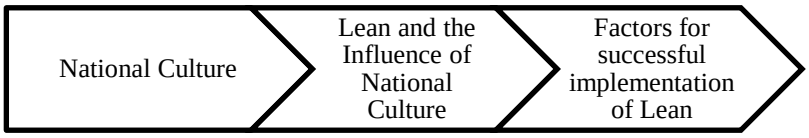


Figure 5 Areas of Literature Review

The focus of the observations from the literature was in the implementation of the management practices, success and failure factors, constructs of measurement of the management practice, theories of culture, constructs of measurement of culture, context of analysis, and the methodologies utilized for the investigation of factors. The papers selected for the determination of the two branches of propositions (influence vs. not) were selected by the concluding remarks with the keywords “influence” and “culture”

This chapter presents three mayor areas relevant for this study, as illustrated in Figure 5. Section 2.2 presents the current relevant instruments in National Culture, with their most important characteristics. Section 2.3 reviews studies that have approached the topic of Lean and the influence of National Culture. Section 2.4 includes the analysis of papers that have described elements of influence for the successful implementation of Lean, both in the soft (human behavior) factors as well as hard (business and process) factors.

2.2 National Culture

Culture in itself represents a broad concept, where common dictionary definitions describe it as the skills, arts, ideology of a given people in a given period; or a particular form of civilization, especially the beliefs, customs, arts and institutions of a society at a given time. In colloquial understanding, it describes the features that distinguish a certain group of people from others.

From a sociological standpoint, the research in Culture is a broad topic. Defining a culture represents a challenging task; moreover, the particular analysis of common factors that define the differences among groups. For several years, the factors that describe cultures and the measurement techniques have been a priority for researchers.

In the field of operations management, recent interest has arisen, as it plays the aforementioned dual role as the influence of the organization on the individual for the development of a particular behavior, and the influence from the individual's background from a geographical context; in other words, organizational culture and national culture. People within organizations belong to national societies, and "if we want to understand their behavior, we have to understand their societies" (G. H. Hofstede et al., 2010).

Therefore, dissecting the elements and identifying the corresponding factors of influence from a national culture perspective is a crucial body of knowledge for the successful implementation and sustainability of lean efforts (Saurin et al., 2013; Wiengarten et al., 2015).

2.2.1 Cultural studies

Metrics drive the success or failure of systems. This reminds us of Drucker's famous quote: "you can't improve what you can't measure." It is only through the understanding of metrics that goals can be set, strategies aligned, and monitoring can be possible. However, it is important to focus only in the relevant metrics, those who will speak the language of the context and the desired analysis.

Defining the proper metrics in the analysis of culture has been the area of focus of many researchers. Table 1 displays a set of selected instruments and their most significant characteristics for this research.

G. H. Hofstede et al. (2010) have one of the most relevant studies in the matter. Through their Value Survey Module (VSM), an instrument of about 30 questions, he derived dichotomies summarized in four dimensions or constructs (one added in his latest version for a total of seven) to compare at a national level the characteristics from employees of IBM. The statistical method employed was factor analysis.

Another popular study is GLOBE (House & Global Leadership and Organizational Behavior Effectiveness Research Program, 2004) that utilizes 9 factors similar to Hoftede's compared with 6 features of leadership. The analysis utilized factor analysis.

Similarly, Schwartz (1999) developed the Universal Values Structure (UVS), in which he explains culture from a perspective of 7 dimensions. He uses the same methodology as Hofstede, obtaining means of the responses for 45 values. He utilized the statistical procedure smallest space analysis.

Trompenaars and Hampden-Turner (2012) created the Value Questionnaire (VQ), which is similar to Hosftede's method of dichotomous comparisons, but utilizes 7 dimensions similar to Schwartz's. They used Multidimensional Scaling and Linear Multiple Regression (P. B. Smith, Dugan, & Trompenaars, 1996).

Inglehart (1997, 2010) created the World Values Survey, which is a longitudinal study that compiles the second largest sample after Hofstede´s. The nature of this study allows for continuous data collection and multiple analysis, but the number of items measured and the questions, makes it impractical.

Table 1 Largest studies of National Culture

Reference	Instrument name	Year	Dimensions-Factors	No. Questions	Statistical analysis	Population type	Countries	Responses
(Schwartz, 1999)	Schwartz Value Survey	1992	10 individual, 7 country + 4 comparisons	56	Smallest space analysis	College students, elementary school teachers	60	6,849
(House & Global Leadership and Organizational Behavior Effectiveness Research Program, 2004)	Global Leadership and Organizational Behavior Effectiveness (GLOBE)	1991	9	78	Factor Analysis	Managers	62	13,412
(G. Hofstede, Neuijen, Ohayv, & Sanders, 1990; G. H. Hofstede et al., 2010)	Value Survey Module 2013	2013	5	30	Factor Analysis	In the original study, IBM employees.	40	116,000
(P. B. Smith et al., 1996; Trompenaars & Hampden-Turner, 2012)	Value Questionnaire	1985	7	58	Multidimensional Scaling, Linear Multiple Regression	Managers and staff	43	8,841
(Inglehart, 1997, 2010; *WORLD VALUES SURVEY Wave 6 2010-2014 OFFICIAL AGGREGATE* 2015)	World Values Survey	1981-2014	258 values	268, 258	Multiple, Factor Analysis most used	>18 years old	57	99,000

Table 2 Factor dimensions for selected studies of National Culture

GLOBE (House)	VSM (Hofstede)	VQ (Trompenaars)	UVS (Schwartz)
Power Distance (PD)	Power Distance Index (PDI)	Individualism vs. Communitarianism	Power
Performance Orientation (PO)	Uncertainty Avoidance Index (UAI)	Neutral vs. Emotional	Security
Uncertainty Avoidance (UA)	Individualism vs. Collectivism (IDV)	Achievement vs. Ascription	Benevolence
In-Group Collectivism (GC)	Masculinity vs. Feminity (MAS)	Specific vs. Diffuse	Self-direction
Gender Egalitarianism (GE)	Long-Term Orientation (LTO)	Sequential vs. Synchronic	Hedonism
Humane Orientation (HO)	Pragmatic vs. Normative (PRA)	Inner-directed vs. Outer-directed	Achievement
Institutional Collectivism (IC)	Indulgence vs. Restraint (IND)	Universalism vs. Particularism	Universalism
Future Orientation (FO)			Stimulation
Assertiveness (AS)			Tradition
			Conformity
			Spirituality

The list of cultural instruments available for both national (alternatively known as societal or environmental) and organizational culture is extensive. Our focus is only in the scales that measure and compare national culture. The previous list of instruments is consistently cited in research due to, among other reasons, their relevance (face validity), reliability, sample size, number of participating countries, and the supporting theory to formulate them.

Regarding the factors that each study had developed, there are similarities as described before, but the definitions and methodologies followed in order to determine each scale may differ in how the researchers have described them. In exception of Inglehart (1997), the other cases presented have a fairly brief set of dimensions which are more practical for further analyses, especially when they combine with other factor scales. As G. H. Hofstede et al. (2010) explains, a dimension is "an aspect of a culture that can be measured relative to other cultures". The dimensions were determined after the statistical analyzes described for each study proved the concept, which for all researchers meant a substantial differentiation within the sampled countries. Perhaps, some of the dimensions might correlate in some cases with a portion of the sample, but for a specific case, being a country, might not with the reminder, creating a unique differentiation. The dimensions for the four studies are depicted in Table 2.

Table 3 Relevance of culture dimensions to the study of culture and workplace by Taras et al. (2009)

Dimensions	Workplace	Culture	Combined	Workplace Rank	Culture Rank	Combined Rank
Achievement orientation	3.14	3.87	7.01	20	5	8
Ambiguity avoidance	3.61	3.73	7.34	8	7	5
Assertiveness	3.87	3.25	7.12	2	18	7
Attitude to ritual suicide	1.85	3.76	5.61	27	6	27
Believing in changeable/unchangeable basic human nature	3.11	2.89	6	21	24	23
Believing in evil/good basic human nature	3.09	2.91	6	22	23	23
Conformity	3.32	3.45	6.77	15	13	15
Conservatism	3.29	3.49	6.78	16	12	14
Determinism	2.64	3.45	6.09	26	13	22
Emotional vs. neutral	3.25	3.62	6.87	18	10	11
Family integration	2.7	4.17	6.87	25	1	11
Gender equality	3.61	4.17	7.78	8	1	2
Humane orientation	3.15	3.14	6.29	19	19	20
Inclination to teamwork	3.87	3.08	6.95	2	22	10
Independent–interdependent self-perception	3.46	3.68	7.14	12	9	6
Machiavellism	3.62	2.1	5.72	7	27	26
Personal independence	3.36	3.51	6.87	14	11	13
Pleasure-seeking	3.09	2.88	5.97	22	25	25
Power distance	3.91	3.99	7.9	1	4	1
Relationship depth	3.41	3.26	6.67	13	17	17
Relationship to environment	3.28	3.09	6.37	17	21	19
Risk avoidance	3.8	2.7	6.5	4	26	18
Self-identity	2.96	3.28	6.24	24	16	21
Self-reliance	3.65	3.35	7	5	15	9
Short- vs. long-term orientation	3.57	3.13	6.7	11	20	16
Status by ascription vs. status by achievement	3.61	4.07	7.68	8	3	3
Universalism vs. particularism	3.65	3.73	7.38	5	7	4

Taras et al. (2009) developed a comprehensive analysis of 121 instruments that measure (quantify -as they mention-) culture, including the five mentioned. Through a survey that included the dimensions used for each instrument, they asked experts in the area the relevance of the dimensions for the study of the workplace and culture. Through a Likert scale where 1 means very irrelevant and 5 very relevant, 28 respondents provided their opinions. Table 3 illustrates a summary and a ranking of their findings.

2.3 Lean And The Influence Of National Culture

Lean manufacturing has proven to be an effective philosophy and a management system. It has provided the means to achieve significant improvements for many organizations. Its measurement of has been another topic widely researched providing different metrics, instruments and methodologies to track progress (Achanga, Shehab, Roy, & Nelder, 2006; Bhasin, 2008; Bhasin & Burcher, 2006; Gurumurthy & Kodali, 2009; Herzog & Tonchia, 2014; Kollberg, Dahlgaard, & Brehmer, 2006; Pakdil & Leonard, 2014; Saurin & Ferreira, 2008; Shah & Ward, 2007; Wan & Frank Chen, 2008). Most studies focus in hard metrics such as time, cost and quality yield, leaving aside soft aspects such as culture.

Culture has received especial attention from the perspective of the organization, but recent interest has been placed in the influence of national culture (Table 4). Friel (2005) describes for a German multinational that the heavily regulated environment in Germany proved conducive to the success of the Lean program there, while the liberal environment contributed to its failure in the transplantation to the United States. Lixia and Bo (2010) make an analysis of Lean implementations in China, concluding that indiscriminately imitating and copying the practices of others have resulted in a big failure since Lean "must be combined with local culture". Wincel and Kull (2013) concluded that not understanding and appreciating the culture in many levels, especially in a geographical context (country and region), Lean systems are doomed to fail.

The analysis of this field is recent, having as a primary platform some of the major cultural studies explained before, yielding mixed conclusions. Love (1997) conducted a qualitative study of the TPS transfer from a large Japanese-American assembler to two smaller American supplier companies, where she examines the impact of multicultural workforces on the process of diffusing and implementing the TPS through participant-observation techniques, concluding the influence of the multicultural environment at the companies as a barrier for the dissemination of the program.

B. L. Rathinam, Thomas (2010) makes a simple comparison between Hofstede's dimensions and some Lean characteristics, concluding that companies quickly encounter barriers that hinder complete success of lean production because it was conceived in a different culture, Japan.

Angelis, Conti, Cooper, and Gill (2011) distributed surveys among 21 facilities in the U.K. with a total of 1391 responses, identifying through multivariate analysis (multiple regression) the relationships among 21 lean work practices and 13 independent variables associated with affective commitment of workers in Lean organizations, in order to build a high commitment lean culture. They conclude that lean is neutral in the commitment of workers.

Table 4 Relevant Studies of Influence of National Culture on Lean Management Systems

Author	Type of study and sample	Type	Study	Conclusion	Future work
Love (1997)	Empirical, U.S., 3 Companies	Qualitative, participant observation techniques	Dissemination of a Japanese subsidiary system into its suppliers.	Influence of multicultural environment.	Adapt proper training for multicultural environments, change management driven changes to full commitment from workers and the impact on sustainability
Wallace (2004)	Empirical, Brazil (Swedish subsidiary)	Qualitative, Interviews, Longitudinal (10 years)	Exploration of the hybridization of Lean to local culture, using as a platform European, American and local experts, knowledge and systems instead of the Japanese.	Influence of national culture	Test if the production strategy being developed around the Brazilian (Curitiba) plant is unique or indicative of a wider trend within the global car industry.
Friel (2005)	Empirical, Germany and U.S.,	Qualitative, Interviews	Policy environment impact for transplantation.	Influence of national culture.	The extent to which firms can resist the institutional context in which they operate.
Wong (2007)	Empirical, Taiwan	Qualitative, Interviews	Exploration of the culturally adaptive features for the adoption of Lean, from the perspective of short vs. long term orientation, using Schein's organizational culture model and Confucian dimensions.	Influence of national culture	Exploration of other Taiwanese organizations that have managed to implement. Once the system is implemented, will there be different culturally adaptive features?
Lixia and Bo (2010)	Empirical, China, one company	Qualitative, anecdotal evidence	The extent of adapting to local culture.	Influence of local culture.	Systematic implementation of Lean production from the proposed sequence
Naor et al. (2010)	Empirical, four Western vs. two Eastern countries, 189 manufacturing plants	Qualitative-Quantitative, Questionnaire (statistical analysis, ANOVA and Hierarchical Linear Modeling)	Analysis of organizational and national culture on manufacturing performance. Comparison of developmental indexes at the national level on manufacturing performance.	Insignificant influence of national culture	Expand the study to other countries, find new clusters to confirm if national culture could have an effect.
Glaser-Segura et al. (2011)	Empirical, Brazil, Argentina and Romania, 248 companies.	Qualitative-Quantitative, Questionnaire	Survey of logistics and production professionals in 15 scales for lean production, and how it is adopted by the organizational culture, taking as a base the national culture of emerging economies.	Inconclusive if the national culture has a specific effect.	Research with other emerging countries, especially from OECD, understand the specific success factor for environments outside the original conception of Lean.
AL-Najem et al. (2013)	Theoretical, validated with an empirical investigation for a case study In Kuwait	Qualitative-Quantitative, Questionnaire	Investigating the factors affecting readiness for lean system adoption within Kuwaiti small and medium-sized manufacturing industries	Influence of national culture	Explore the application in successful organizations for benchmarking. Expand to other sectors. Develop a lean readiness model for Arab countries comparable to Kuwait, sharing similar cultures.
Netland et al. (2013)	Empirical, 23 countries	Qualitative-Quantitative, On-site audits, questionnaire	Analysis of implementations with Swedish and German subsidiaries around the world.	No influence of national culture	Focus on organizational culture and role of plant strategy. Studies using Hofstede's cultural constructs should be avoided. Need for longitudinal studies.
Wincel and Kull (2013)	Analytical, 24 countries, GLOBE and GMRG databases.	Quantitative, statistical analysis (factor analysis & hierarchical linear model)	Analysis of parameters from GLOBE study.	Influence of national culture, and with some levels.	The interaction between organizational and country culture, and how Lean is affected.

Table 4 continued

Author	Type of study and sample	Type	Study	Conclusion	Future work
Yokozawa and Steenhuis (2013)	Empirical, Netherlands, 15 Japanese subsidiaries.	Qualitative, questionnaire and semi-structured interviews	Influence of factors on workers for Kaizen transfer.	Influence on two parameters only.	Develop further operationalization of discipline and eagerness as national level factors, and how these relate to prior constructs (i.e. Hofstede's). Expand the study to other countries.
Miroshnik and Basu (2014)	Empirical, Japan and U.K.	Qualitative-Quantitative, questionnaire, structural equation modeling	Comparison of transplantation from headquarters to subsidiaries.	No influence on national culture.	Demonstration of company citizenship behavior overriding national culture.
Bortolotti and Boscari (2016)	Empirical, Italy and China, Subsidiary and suppliers.	Qualitative, Semi-structured interviews	Analysis of contextual factors: socio-cultural, political-legal, economic, and educational environmental conditions.	Influence of national culture.	Development of multiple cases. Development of a taxonomy of problems for internationalization, and classification into macro-areas.
Netland (2016)	83 factories, 27 countries, 2 multinational organizations	Qualitative-Quantitative, Questionnaire	Analysis of contingencies, including national culture for critical success factors (CSF), based on collectivistic vs. individualistic.	Little influence of national culture on two parameters (rewards and recognition, and use of external experts)	Investigation of failed implementations, the way managers perform CSF. Analysis of other contingencies as moderators of managerial actions. Longitudinal study for real effectiveness of actions.
Pakdil and Leonard (2017)	Theoretical	Qualitative, Literature review	Comparison of Hofstede's constructs for different factors of Lean from a theoretical perspective.	Influence of national culture.	Investigation of the effect of cultural constructs on the specific practices of lean and its sustainability.

Abrahamsson and Isaksson (2012) discuss the balance between a customized implementation and a standardized implementation focusing national culture dimensions. Their approach is an empirical correlation between Liker's 14 principles of the Toyota Production System and Hofstede's 5 dimensions. The validation is conducted through a case study, using interviews, where they conclude that both (custom and standard) implementation methods are necessary depending on the circumstances.

Ahmad (2013) provides a holistic framework for the relationship between culture and Lean Manufacturing through literature survey, where he concludes that the starting point is the understanding of the Toyota Culture, to later understand the ties between the influence of work culture and national culture for organizations.

Wincel and Kull (2013) utilize the data set from the Global Manufacturing Research Group's worldwide survey as the basis for manufacturing performance, and the information provided in the GLOBE study for culture. They used a Hierarchical Linear Model approach for analysis, finding that the cultural constructs (factors) Uncertainty Avoidance, Assertiveness, Future Orientation and Performance

Orientation, out of the nine proposed in the GLOBE study have an effect Lean management practices and the operational performance. Their conclusion is that some cultures will not be effective adopting lean.

Netland et al. (2013) collected data of transnational companies from Sweden and Germany, implementing surveys at 84 facilities in 23 countries. Through simple correlation analysis, comparing with the scores used by Hofstede, they conclude that national culture is not significant in lean implementations.

Yokozawa and Steenhuis (2013) studied 15 Japanese subsidiaries in the Netherlands to identify the factors at the national level influence the transfer of "Kaizen" (continuous improvement, a core element of Lean). They used interviews with a survey instrument to identify the factors. They concluded relevance on two factors, eagerness and discipline of employees. Suggest as future research the relationship within the two factors and prior identified dimensions by Hofstede.

Miroshnik and Basu (2014) take as a reference Japanese national culture and the TPS for the analysis of the Japanese corporate culture, studying its effect using structural equation modeling (maximum likelihood estimation) with data collected through surveys based on 8 values evaluated with 36 questions. They conclude that the differences between the culture at the headquarters in Japan and the subsidiaries abroad are not significant, mainly due to a strong corporate culture. However, they acknowledge the need of incorporating the factors introduced by Hofstede and House to determine principles in multinational organizations' "citizenship" as future research.

In general, besides concluding that research in this field has not yielded uniform conclusions, having the debate of "no influence" vs. "influence" of national culture over Lean implementations, we can see that the variables, instruments and methodologies of research in this area still have opportunity for the development of theories and models. Majority of the studies consider only one theory as their basis to measure culture, and use provided datasets that were not intended to demonstrate the particular philosophy of Lean Manufacturing.

2.4 Factors for Successful Implementation of Lean

The Lean Enterprise Institute reported in 2008 [as cited by (Sawhney, Subburaman, Sonntag, Rao, & Capizzi, 2010)] that the main factors for failure of Lean can be considered as backsliding, middle management resistance, lack of implementation knowledge (skills and technical) and lack of critical

thinking. Figure 6 shows the common factors classified as drivers and barriers identified in the literature in the recent years. These factors are interrelated with each other. However, implementation knowledge is attributed as one of the causal umbrellas for the other failures (Marodin & Saurin, 2015b), shown with the higher frequency in Figure 6. Perhaps, all factors reflect in some way over all dimensions of culture (an underlying factor), which in itself is a highly cited factor, but with opportunity for a deeper understanding in this area.

Implementation knowledge involves more than learning and using the tools. A common problem is designing systems with specific measures and objectives driven by the reduction of waste, leaving aside the consideration that these systems require people to operate them. Most organizations focus only in the process, leaving aside the development of the organizational problem solving philosophy, its people and partners, giving leeway to failure transferring within and to other subsidiaries, not to mention international contexts (Liker & Franz, 2011). Successful organizations operating with Lean are those who place emphasis on the human factors (drivers) in comparison to the organizations that only focused on the tools (Bortolotti, Boscari, & Danese, 2015). These can only be successful when people is convinced and engaged of the potential benefits (Liker, 2004). What made Toyota successful was not the focus on the tools nor the conception of the system itself (Ohno, 1988), but the understanding that every element within the organization had to follow a particular set of principles that would provide guidelines for their expected behavior.

According to Liker et al. (1999), the effectiveness of Lean (or Japanese Management Systems, JMS as identified in their study) is conditioned "by the structure of the broader factory organization and by the corporate management system within which individual factories operate". It is in that structure that they conclude that the successes of the best transplants have shown that Lean systems or a variation (hybrid) can function effectively in foreign institutional and societal contexts.

The subsequent element within the identification of factors and measurement instruments is to identify the rationale behind the requirements, as a justification for implementation (why) and their hierarchical sequence (what and when is needed). As identified in Figure 6, these are addressed from the perspective of barriers and drivers for lean implementation. These can be categorized in three groups: process management, management support and shop floor associates involvement (Marodin & Saurin, 2015a). The perspective includes the operational and attitudinal constructs (Bouville & Alis, 2014) leaving aside health factors (Koukoulaki, 2014).

Drivers (x)	Barriers (y)	(Abolhassani, Layfield, & Gopalakrishnan, 2016)	(Netland, 2016)	(Bortolotti et al., 2015)	(Larteb, Haddout, & Benhadou, 2015)	(Bhamu & Singh Sangwan, 2014)	(Čiarnienė & Vienažindienė, 2014)	(Netland & Aspelund, 2014)	(Alagaraja & Egan, 2013)	(Gupta & Jain, 2013)	(Karim & Arif-Uz-Zaman, 2013)	(Mostafa, Dumrak, & Soltan, 2013)	(Marodin & Saurin, 2013)	(Saurin et al., 2013)	(Moyano-Fuentes & Sacristán-Díaz, 2012)	(Salwan, Ab Rahman, & Deros, 2012)	(Bonavia & Marin-Garcia, 2011)	(Kovacheva, 2010)	(Achanga et al., 2006)	Count
Skills and expertise, knowledge of basic tools, implementation "know-how", technical knowledge, availability of training and willingness to learn	Lack of implementation and technical knowledge	x,y	x	x	x	x	y			y	x	x	x	y		y	x	x	x	15
Active leadership, management commitment	Lack of management commitment	y	x	x	x	x		x	x	y	x		x		x	y		x	x	14
Culture compatibility (organizational and societal), situational analysis, cultural fit, positive environment	Incompatible culture, lean is unsustainable	x,y	x			x	x	x	x			x	x			y		x	x	11
Lean assessment, monitor of goals, regular meetings, objectives, performance indicators, quality over productivity or efficiency	Incongruence of objectives, lack of effective measurement		x		x	x					x	x	x		x	y				8
Holistic strategy for integrating the system in a long term plan, deploy in daily business, stepwise implementation approach, top priority	Lack of systemic anticipation to all areas of the organization		x				x					x	x	y	x			x		7
Employee motivation and buy-in, internal promotion, reward and recognition, pay for performance, safety and attractiveness, job security, reduced turnover (homogeneity in performance)	Employee's negative attitude		x				x		x	y			x		x		x			7
Effective communication of the initiative and results	Poor communication		x		x	x	y					x	x							6
Structured knowledge management (learned lessons), benchmark, standardize and share best practices	Compartmentalization		x			x	y	x			x	x								6
Financial resources	High cost of investment/lack of financial resources	y								y			x			y			x	5
Empowerment (operators autonomy), ownership of process and product quality	Lack of autonomy				x			x					x	y						4
Talent in the organization	Lack of skilled people					x	x						x			y				4
Stakeholders involvement (employees, mid level and top managers)			x		x								x					x		4
Willingness for risk	Failure of past lean effort, resistance to change (management, supervisor, employee); backsliding to the old ways of working	y					x,y			y						y				4
Teamwork, network relationships			x					x				x						x		4
	Lean is viewed as a gimmick or fad, lack of understanding the benefits	y					y									y				3
Workflow initiatives, process map			x						x			x								3
Others*	Others*		x							y						y				3

Figure 6 Drivers and barriers for successful Lean implementation and operation

2.4.1 Lean Factors and Assessments

Academicians and practitioners have tried to define diverse elements and their corresponding measurements through several frameworks of implementation and assessment instruments. Ranging from, specification of a particular tool or element of the practice considered a requirement for its success, to strategic and systemic approaches such as the analysis of the Lean management practice as an enterprise initiative (Hallam & Keating, 2014; Lean Advancement Initiative, 2001; Nightingale & Mize, 2002).

Lean in itself still lacks of a standard definition, and even when the tools and concepts across different studies seem to have a clear belonging to the management practice, no standard set of tools nor a sequence of implementation seems to have reached agreement. (Bhamu & Singh Sangwan, 2014) made a comprehensive literature review of research publications available in Lean (209 papers) dating to 2013, presenting 33 different definitions, seven implementation frameworks and 18 different –as he has named- Lean tools, techniques and methodologies. Table 5 illustrates these tools, techniques and methodologies, where the papers date up to 2011 in most cases. These concepts, perhaps essential for the purpose of Lean, they do not display uniform presence among the available literature. This could be due to the lack of consensus on a framework, or the relevance they acquire respective to their context.

Complementing Bhamu's work, Figure 7 provides the concepts that continue in literature dated to 2011 to 2016. In contrast to Bhamu's findings regarding Value Stream Mapping having used in the highest frequency, Single Minute Exchange of Dies (SMED) and Total Productive Maintenance (TPM) are the most frequently cited elements. The span of time is not comparable; however, a trend in the focus of researchers in the recent years might hint that unsustainable practices are due to a lack of consistency in the shop-floor. This list is more comprehensive in the concepts (28), which demonstrate an overlap with those in Table 5 (16), in exception of Total Quality Management, which is considered a precursor for Lean, but not necessarily an element of; and Simulation, which is a tool that is recursive of a broader field in operations management. Most of the overlapping elements suggest to be essential for inclusion in any particular framework of Lean.

In regards to the measurement of Lean, the literature provides different metrics, instruments and methodologies to track progress (Achanga et al., 2006; Bhasin, 2008; Bhasin & Burcher, 2006; Gurumurthy & Kodali, 2009; Herzog & Tonchia, 2014; Kollberg et al., 2006; Pakdil & Leonard, 2014; Saurin & Ferreira, 2008; Shah & Ward, 2007; Wan & Frank Chen, 2008). Most studies focus in hard metrics such as time, cost and quality yield, leaving aside soft aspects such as culture, although it is considered as an essential element for success.

Concept	(Marodin, Frank, Tortorella, & Saurin, 2016)	(Abolhassani, Layfield, & Gopalakrishnan, 2016)	(Büyüközkan, Kayakutlu, & Karakadılar, 2015)	(Bortolotti, Boscari, & Danese, 2015)	(Singh Sangwan, Bhamu, & Mehta, 2014)	(Jasti & Kodali, 2014)	(Čiarnienė & Vienažindienė, 2014)	(Bhamu & Singh Sangwan, 2014)	(Belekoukias, Garza-Reyes, & Kumar, 2014)	(Karim & Arif-Uz-Zaman, 2013)	(Hofer, Eroglu, & Hofer, 2012)	(Bonavia & Marin-Garcia, 2011)	Frequency
Setup reduction/quick changeover (SMED)	x	x	x	x		x	x	x	x	x	x	x	11
Total productive maintenance (autonomous, preventative, preventive)	x	x	x	x		x	x	x	x	x	x	x	11
5S		x	x		x	x	x	x	x	x		x	9
One-piece-flow/Continuous flow	x	x	x	x		x	x		x	x	x		9
Pull production/Kanban (as part of JIT)	x	x	x	x	x	x		x	x		x		9
Cellular manufacturing (layout)			x	x	x	x	x	x	x	x			8
Jidoka/Pokayoke	x	x	x				x	x	x	x			7
Standardized work	x				x	x	x	x				x	6
Value stream map			x			x	x	x	x	x			6
Kaizen (continuous improvement)			x	x		x	x	x		x			6
Problem-solving (root cause analysis, small group)	x		x	x		x			x		x		6
Heijunka (smoothed production)	x				x	x		x	x				5
Visual Management	x					x			x			x	4
Multi-functionality	x					x		x	x				4
Andon	x							x	x	x			4
Inventory/reduce inventory	x	x	x				x						4
Eliminate waste		x	x		x	x							4
Statistical Quality Control							x			x	x	x	4
Quality	x		x									x	3
Lead time/reduce cycle time	x	x	x										3
Reduce lot size (small lot)		x	x			x							3
Flexibility			x		x								2
On-time delivery (Just in Time)	x			x									2
Single supplier focus		x						x					2
Concurrent engineering					x					x			2
Process flow improvement			x										1
Line balancing										x			1
Group suggestion programmes (quality circles)												x	1
Others	x	x	x			x			x				5

Figure 7 Lean tools, techniques and methodologies determining success of Lean

Table 5 Lean tools/techniques/methodologies identified in Lean literature (Bhamu & Singh Sangwan, 2014)

Lean tools/techniques/ methodologies	No. of References
Value stream map	53
Pull production/Kanban (as part of JIT)	37
On-time delivery (Just in Time)*	34
Kaizen/continuous improvement**	33
5S	23
Total productive maintenance (autonomous, preventative, preventive)	22
Cellular manufacturing (layout)	20
TQM***	18
Heijunka (smoothed production)	15
Setup reduction/quick changeover (SMED)	14
Multi-functionality	14
Jidoka/Pokayoke	14
Visual Management/Andon**	13
Single supplier focus	11
Simulation***	10
Standardized work	7

The original concept is Just In Time, but was merged with on time delivery for comparison purposes. ** Concepts are displayed as separate items in the original study. Here they are merged for comparison purposes and the number of references is recalculated to avoid duplicates. * Concepts excluded from Figure 7, as not considered to be specific elements in Lean lexicon.*

The available literature provides a diverse set of Lean assessment instruments that differ in type, method, scale, elements for measurement and framework. Narayanamurthy and Gurumurthy (2016) provide a comprehensive review of 53 Lean assessment publications available in peer reviewed journals and conferences with indexed proceedings dated from 1996 to 2013. Their study focused on finding any assessment techniques that audit and account the outcomes of Lean. A summary of their findings is in Table 6.

Among the most relevant findings pertinent in this study, Narayanamurthy and Gurumurthy (2016) the studies with a numerical index had a better opportunity to be used to benchmark progress, hence the opportunity to use indexes (called Leanness) to compare among different contexts, which in this case are different national cultures. In addition, using firm inputs, and displaying relevance in the outcomes, increased the probability of organizations to use the information for decision making in the Lean implementation. This provides an opportunity to work directly with generic goals, define the specific environment surrounding the organization from the perspective of national culture, and provide relevant information for decision making when Lean is the selected strategy for their management practices. On the behavioral aspect, they observed that none focused on any behavioral elements, key for the success of Lean.

Table 6 Characteristics of Lean Assessments (Narayanamurthy & Gurumurthy, 2016)

Characteristic	percent of papers (N=53)	Characteristic (cont.)	percent of papers (N=53)
Publication within 2009-2013	66%	**Reporting method of data collection**	72%
Reporting region	75%	• Interview	26%
• In U.S.	9%	• Questionnaire	43%
• In Latin America	N/A	• Public report	2%
Reporting sector	100%	**Reporting usage of scale**	57%
• Manufacturing	87%	**Reporting no. of organizations**	72%
○ Automotive	21%	• 1	42%
○ Electronics	25%	• >1	13%
• Service	13%	• Empirical (not organization based)	17%
Reporting type of data analysis	100%	**Reporting benchmark used**	23%
• Quantitative	74%	**Methodology Technique**	83%
• Qualitative	26%	• Fuzzy	26%
Reporting nature of study	100%	• Hypothesis testing, regression, correlation and ANOVA	8%
• Practical	79%	• Value Stream Mapping and Simulation	6%
• Conceptual	21%	• Average of exploratory data	4%
Reporting base of assessment	100%	• Exploratory and Confirmatory Factor Analyses	2%
• Practices	85%	• Relationship model development	2%
• Performance measures	15%	• Other	36%

There are three assessments that in particular met in different perspectives the objectives of this study. Saurin, Marodin, and Ribeiro (2010) identified two types of assessments: those that focus on obtaining statistical conclusions through a survey, and those focused on simply providing a scale for the level of implementation at a single organization, more in the lines of an internal audit.

Among those provided that meet the first criteria, the study of Shah and Ward (2007) assesses through exploratory and confirmatory factor analyses 41 items (questions) loading in 10 factors. In the second type, the standards created by the Society of Automotive Engineers (SAE) International (1999a, 1999b), "*J4000 - Identification and Measurement of Best Practice in Implementation of Lean Operation"* and *"J4001 – Implementation of Lean Operation User Manual"*, provide a comprehensive set of 52 questions for six areas among the entire enterprise, assessing the level (from 0 to 3) of implementation for each item audited. These standards arithmetically provide a score as a basis to describe where the organization undertaking the audit is standing. Another assessment left out in the observations by Saurin et al. (2010) which fits in the second category is the instrument provided by Kobayashi (1995), *"20 Keys to Workplace*

Improvement", which provides a framework and sequential implementation of the basic elements for continuous improvement. These instruments come from different backgrounds, possessing in their differences certain common characteristics, summarized in Table 7.

2.4.2 Human Factors in Lean

The perspective of people in operations is a broad and complex topic. Lean is not the exception. Consistently, literature cites as important attributes for successful lean practices discipline and control, continuous learning, teamwork, participation and empowerment, multi-skilling (multi-tasking) and adaptability, commitment, communication, among others (Bhamu & Singh Sangwan, 2014). Bidanda, Ariyawongrat, Needy, Norman, and Tharmmaphornphilas (2005) categorized human issues when implementing cellular design in eight areas: worker assignment strategies, skill identification, training, communication, autonomy, reward/compensation system, teamwork, and conflict management. In their study, they found that communication was the highest priority among managers and workers, but not for academicians, for whom training received the highest rank. Overall, the issues with the highest priority were communication, teamwork and training.

Table 7 Relevant Assessments for Leanness

	Kobayashi (1995)	**SAE International (1999a); (1999b)**	**Shah and Ward (2007)**
Type	Audit	Audit	Survey
Source	Book	Standard	Research Paper (Journal)
Items	20	52	41
Factors	20	6	10
Scale type	Likert	Likert	Likert
Response points	5	Varies, 2 & 4	5
Scale tags	Level 1 - Level 5, statements corresponding to each item	Level 0 - Level 3, statements corresponding to each item	No implementation - Fully Implemented
Reach	Workplace	Enterprise-wide	Enterprise-wide
Scoring	Arithmetic sum of levels, totaling 100 points	Areas 1, 2 & 6, 25 percent each; areas 3,4 & 5, 25 percent combined. Total 100 percent	Factor Analysis (Loadings)
Focus	Progressive roadmap for 20 keys at the workplace, through strengthening manufacturing quality and energizing the workplace, with the goal to have better quality, cheaper cost and faster manufacturing time.	Identify and measure best practice in the implementation of lean operation in a manufacturing organization. The focus is in six areas: management/trust, people, information, supplier/organization, customer chain, product, and process/flow.	Compiles previous measurement instruments. Provides an operational dimension for Lean production, including the "synergistic relationships".

Liker et al. (2008) listed the competencies that the human resources department at the Toyota Motor Manufacturing facility in Kentucky (TMMK) considered to make the selection of personnel that would meet the requirements for their operations. The organization behind the process was Select International, Inc. whose mission is to provide solutions on human resources activities. The requirements are compiled in nine dimensions (TMMK Dimensions as illustrated in Table 8). The Toyota approach was a customized product that was relevant in that context. Nonetheless, it can be considered a reference for requirements, even when the system and the factory have evolved to a more sophisticated version.

In a more robust solution, Select International has designed an assessment methodology intended for manufacturing jobs (Kung, Lawrence, & O'Connell, 2012). This assessment consists in fourteen different competencies (SAM Competencies), finding partial overlap over the original used at TMMK.

Bangre (2017) analyzed which competencies (Flow Dimensions) from the proposed by both sets would be more relevant for the flow of production, collecting information using a survey with subject matter experts. Even when her sample size was limited, it provides a framework of reference for the requirements in Lean of the stakeholders. Table 8 shows the comparison of factors considered.

Table 8 Human Requirements for Manufacturing (Bangre, 2017; Kung et al., 2012; Liker et al., 2008)

SAM Competencies	TMMK Dimensions	Flow Dimensions
Attention to Detail	Adaptability	Attention to Detail
Basic Math (Optional)	Initiative	Communication
Leadership Potential	Mechanical Ability	Flexibility (Adaptability)
Mechanical Reasoning (Optional)	Oral Communication	Initiative
Positive Attitude	Practical Learning	Teamwork
Process Monitoring	Problem Identification	
Qualitative Problem Solving	Problem Solution	
Quantitative Problem Solving	Team Orientation	
Responsibility	Work Tempo	
Risk Reliability		
Safety Orientation		
Teamwork		
Work Ethic		
Work Tempo		

2.5 Findings and Summary

This chapter initially explored five different instruments in the analysis of culture, considered the most popular in the field. The summary of factors illustrated some overlap among the instruments measuring culture. The compilation performed by Taras et al. (2009) provided factors from 121 instruments, where the aforementioned five have cross-reference with the higher relevance in their study, from the perspective of importance to workplace and as instruments to measure national culture.

The research in Lean has shown the debate of the influence of national culture from the perspective of three propositions: convergent theories, divergent theories and mixed theories. From fifteen studies investigated, nine propose divergence of Lean as a management practice, finding significant influence of national culture; three studies demonstrated no influence, with a predominant corporate culture, hence proving the convergent theory; two studies provided partial influence, with most characteristics seemingly outside the reach of corporate culture; and one study with inconclusive results in emerging economies. The evidence shows the diversity of thought and the lack of consensus about the influencing effects of national culture.

Another topic in discussion with lack of consensus is the factors determining the success for the Lean management practice. Several studies focus on different aspects on both ends, technical and human factors. Figure 6 and Figure 7 described the most frequently cited in the selected literature, proposing those essential in constructing a framework of Lean. Additionally, the assessments to cover the progress are as well diverse, finding several characteristics among them. Three selected assessments provide match with the purpose of this study.

Lastly, this chapter covered the requirements for a successful Lean management practice from the people participating in it, summarized in respect to two instrumented definitions, with validation in a research project that identified five common and relevant competencies.

The following chapter will introduce how these findings provide the global framework for the model of hypothesized influence of national culture between the human requirements and the structure of the Lean management practice. Each concept will describe their respective framework and variable selection, as well as the items for measurement with the design of the relationships within each other.

Chapter 3: Methodology

3.1 Introduction

The focus of this chapter is to introduce the development of the framework that supports the rationale of the project and to explain the details of the procedure followed designing and conducting the research. The first section explains the research design, detailing in the methodology, population and instrument for data collection. The second, data collection and sample size, covers the nuances of the sample size requirements for statistical validity. The third section provides the parameters of the study, in a thorough explanation of the variables and the logic that supports the selection of these. The last section explains the development of the structural model, and its special considerations.

3.2 Research Design

As mentioned in the first chapter, this research follows a hybrid model (descriptive and analytical). From a Systems Engineering perspective, this is mainly due to the capacity of analyzing the relationships of a descriptive model providing inferences about the system, but not superseding the logical analysis over the quantitative analysis (SEBoK authors, 2015). In this context, the framework that supports this research intends to establish a causal model that provides relevant information for the relationships within the concepts that will be approached quantitatively on a basis of qualitative data, where the results expected should explain a logic over the evidence, not forcing conclusions suggested solely by the mathematics without further foundation.

The research is conducted in five stages (Figure 8), using as a reference the model proposed by Flynn, Sakakibara, Schroeder, Bates, and Flynn (1990). The literature review provided the theoretical foundation for the study, as described in chapter 2, where the research gap along with the relevant variables with their corresponding definitions set to measure in this study were identified, furtherly explained in section 3.4.

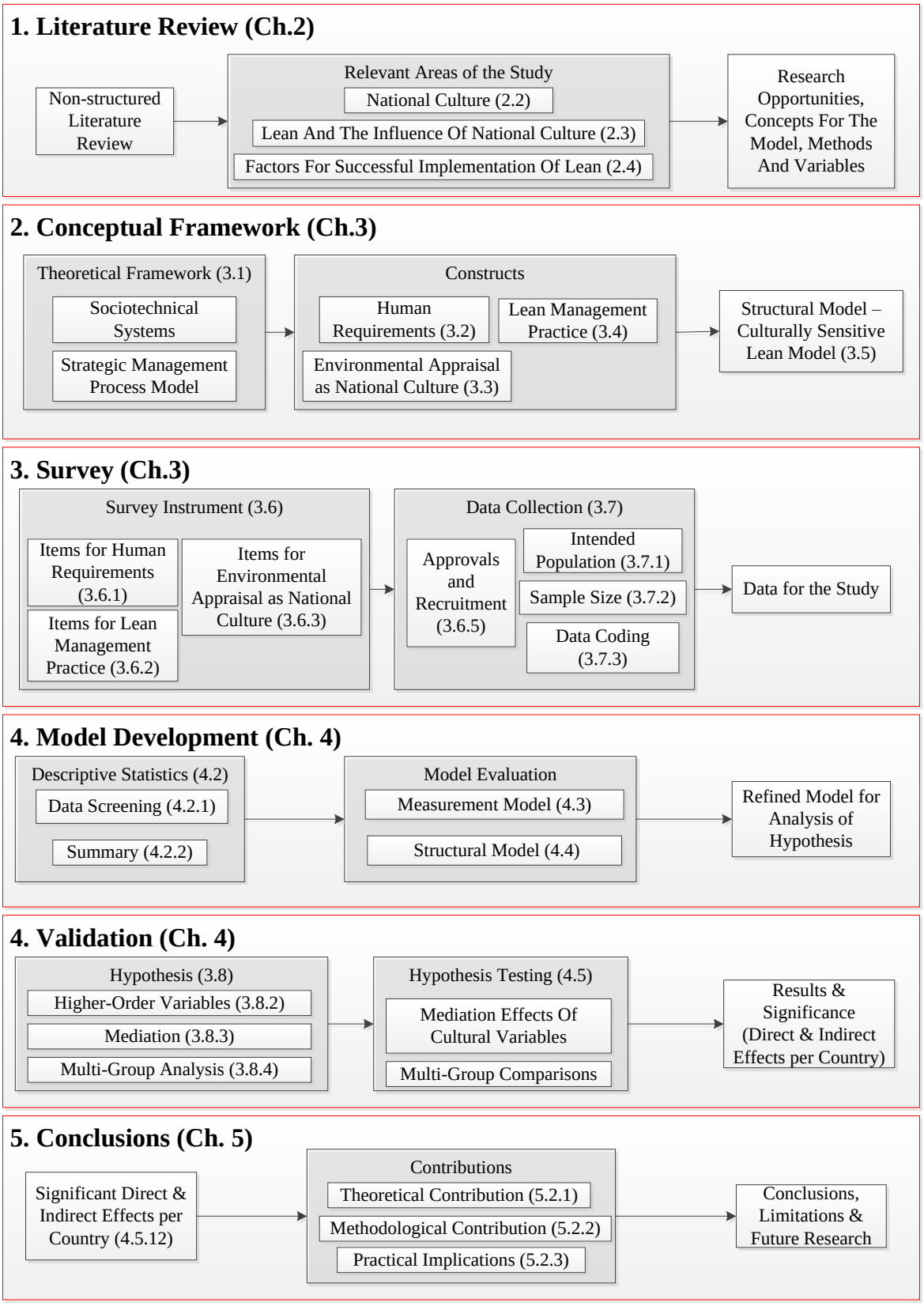


Figure 8 Detailed Research Methodology

This research design as Flynn et al. (1990) propose is an empirical survey based on a single cross-cultural and cross-sectional case study, for which the most adequate instrument is a questionnaire. The purpose is the data collection on cultural preferences, personal preferences of behaviors and attitudes at work (competencies), the perception of the current state of lean ("leanness") through workplace and process conditions, and the current performance of outcomes for the business. The advantage of using a cross-sectional method is reflected in the cost of the project, as we can use the information to provide insights upon completion of the study, without a significant waiting period (as compared with a longitudinal study).

The statistical model and data collection instrument were developed in parallel. The selected method of analysis is Structural Equation Modeling (SEM), which utilizes latent variables (unobserved variables) to explain the theory from the proposed framework, via the observed variables captured by the questionnaire. Section 3.4 details each of these variables.

Within SEM, the method selected for model estimation is Partial Least Squares, which will be furtherly explained in section 3.5. The third stage relates to data collection, which is furtherly explained in section 3.3. The last two stages refer to the statistical analysis, describing the parameters and steps to reach the validated structural equation model, illustrating the results and conclusions of the study.

3.1 Framework and Parameters of the Study

The framework of the model utilizes two theories. The first theory is the Strategic Management Process Model (Kazmi & Kazmi, 2008). This model is adapted to determine the effects of the selected strategy, being this the Lean management practice, analyzing the influence of the environmental variables as mediation for both, the assessment of the initiative as well as the evaluation of the organizational performance, as depicted in Figure 9.

For the purpose of this study, Lean management practice is the strategic choice in the proposed model, reason why not to include any parameters for the process followed in reaching this decision. Therefore, the study is focused in the determination of the requirements of the strategy as the initial step. In this context, the second theory behind the model is the Sociotechnical Systems Theory, which supports the framework structure of both the requirements as well as the assessment of the environmental appraisal.

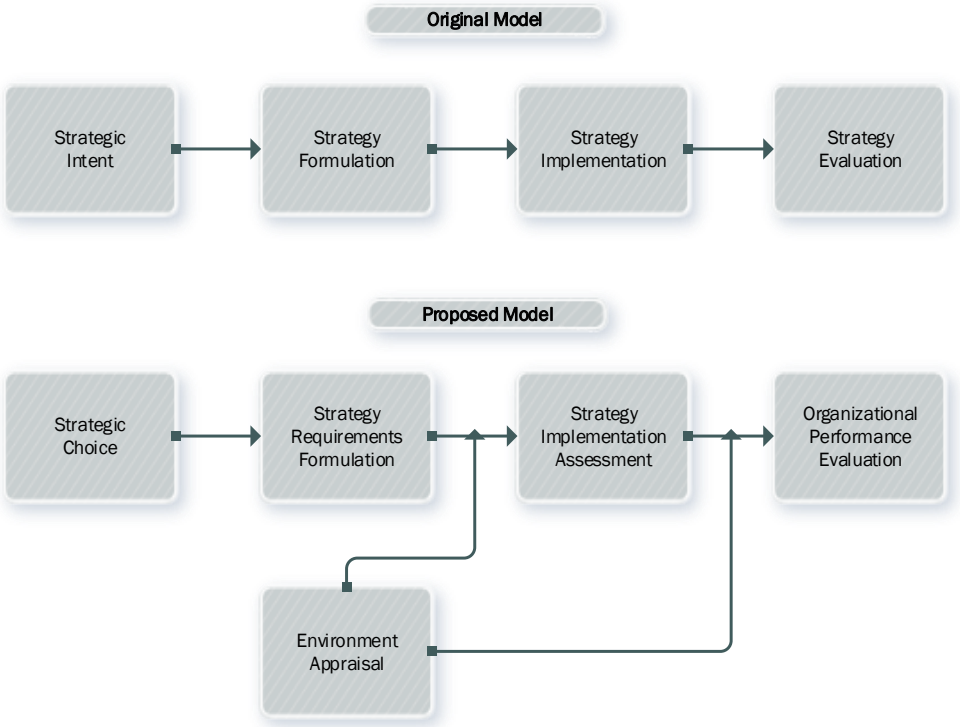


Figure 9 Strategic Management Process Model (Kazmi & Kazmi, 2008) and the proposed model

Sociotechnical Systems Theory establishes that "the design and performance of new systems can be improved, and indeed can only work satisfactorily, if the *social* and the *technical* are brought together and treated as interdependent aspects of a work system (Clegg, 2000)." Hendrick and Kleiner (2001, as cited in Marodin and Saurin (2013)) proposed that Sociotechnical Systems can be grouped in four subsystems: Human, Work Organization, External Environment and Technology. Early theorists of Sociotechnical Systems (Bostrom & Heinen, 1977b) proposed that all four subsystems coexist in continuous interaction within work systems. However, they distinguish a clear boundary between the subsystems that belong to the Social System (in this case, Human and External Environment) and the Technical System (Technology and Work Organization).

Bostrom and Heinen (1977a) mention that the social system is generally concerned with the investigation of individual needs, characteristics and abilities of people in the work system; the internal work system characteristics, such as the organization structure; external environment of the system, i.e. the prevailing characteristics over which the system has no extrinsic influence; and, support systems for the work system. In this model, the Social System consists of the pertaining attributes required from the people participating in the Lean Management Practice, as well as the assessment of the national culture constructs as elements from the external environment.

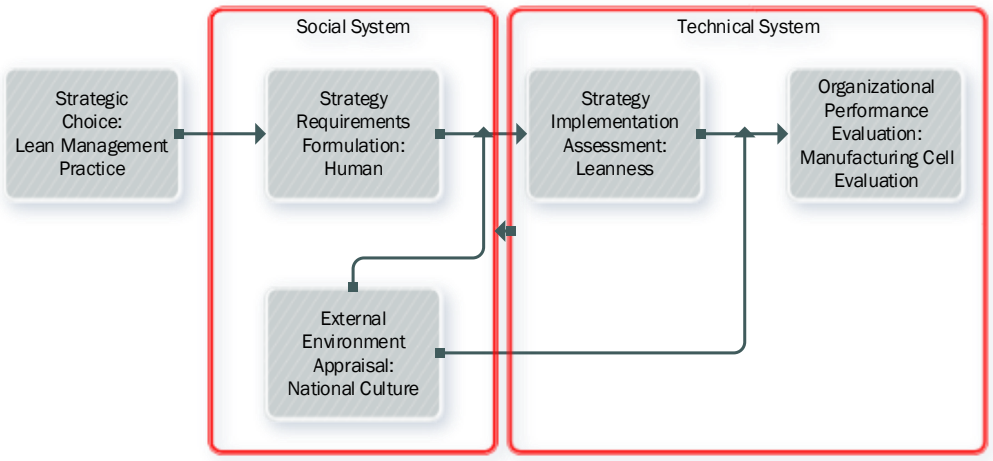


Figure 10: Sociotechnical structure

In turn, the technical system is assessed by the perceived implementation of the Lean Management Practice (the "technology") or Leanness at the organization, along the specific context of the design where the outcomes are measured (the "work organization"), i.e. the manufacturing cell or the productive area that are supported by the practice. Hence, the hypothesized relationships consider the social system being the requirement and the mediator for the outcomes of both, the Lean Management Practice, and the Organizational Performance (Figure 10). The latter is not included for the final model framework. Each element is furtherly described in the subsequent section, following the logic of appearance in the model.

3.2 Social System: Human Requirements

As discussed in chapter 2, the drivers for the successful operation of the Lean Management Practice are mostly elements of people's behavior. In other words, skills and attributes are relevant factors to determine not only the success of the initiative, but also, its sustainability.

From this perspective, the drivers and barriers previously identified support the identification of requirements expected from the people that work under a Lean Management Practice. These requirements should support not only the psychological attributes from people participating in this practice, but as well, their predisposition for attitudes and behaviors that reflect alignment with the expectations of Lean.

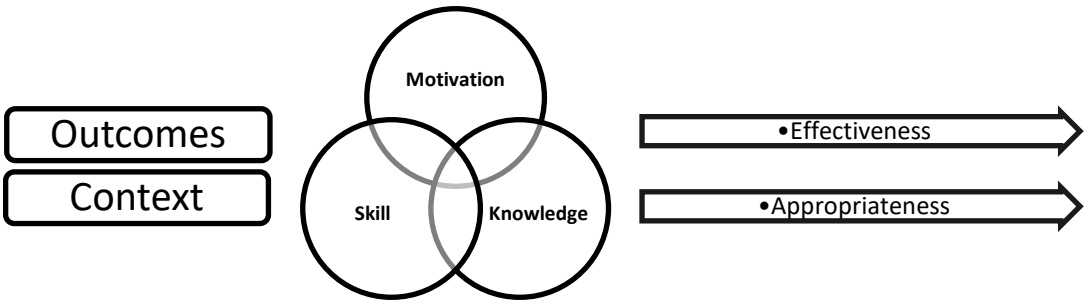


Figure 11 Conceptual Model of Relational Competence (Klakovich & dela Cruz, 2006).

An underlying characteristic of the requirements is competence. Competence is the interaction of skills, motivation and knowledge (Figure 11) and their perceived effectiveness of the outcomes and their appropriateness with the context (Klakovich & dela Cruz, 2006). Hence, the assessment of the personal (human) requirements provides a reflection of the level of competence an individual possesses to fit in the practice of Lean.

The list of competencies utilized as Human Requirements uses the ones suggested by (Bangre, 2017) illustrated in chapter 2, Table 8: attention to detail, communication, flexibility, initiative and teamwork. In addition, the list includes other elements not considered by Bangre, that are essential for the purpose of this study: problem solving, identified in Kung et al. (2012) and Liker et al. (2008); self-efficacy, as proposed by Maslow's *Hierarchy of Needs*; and autonomy, provided by the construct of *job control*.

3.2.1 Attention to Detail

Attention to detail, as described by Kung et al. (2012) is about placing special care "to ensure all aspects of work are completed correctly, developing effective methods for tracking specifics and checking the quality of one's work in order to ensure accuracy." The application of the construct in a study by Miron, Erez, and Naveh (2004) as a mediator of quality and performance, in conjunction with innovation, encountered that perhaps innovation and attention to detail do not compete culturally, but the latter might be sacrificed when innovation is pursued for enhanced performance. This suggests that for Lean Management Practice, the construct might relate to the implementation of standard operations. To measure this factor, Moorman and Blakely (1995) defined a construct that grasps in a slightly different approach the attitude towards attention to detail, called "personal industry". This factor explains how an individual takes responsibility and executes beyond expectations. The construct consists of four items.

3.2.2 Communication

Communication, is defined in the TMMK Dimensions in Liker et al. (2008) as "effectively expresses ideas and information in individual or group situations (includes organization, gestures, and non-verbal communications) and has active listening skills." From the perspective of work, Bidanda et al. (2005) argument that effective communication provides better results for the organization, especially in contexts of lean (cellular manufacturing in specific). They found three contexts: intra-cell, for daily tasks, and across shifts; inter-cell, for collaboration across different organizations, both vertically and horizontally; and the manager-to-cell communication which is intended for "longer-range changes such as worker assignment, training, movement towards a flexible workforce, expectations, etc." Losonci, Demeter, and Jenei (2011) identified communication as the greatest effect in the perception of people as a predictor of Lean success.

The measurement for the construct of communication in this study has a particular focus on the individual skills for interpersonal communication, in the context of work. Glickman (2002) developed an instrument to identify communication skills in lieu of developing optimal thinking. An adapted version of this instrument was used as a reference to build a self-assessment of communication skills among nurses dealing with complex communication situations (Zacharias, 2013). The original construct consists of 25 items.

3.2.3 Flexibility

Flexibility, as rephrased from *Adaptability* (Liker et al., 2008) is the person that "maintains effectiveness in varying environments, tasks responsibilities, or people situations." The National Research Council (2015) has defined it as "the ability to adjust and accommodate to changing and often unpredictable physical, interpersonal, cultural, and task environments." In Industrial and Organizational Psychology, two concepts approach both definitions: Adaptive Performance, which deals with workplace contexts and change; and Psychological Flexibility (or inflexibility, as per original definition), which deals with the person's ability to cope with change. Two scales are the most relevant measuring Adaptive Performance: the "Job Adaptability Inventory" (JAI) (Pulakos, Arad, Donovan, & Plamondon, 2000), and the "Individual Adaptability Measurement" (I-ADAPT-M) (Ployhart & Bliese, 2006). For the purpose of this study, we use the second instrument.

Ployhart and Bliese (2006) developed the Individual Adaptability theory from an extensive review of adaptability research, which considers the mediation of the situation, the strategy selected to deal with the situation, dealing with the situation itself (self-regulation and coping) and the learning process about this type of situation, all influencing performance. This mediation process is highly influenced by environmental factors (such as in this case, national culture). Hence, the concept of Individual Adaptability is "an individual's ability, skill, disposition, willingness, and/or motivation, to change or fit different task, social, and environmental features."

3.2.4 Problem Solving

Problem solving, not included in Bangre's analysis, still possesses high importance in the requirements for the operation of the Lean manufacturing management practice. SAM Competencies include two different types of problem solving: qualitative and quantitative. Qualitative problem solving refers to "being able to effectively resolve problems that involve people, things and processes requiring general logic and common sense." Quantitative problem solving refers to "being able to work with numbers and perform simple mathematical calculations to accurately solve a problem." Given the nature of the concept, quantitative problem solving becomes more difficult to measure without using mathematical calculations in a self-assessment. Hence, the preferred approach in this case is the qualitative.

The instrument I-ADAPT-M captures in different factors the concept of problem solving qualitatively. Eight factors comprise this instrument: handling emergency or crisis situations, handling work stress, solving problems creatively, dealing with uncertain and unpredictable situations, learning new work tasks, technologies, and procedures, demonstrating interpersonal adaptability, demonstrating cultural adaptability, and demonstrating physically oriented adaptability. For this study, this instrument supports the measurement of the two aforementioned factors: flexibility and problem solving. The instrument consists of 55 items.

3.2.5 Initiative

Initiative (Liker et al., 2008) is considered in the person that constantly pursues personal or team goals proactively, taking action beyond expectations. Some characteristis are: "seeks information needed to do the job; takes action as opposed to waiting to be told what needs to be done; feels ownership for the job; accepts responsibility for work and/or team effectiveness; provides support to team members and will take action to correct a situation collaboratively with team members if required (e.g., absenteeism, quality)."

Morrison and Phelps (1999) developed a construct that characterizes the factors that motivate employees in furthering their efforts from their regular expectations in their jobs to generate positive change at work. They classified this construct as an extra-role behavior, defined as "*taking charge"*, which is a more comprehensive assessment of initiative.

Taking charge is a "voluntary and constructive effort, by individual employees, to effect organizationally functional change with respect to how work is executed within the contexts of their jobs, work units, or organizations." Its difference from other constructs relies in that this is not an expected attribute from the employees, but in turn its focus is in improvement through organizational change. Due to its described nature, it is an essential characteristic of less hierarchical organizations and cross-functional teams, which are as well essential foundations of the Lean Management Practice. For the purpose of this study, this construct captures the necessary information for the context of Lean, as a requirement for the continuous improvement effort. This factor consists of 10 items.

3.2.6 Team Orientation

Teamwork as defined in Liker et al. (2008) is the attribute of the person that "uses appropriate interpersonal styles and methods in helping a team reach its goal; maintains group cohesiveness and cooperation and facilitates group process; provides procedural suggestions when appropriate; is aware of needs and potential contributions of others." In the SAM Competencies (Kung et al., 2012), it is defined as the person that is "cooperating and working effectively with others in the pursuit of common goals."

In this context, a similar construct called "*team orientation*" reflects the extent to which individuals agree with these attributes. This construct captures the individual's tendency for cooperation within team

settings, willingness to learn from team members and trust in their productivity capacity (Mohammed & Linda, 2004). The construct is part of a scale created by Denison & Neale (1996) [as cited in (D. Denison, Nieminen, & Kotrba, 2014)] called the "Denison Organizational Culture Survey" or DOCS. The construct has been used by several researchers (Bailey et al., 2002; Jacobs, 2015; Mohammed & Linda, 2004; Ur, Abdul, Kashif, & Usman, 2017) receiving high reliability consistently. The items identified are extracted from a study measuring attitudes towards military within teenagers and young adults (Bailey et al., 2002) using the modified version by D. R. Denison, Janovics, Young, and Cho (2006) to identify their preference to work in teams. This factor consists of nine items.

3.2.7 Self-efficacy

In addition to the previous dimensions, an essential requirement for the success of a strategy is determined by the engagement a person has with respect to work and the organization. Maslow's *"Theory of Human Motivation"* (1943) describes the *"Hierarchy of Needs"* model, where personal development is achieved in four stages: physiological needs, social needs, egoistical needs and self-actualization (Kucner, 2008). Maslow explains that people fulfill naturally the first three stages, but the fourth one requires effort. Also, this fourth stage is possibly the most pertinent for engagement in the workplace.

Self-actualization, according to Maslow (1943), is "the desire for self-fulfillment, namely, to the tendency for [a person] to become actualized in what he is potentially." This implies the continuous pursuit for self-realization, which reflects the ambition of an individual to grow and fullfill his potential.

In a more detailed description of this dimension, Erez and Earley (1993) expand and rename the concept as "Self-motive" in regards of three components:

1) Self-enhancement: "seeking and maintaining a positive cognitive and affective state about self worth and well-being."
2) Self-efficacy: "desire to perceive oneself as competent and efficacious in relation to specific tasks", feeling of growth.
3) Self-consistency: "desire to sense and experience coherence and continuity".

The measurement for both, self-enhancement and self- consistency, is difficult to capture in a cross-sectional study. They are mostly ideal for longitudinal projects, where constructs can be compared within

the same subjects to determine both, consistency and enhancement of the self. However, *self-efficacy* remains as one of the measurable constructs that provide indication of motives to develop an engagement profile in the subject's job. It suggests the perception of the individual to fit within a context, as a function of his competencies. The International Personality Item Pool or IPIP (Goldberg et al., 2006), provides a 10 item instrument to measure this construct.

3.2.8 Autonomy

The last construct to be included in this study is *autonomy*, as another approach to account for engagement with the workplace, usually associated with the concept of empowerment. Landsbergis, Cahill, and Schnall (1999) concluded that in Lean contexts, workers do not receive empowerment but they perceive an increase in work intensity. The enhancement of decision authority and skills are just momentary. Askin and Estrada (1999) investigated autonomy within manufacturing cells, finding only a collective responsibility in quality and productivity, what they acknowledge as "semi-autonomy". Karasek et al. (1998) defined "decision latitude" as a construct widely used in literature exploring "activation, worker motivation, and job satisfaction." It is also a reflection of autonomy (empowerment) for people at work, where decisions are made at all levels (Robert et al., 2000). Dwyer and Ganster (1991) used Karasek's model to develop a construct of "job control", to determine the attendance and satisfaction of employees. This measure correlated closely with Karasek's in a study performed by C. S. Smith, Tisak, Hahn, and Schmieder (1997). In addition, they identified that from the original 17 items that loaded in job control, only nine are significant among different samples.

A pilot study supported the selection among each of the constructs, which will be furtherly detailed in section 3.6.

3.3 Social System: Environmental Appraisal as National Culture

Several instruments have been developed and documented in literature in respect to the measurement of national culture, as discussed in section 2.2.1. The task of selecting instruments and factors remains a challenge for research. An opportunity identified is to utilize different factors from different scales in order

to create a more robust approach to the measurement of national culture. The methodology to select the factors uses the rank (as illustrated in Table 3) of the most important factor scales based on the results of the work by Taras et al. (2009), through a semantic analysis paraphrasing the factors (Table 2) from each of the previously mentioned studies. Figure 12 shows the process steps to obtain the final list of variables, hence the items that measure national culture in this project.

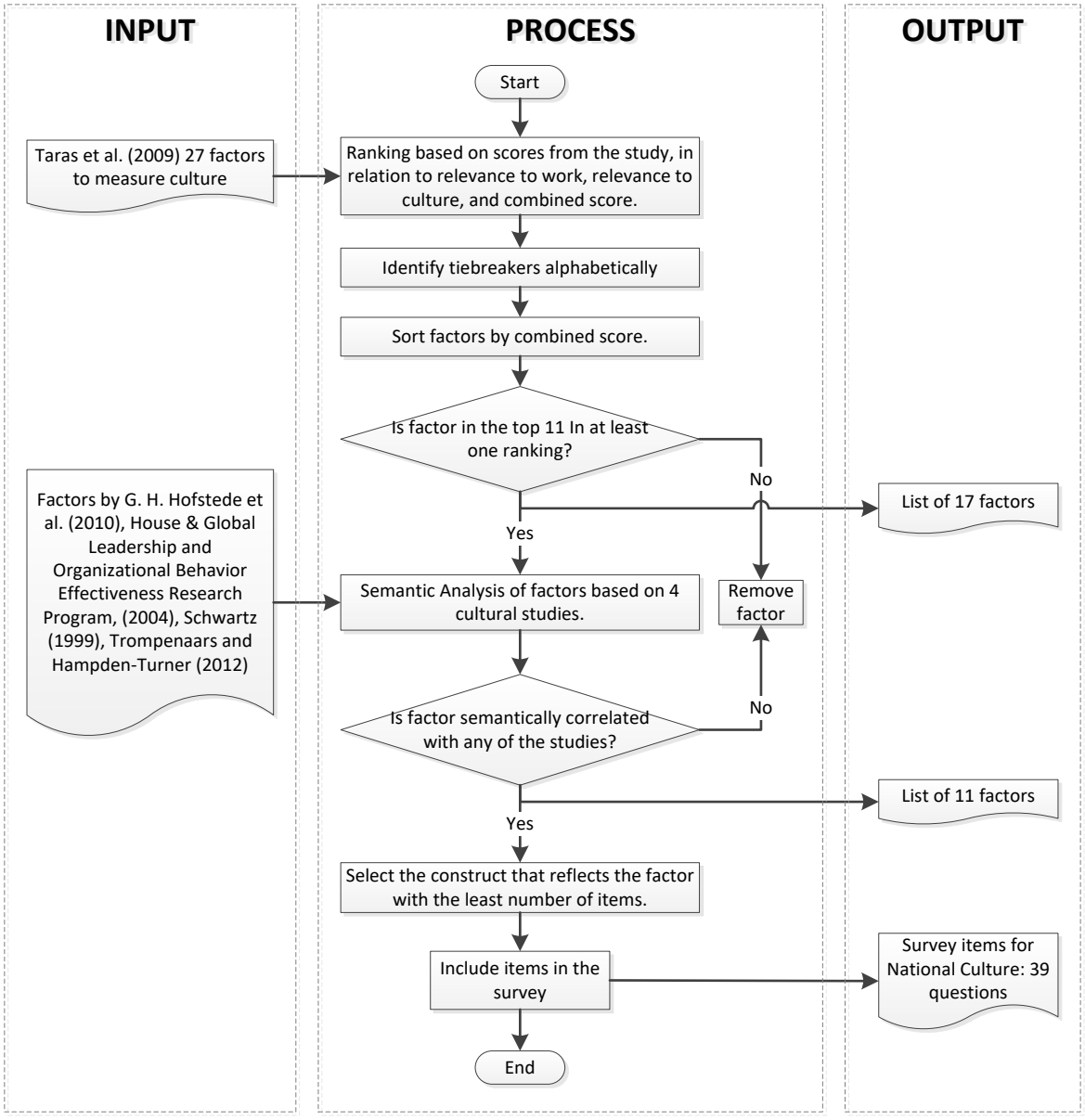


Figure 12 Selection of factors and survey items to measure national culture

First, with the scores obtained by Taras et al. (2009) the factors are ranked (highest score first) for relevance in workplace, relevance in culture and combined score. For example, the factor "Power Distance" ranks 1st in relevance to workplace with an average score of 3.91, 4th in relevance to culture with an average score of 3.99, and 1st place in combined scores (3.91+3.99=7.9). The same logic applies to the 27 factors.

The following step is to consider the top 11 factors for each category. A total of 17 factors rank in the top 11 in at least one category. These factors were cross-referenced through semantic analysis (Goddard, 2011), paraphrasing the definitions provided by Taras et al. (2009), and those from each instrument. The final list includes only those factors that semantically are included or similar to at least one of the instruments, deriving a total of 11 factors (Figure 13).

The following sections describe the definitions provided by Taras et al. (2009), as well as those provided by each of the instruments in which the case applies, used for the semantic analysis, as well as a reflection on their importance to include within this study.

		Ranking			Cross-reference			
CULTURAL FACTOR SCALES	**EQUIVALENT TERM**	**Workplace**	**Culture**	**Both**	**GLOBE (House)**	**Hofstede**	**Trompenaars**	**Schwartz**
Power Distance	Power	1	4	1	X	X		X
Gender Equality	Masculinity vs. Feminity	9	1	2	X	X		
Status by Ascription vs. Status by Achievement	Achievement	10	3	3			X	X
Universalism vs. Particularism	Universalism	6	7	4			X	X
Ambiguity Avoidance	Uncertainty Avoidance	8	8	5	X	X		
Independent–Interdependent Self-Perception	In-group Collectivism, Collectivism 2		9	6	X			
Assertiveness		2		7	X			
Achievement Orientation	Performance Orientation		5	8	X			X
Self-Reliance	Individualism-Communitarianism/Collectivism	5		9		X	X	X
Emotional vs. Neutral			10	11			X	
Short- vs. Long-Term Orientation	Future Orientation	11			X	X		

Figure 13 Semantic cross-reference of National Culture factors

3.3.1 Power Distance

This factor sits at the top of the rankings in its importance for the workplace as well as the combined score. According to Taras et al. (2009), 23 instruments use this factor to measure culture. The definition they provide is "the extent to which people expect and accept that power in organizations is distributed unequally; degree of inequality among people which the individual accepts as normal."

In regards to this study, three of the five instruments utilize this factor as a measurement of culture. House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004) defines it as "the degree to which members of a collective expect power to be stratified and concentrated at higher levels." This definition, yet simple, suggests an appreciation of not only the existing distance, but that hierarchical nature of it. Compared to Taras's et. al. definition, this seems to relate more to the second statement. However, this hints more of an expectation of the distribution of power rather than their acceptance of it. (G. H. Hofstede et al., 2010) defines this factor as " the degree to which the less powerful members of a society accept and expect that power is distributed unequally." This definition seems to connect closely with the one provided by Taras, et. al. Hofstede adds that this factor appreciates how societies handle inequalities among their people. Higher power distance societies accept hierarchies with no question, opposed to societies with low power distance, where equality is not only an expectation, but a demand. Lastly, Schwartz (1999) suggested that power as a value consists of the "attainment of social status and prestige, and control or dominance over people and resources". This suggests a definition as the end purpose, more than the degree of acceptance from a particular society. From the three definitions, Hofstede's has a closer semantic meaning to the one provided by Taras, et. al. The latest version of Hofstede's instrument measures this factor with four items.

3.3.2 Gender Equality

Taras et al. (2009) have defined this factor as "perceiving roles and abilities of men and women as equal and believing that men and women have the same rights and responsibilities and are capable of performing equally well on most work-related tasks including managing people." The instrumentality of this definition makes a clear statement on perception about three dimensions: rights, obligations and performance, especially in work contexts.

Only two instruments suggest approximate definitions for this factor. House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004) study the factor as *Gender Egalitarianism*, which is defined as "the degree to which a collective minimizes gender inequality". On the other hand, G. H. Hofstede et al. (2010) has defined a dichotomous construct of *Masculinity vs. Feminity*, where one end (the masculine) of this dimension societies reflect success as a function of "achievement, heroism, assertiveness and material rewards"; on the other (the feminine), societies prefer to be more "cooperative, modest, caring for the weak and quality of life". He adds that masculine societies are more competitive, where the feminine are more consensual. The reason of such labels hypothesize that the values of both genders are more in line with those described in the societies in general. This is where some confusion might arise, as Taras, et. al. suggest, where *Masculinity* in itself would be more related to the factor of *Achievement and Competitiveness*, rather than *Gender Egarlitarianism* or *Equality.* Nonetheless, this factor still builds upon the difference that genders provide within the characteristics (values) of their society, but in a contrasting approach to the preference for equality.

In a deeper analysis, the items and scale that measure both different factors provide approaches that result in less practical interpretations for the purpose of this study. House's scale suggests that higher scores mean societies promoting the equality of gender, where in Hofstede's , the scale provides higher scores to masculine societies, leaving the equality for societies in the middle of their scoring system. The operational connotation of this factor in the present study takes an easier approach when using Hofstede's latest version of his instrument, measured by four items.

3.3.3 Status by Ascription vs. Status by Achievement

Taras et al. (2009) provide the definition as "perceiving status based on who the person is (son of a famous or wealthy person royalty older person man) vs. perceiving status based on person's personal achievement and skills", which goes in line with the definition provided by Trompenaars and Hampden-Turner (2012). Achievement oriented societies focus more on the recognition by effort and all the activities that a person has developed than ascriptive societies, where recognition is by personal inherent background, provided by family ties or connections.

Schwartz (1999) defines this factor only from the perspective of *achievement*. He describes this as a value associated with personal success when a person demonstrates "competence according to social

standards." In his definition, both ends proposed by Trompenaars and Hampden-Turner seem to be included, depending on the context where it is analyzed. For societies leaning towards ascription, the competence of a person might be associated with their background, based on those standards, as opposed to achievement societies, where the character and grit of the individual would provide a better insight for competence. This is reason why Taras, et. al. suggest that this factor, from the perspective of Schwartz, is more related to the definition of *masculinity* by Hofstede.

Hence, this factor considers the items defined in Trompenaars and Hampden-Turner for measurement, which includes two items.

3.3.4 Universalism vs. Particularism

This factor is both important and defining for workplace and culture, but at a smaller scale compared to the precedent factors. Similar to the previous factor, Taras et al. (2009) provide the definition by Trompenaars and Hampden-Turner (2012): "people with universalism orientation believe that rules must apply equally to everyone and under every circumstance; while people with particularism orientation believe that some exceptions from rules can be made depending on the person (e.g., close friend) and mitigating circumstances." Universalist cultures favor absolute ruling from an abstract approach, opposed to particular cultures, which favor relationships and the context.

On the same line, Schwartz (1999) provides a holistic concept behind *universalism* where "understanding, appreciation, tolerance, and protection for the welfare of all people and for nature" become the priority for these societies. Again, this factor seems to include parts of both ends from the one defined by Trompenaars and Hampden-Turner. However, a substantial difference is the particular appreciation of nature, suggesting a different approach. Schwartz's definition provides a closer fit to the concept described in *Achievement Orientation.*

The factor is defined by Trompenaars and Hampden-Turner as a conditional instrument, where the combination of responses provide a particular conclusion. The items are three general scenarios that put the respondent under ethical dilemmas, having two questions per scenario. Depending on the responses in the first and second question, would be the deliberation of a characteristic universalistic or particularistic tendency.

3.3.5 Ambiguity Avoidance

This factor is the only one that Taras et al. (2009) recognize its semantic similitude with another factor, *Uncertainty Avoidance*. House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004) and G. H. Hofstede et al. (2010) both provide a definition for the latter term. Taras, et. al. describe *Ambiguity Avoidance* as " the degree to which people are made nervous by uncertain situations and ambiguity and prefer to have clear rules, guidance, bureaucratic practices and rituals for every situation." In their definition, they have considered the term "ambiguity", for which a semantic analysis from both definitions by the other authors acquire significant relevance.

The context for the definition of the House instrument provides a temporal context: "the extent to which a society, organization, or group relies on social norms, rules, and procedures to alleviate the unpredictability of future events". Hofstede also provides a temporal connotation. He adds that societies highly avoidant of uncertainty are ruled predominantly by principles and will not tolerate radical behavior, opposite to tolerant societies, which are more lenient towards practice over principles. With the inclusion of time in this definition, this factor provides a similar concept to that of *Future Orientation.* In practical terms, both differ given the capacity of societies to plan for the future (positive connotation), and accept or reject the uncertainty it brings. Consequently, the construct of *Uncertainty Avoidance* by Hofstede is the choice to measure this construct, which provides four items for measurement.

3.3.6 Independent–Interdependent Self-Perception

The definition of this construct would suggest more of a personal trait rather than a cultural one. However, this can be translated to collective terms in function of how interactions and a person's identity are perceived. Taras et al. (2009) provide this definition as "the extent to which individuals feel that their relatives, friends, and organizations they belong to are an important part of themselves". They add that similar constructs (including this one) that research commonly labels as *Individualism* should be considered independent from each other. Taras, et. al. identified, in the latter definition of this factor, as the most used in research. A possible explanation is the interpretation that it provides as a reference for teamwork and collaboration in the workplace, as the example cited in section 1.4.2.

From the perspective of the semantic analysis, only the construct provided by House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004) labeled *In-Group Collectivism* or *Collectivism 2* provides a similar meaning: "the degree to which individuals express pride, loyalty, and cohesiveness in their organizations or families." The commonality with the factor defined previously resides in the sense of belonging. This is the factor of choice for the present study, which uses four items for measurement.

3.3.7 Assertiveness

The definition provided by Taras et al. (2009) is the same as provided by House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004), describing the degree to which individuals of a society display "assertive, self-confident, confrontational, and aggressive" interactions with others. Societies with this characteristic suggest an overlap over *Power Distance* and *Uncertainty Avoidance*. Taras, et. al. and House suggest a possible overlap with the definition of *Masculinity* by Hofstede. When the GLOBE scales where compared to those by Hofstede, the results showed a divided perspective. Practices where significantly correlated, but values were not. Additionally, the purpose of both factors is inherently different, finding only coincidental overlaps that lead to hypothetical conclusions from these similarities. Three items measure this factor, extracted from the instrument that captures the societal values of *Assertiveness* proposed in GLOBE.

3.3.8 Achievement Orientation

Similar to the factor described in section 3.3.3, *Achievement Orientation*, has an underlying relationship with Hofstede's *Masculinity*. However, different to *Status by Achievement* and *Masculinity*, Taras et al. (2009) define it as the "willingness to win, advance, get a better position, earn more and succeed at any cost even if it means harmed interpersonal relations and/or sacrifice of personal life." This definition is closer to the one by Schwartz (1999), but it removes the humane essence that is provided as a value for success.

House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004) provide a similar factor, *Performance Orientation*, that reflects the degree a society "encourages and

rewards innovation, high standards, and performance improvement." The constructivist approach of this description provides a better alignment with the purpose of this study. This item is captured through four items.

3.3.9 Self-Reliance

From the definition provided byTaras et al. (2009), "the degree to which individuals tend to rely on themselves in difficult situations rather than expect help from others", it slightly suggest a relationship with the factors related with *Individualism* by G. H. Hofstede et al. (2010), Trompenaars and Hampden-Turner (2012) and Schwartz (1999). It is also explained similarly with *Independent-Interdependent Self-Perception* (section 3.3.6).

This construct relates closer to the belief of self-competence than the appreciation of belonging to a particular group. Hofstede et. al. define it as "a preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families." Trompenaars and Hampden-Turner motivation for this factor parts from questioning the importance that a society delivers in the expectations from its individuals and their contributions versus the importance of the society formed and shared by several individuals. Schwartz factor differs conceptually, as *Self-Direction,* described as independent thought and action-choosing, creating and exploring. Semantically, the first two definitions relate closer to the originally proposed by Taras, et. al. For this study, the selected instrument is the one by Trompenaars and Hampden-Turner, characterized as *Individualism-Comunitarianism,* which is captured in three items.

3.3.10 Emotional vs. Neutral

The factor identified by Taras et al. (2009) is the one defined by Trompenaars and Hampden-Turner (2012), "the degree to which people believe that displaying feelings at work is unprofessional and inappropriate." This factor, perhaps in its simplistic nature, provides a significant differentiation for the perspective of the societies that demonstrate a preference for a "neutral" behavior at work. The other instruments do not provide any other approximate meaning or concept. A single item captures the factor,

proposing a binomial response. The measurement captures the percentage of respondents providing a positive response, segregated by groups, i.e. by country.

3.3.11 Short- vs. Long-Term Orientation

At the bottom of the list, this factor perhaps not included in the combined ranking, semantically is found in two of the instruments, and is considered the last factor within the final list considered for the relevance at the workplace. Moreover, one of the purposes of this study is to identify the sustainability of Lean practices, for which this factor seems to be an important element. The definition provided by Taras et al. (2009) is explained by the trade-off on both ends of the spectrum: “seeking quick gains even if it means losses in the future vs. focusing on the future outcomes and being ready to suffer losses in the short-run for the sake of future gains.”

From a nominal perspective, G. H. Hofstede et al. (2010) provide a similar factor *Long Term Orientation,* described from the perspective of the values that it defines (derived from Confucianism). Societies with *Long Term Orientation* value thrift and perseverance, and on the opposite end, *Short Term* societies respect tradition, fulfilling social obligations, protecting image and reputation. The construct has been replaced in recent versions of their instrument by a dimension of *Pragmantic vs. Normative* societies.

A current factor still resides in the one defined by House and Global Leadership and Organizational Behavior Effectiveness Research Program (2004) as *Future Orientation,* as “the degree to which a collectivity encourages and rewards future-oriented behaviors such as planning and delaying gratification." This factor includes four items for measurement.

3.4 Technical system: Lean Management Practice

As stated in chapter 2, the Lean Management Practice follows the principles of the TPS. In some cases, it is considered a synonym for the description of the concept, specially within the western cultures, where the methodology acquired its popular name (Lean). TPS subsystems represent different stages that are fundamental for its operation. They have to be dissected in order to identify the stepwise evolution of the system, ensuring a succinct implementation, hence, its success.

One of the goals of the TPS that represents direct impact on the production floor is securing continuous flow to achieve throughput. This can be approached by the subsystem commonly identified as "Just In Time" (JIT). The purpose of this system is to support the structured identification of waste (*muda*) throughout the shop floor, facilitating the administration of the field (*gemba*) with a diverse set of tools, techniques and methodologies that interact as the core of the mechanics of the system. Literature commonly identifies these elements as illustrated in Table 5 Lean tools/techniques/methodologies identified in Lean literature (Bhamu & Singh Sangwan, 2014). These elements provide a manageable understanding and operability, for control and sustainability. However, independent use or implementation might result counterproductive.

Considering the lack of a common framework in the practice of Lean (Bhamu & Singh Sangwan, 2014; Yadav, Nepal, Rahaman, & Lal, 2017), the instrumental elements proposed as tools, techniques and methodologies possess unique operational characteristics, with the opportunity to create groups with shared characteristics and purpose, i.e. clusters. The logic behind these clusters is aligned with the purpose of this study: ease of analysis, an approach for a generic framework, and a sequential set of requirements for implementation. The fundamental structure is adapted from the work of Monden (2011). Even when the elements are included in a particular a group, some of them could have partial membership in more than one group. The role these tools, techniques and methodologies play in their respective group provides a reference for their association.

Therefore, the proposition in this project is that the JIT subsystem has six identifiable clusters (Figure 14), which are sequential in how they work for the achievement of the desired throughput, adapted from Monden's work (Paez et al., 2004).

Foundation and Prerequisites of TPS – These are the elements necessary for the operation of all the rest, hence the importance of being meticulous in the proper understanding that guarantees the operation and furthermore, the development of the habits that shape a continuous improvement culture. It also provides the baseline to identify where value is created, identifying the opportunities to eliminate waste.

Workplace Design - To attain this wherever possible within the facility, we need to evaluate interaction of the sociotechnical systems in order to reorganize the best layout for the lines (machines, conveyors, workstations) and the functions performed by the workers, making possible to establish the platform to create a balanced workload for each production area.

Standard Operations – This element becomes the heart of the entire subsystem, as it is interconnected with all the other elements. It represents a core element as it is a reflection of the everyday activities in

operations, it is the repository for the achievements through the practice of 5's, a new breakdown of distributed work, the parameters of operation for quality purposes, and the empowerment of the people to develop and improve everyday operations in pursuit of the best method.

Consistency – This subsystem supports the quality levels attained in production by variation reduction. The focus is the creation of the attitudinal elements that support the people in the shop floor to make decisions for problem solving, eliminating errors at the source, as well as development of mechanisms to prevent errors and keep the equipment working. This is supported by the controls that monitor the desired standards that will comply with customer requirements, as well as the maintenance methodologies that secure continuity in the process.

Flow – With the facilitation of the fundamentals, workplace design and standard operations, the next step is to establish the most manageable production quantity: one piece. The ability to be responsive to production changes needs to be developed in parallel. Perhaps this segment represents the most controversial of the elements in supporting flow due to constant changes, but proven to be effective to respond to customer demands, which involve changes in product quantities. This subsystem has a direct impact with faster turnover of orders, therefore on-time delivery by the reduction of lead-time.

Production Scheduling and Sequencing – In this approach, this subsystem deals more with the logistical part from the planning and sequencing of orders, the total number of products that will be part of the schedule for a timeframe, and the control that facilitates the transit of these materials between major production areas (also with suppliers and customers).

The sequence of the diagram follows a bottom-up approach, where the lines represent the interconnectedness within each one of the concepts included. The baseline represents the starting point for the Lean management practice, where the top represents the ultimate goal in regards to throughput. This framework follows only those elements that provide impact in throughput. However, not all of them (especially at the baseline) would have an immediate impact in reaching production goals, but they are considered necessary for the sustainable operation of the practice, leading tangible results if followed thoroughly. The following subsections explain each of the six clusters.

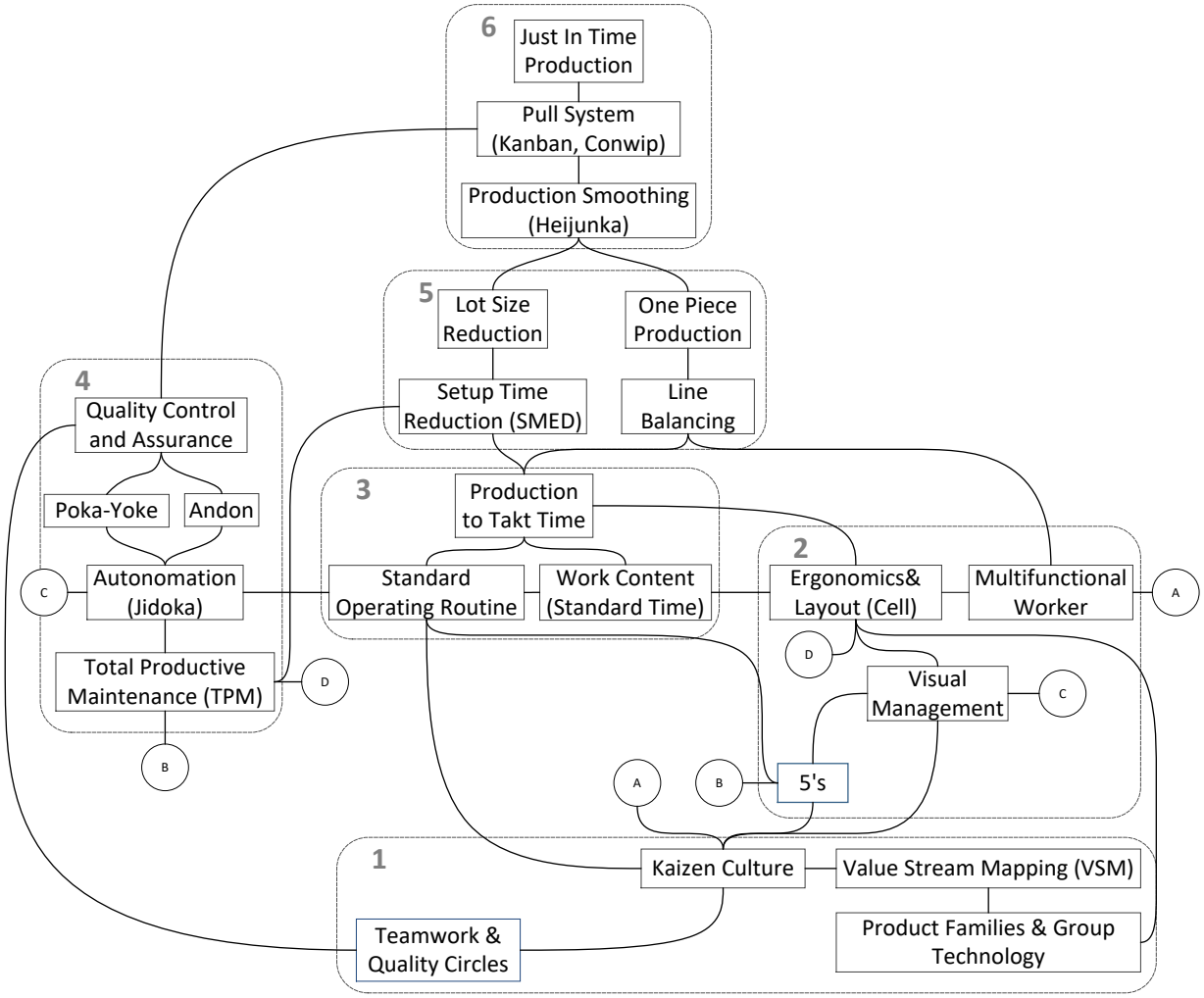


Figure 14: Just in Time Throughput Production Subsystem for the Lean Management Practice

3.4.1 Foundation and Prerequisites of Lean

The platform for the entire system operation of the Lean Management Practice relies in the proper understanding of the philosophy of continuous improvement and the fundamental mechanisms that facilitate the process. Teamwork becomes the fundamental organization to approach many of the "in-line" targets (production) as well as the "out of the line" objectives (improvement projects, supporting operations) (Biazzo & Panizzolo, 2000). Cooperation and collaboration are the essential interactions that instrument a solid foundation for the development and operation of the rest of the elements within all the subsystems. Depending on the context of the work or proposed improvement, we commonly find "quality circles".

Hence the first element of this cluster is *quality circles,* which are small groups of workers that gather periodically (in some areas, daily at the beginning and end of the shift) to provide solutions in their workplace, and commonly identified as a basis for the Lean management practice (Olivella, Cuatrecasas, & Gavilan, 2008). Some of these teams are formal and permanent, in the pursuit of continuously improve the work area, in other cases, these could be informal and temporary, where a particular problematic situation needs special attention . These teams consist of a team leader and the subordinates, advised by the supervisor/section head and the foreman. The circles operate to resolve issues in quality, cost reduction, maintenance, safety, and alternative resources. Quality circles represent an essential part of the improvement platform, as teamwork does for everyday operation .

The second concept, which is essential for the identification of "value streams" and workplace design is the identification of the products that will be processed by the different equipment. In a Lean environment, the product-flow type machine layout assumes that similar products are flowing through the process. In order to identify these products, the concept of *group technology* aids to identify these similar products or *families,* by their shared characteristics either in processing steps or the physical characteristics of the materials (Saurin et al., 2010; Zammuto & O'Connor, 1992). This element is essential for the design and implementation of manufacturing cells (Monden, 2011).

This particular activity is not performed by shop floor associates, but it is their responsibility to become skilled in the tasks when new products with similar characteristics are introduced into a manufacturing cell. Hence, there is no involvement in the design, but there is in its operation. The operation of this strategy from a shop floor perspective has a closer relationship in learning and adjusting for changes in the operation of the cell, which will be explained furtherly in the following section.

The third concept is the most studied in the literature as identified by Bhamu and Singh Sangwan (2014) (Figure 7). In most literature, a common denominator as a starting point for the Lean Management Practice is that it should start from the requirements of the customer. The most important requirement is to understand the customer's perspective of value. Developing the ability to understand value in the same way as the customers would result in a streamline to create that value and anything else becomes a wasteful or a value aiding activity.

Known at Toyota as "Material and Information Flow Mapping" (Rother & Shook, 2003), *Value Stream Mapping* (VSM) becomes an effective tool to depict the flow of four main elements: people, process, material and information.

Rother and Shook (2003) list the following advantages of Value Stream Mapping:

- Aids depicting the flow of production within multiple processes and even facilities, providing a common and simple language to describe the process.
- Facilitates visualizing waste where it is generated, while providing clarity of the decisions about the flow.
- Supports linking lean concepts (as the initial breakdown suggests), hence providing the basis for implementation.
- An essential requirement is the development of the map through a product family, as it will contemplate the similarities of products/processes as mentioned earlier, developing a narrower focus for elements that are relevant. It is suggested as well that the processes under analysis to be repetitive in nature, as it makes it easy to analyze the information, and achieve initial breakthroughs.

This particular tool used to map and detect the potential areas where opportunities for improvement exist. From a shop floor perspective, it is just a map of flow, where associates could refer to in case they need to improve a particular area, but in essence, it does not affect everyday operations. It is more used in the context of design and analysis than operation.

The last element within the group is *Kaizen*. It is the foundation for lean as it means "continuous improvement". Taiichi Ohno considered that this principle had to be engrained within people with proper guidance and development, that eventually would translate in their motivation to continue with the improvement journey (Monden, 2011).

Monden concludes that besides the technicalities of a Kaizen system, Ohno had the following three strategies to motivate people:

1. *"Get them to exercise their ingenuity by creating a difficult situation and giving them a problem to solve."*
2. *"Never lead people by their noses to the solution of the problem, but always make them come up with their own improvement strategies, and encourage them to develop their own problem-solving abilities."*
3. *"Even when people fail, do not communicate frustration; lend a helping hand, as leaders should become charismatic people on whom others can rely."*

These strategies are intended to instill the "kaizen mind" in the culture of the organization. However, it still needs to be described in the way it operates systematically, before the habits that shape the culture

are developed. Hence, the responsibilities at the floor level are shared through teamwork by the quality circles and the suggestion systems. Usually, at this level, the expectation is that non-monetary (or minimal cost) measures are established as the goals for control such as reduction of lead-time, improvement of quality levels, reduction of inventory levels, etc.

Kaizen takes many forms and there are many different interpretations (Suárez‐Barraza, Ramis‐Pujol, & Kerbache, 2011), from an activity that is determined to make a particular improvement, to an overall system that deems to have a sense of self-determination for improvement spread among all members of the organization and among dimensions beyond the work relations (i.e. personal life).

For the purpose of this study, Kaizen represents the foundational spirit that needs to be ingrained within the organization in order to make the improvements necessary to achieve continuous flow. Every associate should become an "improvement police", finding opportunities constantly and developing the solutions with their teams.

3.4.2 Standard Operations

Standard Operations sits at the core of the Lean management practice. On one perspective, it is a result of the discipline developed through conscious improvements achieved by the preceding elements. By consequence, it is a reflection of the kaizen spirit, as it begins to show as first nature for all members of the organization. On the other perspective,, it represents a vital requirement for consistency, developing a stable process and as a platform to build a balanced and smooth production (Paez et al., 2004).

On the human side, this element can be instrumental in developing work methodologies that are accepted by the people. But also, as proven methods to obtain the best attainable result (Wagner, 2011) because it involves the documentation and discipline of execution throughout the different decisions that facilitate the flow of a unit at a time.

Achieving a standard operation comprises three different elements, using as a reference the proposition by Monden (2011). The first element is the *Standard Operating Routine*, Imai [as cited in (Treville & Antonakis, 2006)] defines it as "a set ofpolicies, rules, directives, and procedures. .. . for all major operations, which serves as guidelines that enable all employees to perform their jobs successfully." This element becomes tangible when printed standards or training manuals explain the elements of the job. This

routine reflects more in the perspective of method, but should be aligned with the concept of time through the detailed analysis of *Work Content,* commonly known as *Standard Time* (Paez et al., 2004). This is the time that a unit of production takes in its transformation, at a given workstation, manufacturing cell or assembly line. It provides the reference to produce according to expected pace, also known as *takt time (Cochran & Dobbs, 2001).*

It is important to mention that standard operations have to be constantly adjusted, according to company policy, to meet the variations in the Master Production Schedule or MPS, which could be done in a daily, weekly, monthly, quarterly and annual basis, to cope with demand fluctuations. Hence, the importance to have the entire platform of flexibility provided by the other elements presented.

3.4.3 Workplace Design

The first element of this cluster, *5S* is what empirically most organizations use either as a start of the Lean Management Practice implementation (Bhasin, 2013), or homologate as "being" or "doing" Lean. 5S represents the basic principle behind Kaizen, for the achievement of the removal of organizational slack (muda) both in prosperous times and in crises. It is important to mention as Monden (2011) describes that this practice is usually attained when companies are in crises, but the TPS model promotes a continuous practice (even in benevolent times). The operation of the 5S is attained by teamwork, usually in the form of quality circles, following the principles behind Kaizen. If not the first step within a Lean Management Practice implementation, indeed it is the first step working towards designing "leaner" work areas, and a fundamental requirement for developing *visual management*.

In order to make opportunities of improvement visible, the kaizen mind and the discipline of the 5s must take place. In addition, the concept of *Visual Management,* which is the second element of this cluster, considers the instrumentation of a work area in order to make non-standard operations to become easily visible (Mendis, 2012). The importance behind this element resides in its practicability to assess problems in the shop floor without deeper analysis (Bhasin, 2011). It also operates as a fundamental element for creating consistency within operations (Pakdil & Leonard, 2017). Hence, a clear understanding and use of *visual management* supports the proper design of the physical space within the work areas.

The third element in this cluster represents the platform to create an improved flow with physical changes to the workplace. At the same time, it requires ergonomic changes supporting the human aspect

and the sequence of work. Labeled as *Ergonomics and Layout (Cell)*, this uses the elements previously mentioned in order to create a work area that satisfies the needs of the production process, but at the same time, those by the people working in it. The goal is to design a work area that is capable of having an installed capacity to produce based on the expected pace at which the customer demands product, and that the operations follow the principle of "Ikko-Nagashi" (Monden, 2011), which means single-unit production and conveyance (better known as *one-piece production*).

The whole purpose of the redesign is to habilitate the flexibility for the person to operate within different machines, as well as to change the necessary labor to work in within the production unit when product changes or demand fluctuates. By utilizing a cell design, the physical arrangement of the work area facilitates to include multiple configurations and changes to the work breakdown for the operations performed by each person (Matt, 2008). Additionally, it supports inventory and quality control with the principle of one-piece production by controlling the inflow and outflow of the line having the both beginning and end side-to-side. The flow of work, from the perspective of machines and the physical arrangement of the work area, becomes visual and flexible allowing for improvement and changes when necessary (Wilson, 2009).

With the implementation of cell design, the need for people to handle more than one piece of equipment at a time becomes evident. This will support the elimination of waiting time (waste) while a part is in the machine, increasing the productivity (or at least conceptually, the capacity). Besides the arrangement of the area, training becomes a fundamental part to develop the abilities within a person to handle multiple machines simultaneously, but also, adjust to sudden changes in the process, such as variations in cycle time, modifications to operations routines and processing orders with individual jobs. The attainment of such ability is based in job rotation, where every person learns how to do every job in their area., becoming a *Multifunctional Worker* (Monden, 2011), as the last element identified exclusively in this group.

Autonomation or *Jidoka* finds a tight connection between the current cluster (workplace design) and the one identified as *Consistency* in this study. With strong fundamentals for providing mechanisms that aid the design and operation of work, the initial efforts behind *jidoka* take place during the design of a cell, and provide elements characteristic of visual management . However, this is not included as part of this cluster, hence the definition of this concept will be further covered within section 3.4.3.

3.4.4 Consistency

The first element in this cluster is *Total Productive Maintenance* or *TPM*. The purpose behind is to keep equipment performing with consistency to support the manufacturing operations (Chan, Lau, Ip, Chan, & Kong, 2005). It takes 5S as a preceding stage, but also serves as the platform to the operation of *Cells* and more importantly, for autonomous operations, including maintenance (Agustiady & Cudney, 2016).

The concept of *Autonomation* or *Jidoka* was briefly described in section 3.4.3, as the process to decouple the operator from the machines. In addition, *Jidoka* corresponds to the concept of automatic or semiautomatic response from the equipment when the operating condition is out of standard, hence the process becomes "autonomous". Whereby this concept is crucial for quality assurance. It brings attention to problems once a non-conforming operation occurs, with a methodical approach to solve it (Monden, 2011). *Jidoka* is one of the pillars of the Toyota Production System, as it provides the intelligence behind machine operations and quality control (Liker, 2004). The principles of *Jidoka* are executed commonly in two ways: *Poka-Yoke* and *Andon*. These are mechanisms that allow to halt the process when a deviation from the standard is detected.

The concept in Japanese of *Poka-Yoke*, which means "mistake proofing", is a mechanism that aids in automatically stopping production when an anomaly is detected. The main goal is to prevent errors that people find difficult to detect. Three elements are essential: sensing device, action and signal mechanism. The system works automatically to stop or discard products that are out of conformity (Saurin, Ribeiro, & Vidor, 2012).

Andon is the mechanism utilized to signal when a non-conforming condition is found in the production process by an associate. These mechanisms commonly take three forms: lights, boards and cords. The purpose is to stop the production and catch the attention of the associates, in order to correct any defects or retrieve the part from the process before it moves a step further. The associate can pull the cord that will trigger the light or music, similarly as the *Poka-Yoke*, but intentionally.

Implementing these mechanisms provides benefits for both production outcomes and the attitude of people. Even as it might be counterproductive to stop the process, the overall system flow (throughput) improves (Li & Blumenfeld, 2006). On the people side, both mechanisms promote empowerment with associates, by providing the confidence to any team member to take a decision on preventing a quality problem to pass from the point where it is detected, providing a solid ground for *quality.*

According to Toyota, the goal behind *quality control and assurance* involves the satisfaction, reliability and economy in their products from the perspective of the consumer. It has had an evolution from specialized inspection to have companywide initiatives and self-inspection at each step of the processes. Reason for this evolution is that inspection is not a value adding activity, but quality is, and when each person in the organization practices it, the culture aims for continuous improvement (Monden, 2011).

When the Lean Management Practice is in place, specifically in the shop floor, manufacturing is responsible for verifying quality against defined standards, the establishment of controlled production lines and the maintenance of capacity. Hence, the need to have a well-established process with reliable equipment, Jidoka principles for product quality, and with additional support of maintenance to prevent/solve any deviation in machine operation.

3.4.5 Flow

Setup Time Reduction constitutes the first step in the responsiveness to production changes. First , by shortening the preparation time for changeover of products within a standard line, or either to overcome quick engineering changes to the production line. Either standardizing the external setup actions or only the necessary portions of the machine that need adjustment can achieve this.

Setup Time Reduction follows the concept of "Single Minute Exchange of Dies" or SMED, proposed by Shigeo Shingo (Shingō & Productivity Press. Development Team., 1996). The ultimate goal is to prepare the machinery for the change in products within a single digit of time, preventing from a long stop in the production run. However, this is not attained in all cases. Appropriate scheduling is necessary to optimize the use of the equipment while meeting demand.

Lot Size Reduction utilizes the added flexibility of SMED in the process to improve the scheduling of production runs, decreasing work in process or WIP (Daniel & Reitsperger, 1996). The benefit of a reduced lot size is reflected when various products/models are produced to fulfill orders. This particular activity will increase the number of setups due to the constant changes of products. Hence, the importance to reduce the setup time to implement such a simple concept. Both concepts are coupled in parallel to one-piece flow, mainly because they can be implemented independently from each other. In other words, lot size reduction is focused on conveyance within areas that have substantial difference in the process, or that are physically

distant for justifiable reasons, while *one-piece flow* can be implemented within the same work area, generally, the manufacturing cell (Monden, 2011).

The principle of *line balancing* is the precursor to *one-piece flow*, as it is necessary to synchronize all the operations to the extent of possibilities, utilizing the tools, methodologies and techniques mentioned until this point. The focus is in finding and equilibrium within the workload at all stations or cells. At a high level, the human factors for this element focus on skills, capacity to handle the workload, and speed in performing tasks, as well as other ergonomic matters (Bidanda et al., 2005).

When the demand fluctuates, in highly flexible operations, the adjustments to balance the workload can be made by reassigning operations within the associates in the line, requiring flexibility from them as well (Alves, Dinis - Carvalho, & Sousa, 2012). Less flexible operations require either lower utilization of the process, or a slower conveyance when automation is involved. Depending on the scheduling mechanism employed at the organization, adjustments can be as frequent as every half-shift in highly flexible systems. Similarly as *standard operating routines*, most organizations would follow the MPS and plan for monthly production or quarterly production before making substantial adjustments to the process and the work fleet.

Lastly, *one-piece flow* is the principle that drives the goals of the Lean Management Practice in many organizations (Belekoukias, Garza-Reyes, & Kumar, 2014; Kulak, Durmusoglu, & Tufekci, 2005; Marodin, Frank, Tortorella, & Saurin, 2016; Motwani, 2003). Should not be misinterpreted as a final goal, but as the means to establish a platform that will uncover other opportunities for improvement. It requires that all the elements previously described work in harmony, otherwise it will be a challenging task while trying to meet production quotas. It is the single focus of producing one unit at a time, having a transfer batch size of one (Lean Advancement Initiative, 2001), all performing under the established *takt time.*

As its name suggests, it is the utopia in production systems, as it enhances the visibility of production to detect any potential sources of waste. This type of operation is achieved by design, where the associates in the shop floor sole purpose is to follow the established standard operating procedure in order to keep the sequence, and detect any abnormality. This would require the associates to maintain high levels of attention to detail, as well as having the initiative to denounce and fix any abnormal condition. Altogether, the elements presented in the five clusters are the requirements to the mechanisms that have direct impact in throughput, having only the last cluster to coordinate the operations.

3.4.6 Scheduling and Sequencing Efficiency

Production Smoothing or *Heijunka,* is the mechanism that supports the reduction of inventories by producing only what is necessary. It happens in two stages: smoothing of the production volume and smoothing of product mix (Matzka, Di Mascolo, & Furmans, 2012).

When dealing with the total production quantity, this to prevent drastic changes between two production planning periods. The ideal of this stage is to have a constant production daily (or at least, as much as possible). The other type of leveling occurs when dealing with different products being produced within a day's schedule or within the same production line. This deals particularly with the sequencing schedule (Monden, 2011). This concept demands from people to keep constant communication, flexibility for any changes that might occur, initiative to suggest adjustments to fluctuations, and a high sense of future orientation, to avoid the temptation of overproduction.

The control mechanism for the production, and possibly the most recognizable element within the Lean Management Practice in regards to throughput, is the concept of *Pull Systems.* Establishing a pulling flow benefits the operation by keeping inventories at minimum. Even this is a popular concept, it is sometimes misinterpreted as a system that automatically converts organizations to "lean". The most common instrument recognized as a pull system is *Kanban,* a card that contains information about the products or materials and controls their flow between processes. Monden (2011) summarizes three rules for the proper operation of Kanban. First, the subsequent process should withdraw the necessary products from the preceding process in the necessary quantities at the necessary point in time (strictly using the cards). Second, defective products should never be conveyed to the subsequent process. Lastly, Kanban should be used to adapt to small fluctuations in demand. Associates must be disciplined to follow the system, and respond proactively to any signals triggered.

3.5 Structural Equation Model – Culturally Sensitive Lean Model (CSLM)

Structural Equation Modeling (SEM) has the purpose to model the relations between variables, where input data (at least in the basic level) is an observation (measurement). The combination of observed variables generate unobserved variables, referred as "latent" variables (Hoyle, 2012). The goal of estimation in SEM is to find values of the parameters that best account for the observed data given a substantively

interesting model, where the goal is to minimize the difference between the observed and estimated data, where residuals constitute the differences between the observed variances and covariances and the estimated ones(Hoyle, 2012).

SEM is generally used in three situations: model confirmation, where a single model is tested; model selection, where different models are presented and tested, but one provides the best fit with the observed data; and model generation, where an initial model is proposed, tested and adjusted (re-specified) on a single data set (Noronha, 2002). This study focuses in model generation.

Certain models include a higher order of specification, beyond the directly observed variables and the latent generated by the direct relationship of those. The objective is to capture the contributions each dimension provides to a higher level construct (Koufteros, Babbar, & Kaighobadi, 2009). Each level after the initial identified latent variables acquires a cardinal classification (e.g. second, third, etc.) of order. In particular, this project explores in an initial stage the second-order latent variables.

The framework proposed in Figure 10 adapts the Strategic Management Process Model with sociotechnical systems theory to provide a dissection of elements in the social system and the technical system to provide the structure of the Culturally Sensitive Lean Model (CSLM). The elements of each system form factors of second-order: Human requirements and the Environmental Appraisal as National Culture within the first; Lean Management Practice in the second, as illustrated in Figure 15, respectively.

This *a priori* model (Kline, 2011) provides the "big picture" within the variables described. The human requirements are the independent latent variables, hereafter referred as exogenous latent variables; the defined clusters for the Lean Management Practice framework represent the dependent latent variables, referred as endogenous latent variables (Haenlein & Kaplan, 2004). The variables that shift their function within this model, which in essence provide the major difference with regression methods, are the mediating variables. These are represented by the factors described in the Environmental Appraisal as National Culture. With these set of variables and relationships, the objective of the model is to identify the existence of mediation (influence) of national culture between the competencies (human requirements) and the Lean Management Practice clusters, addressing the first research question.

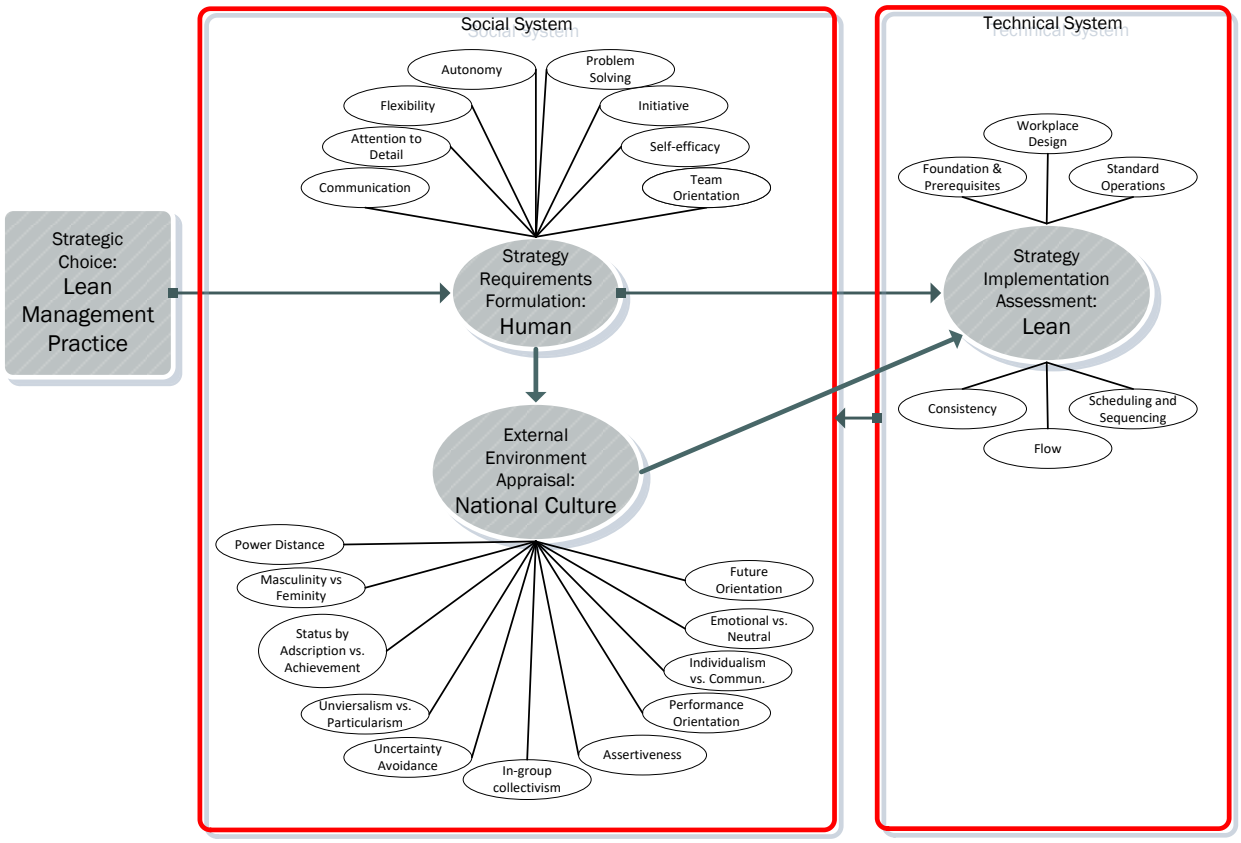


Figure 15 The Culturally Sensitive Lean Model - Hypothesized Second-order Structural Equation Model

This approach seeks to provide a reference framework for managers to evaluate the strengths and weaknesses of a particular culture when implementing the Lean Management Practice, providing focal points for development of training efforts to enhance the culture. A solid alignment of culture should provide a favorable environment to adopt and sustain the Lean Management Practice. This assessment won't be dynamic in nature, provided the cross-sectional nature of this study; however, as a future research activity, developing a longitudinal study within the same organization can reflect results of progress for the same organization, and monitor the transition between national and organizational cultures. Is in this context that the last element to include is MGA, as a Type II model (Tsui et al., 2007), using country (location) as the grouping variable.

A common approach to compare groups is to use moderation. A basic definition of a moderator is a qualitative (e.g., country, gender, religious affiliation, etc.) or quantitative (e.g., income, performance, etc.) variable "that affects the direction and/or strength of the relation" between the exogenous and endogenous variables (Baron & Kenny, 1986).This moderator separates the analysis into subgroups, which in this case, are the countries (assumed to be national cultures). Hence, the effects from a group are defined by the

categorical moderator providing the membership to each case Ringle, Sinkovics, and Henseler (2009), where Multi-Group Analysis (MGA) is considered a special case of moderation (Henseler, Ringle, & Sarstedt, 2011). This part of the analysis addresses the second research question.

3.6 Survey Instrument

The instrument that surveys the elements described is a questionnaire, which considers the elements presented for each of the sections in the structural model, having the direct measurements for each of the variables presented. The selection of the items in each case (first and second-order latent variables) followed a distinct approach.

3.6.1 Items for Human Requirements

The process of selection of items in this section followed a mixed approach between Exploratory and Confirmatory Factor Analysis (EFA and CFA, respectively). These techniques are used to capture the observed relationships among the variables of interest with a smaller set of latent variables. In particular, EFA provides researchers with the observable factors and ascertains the items that provide the best representation to measure those factors (Hoyle, 2012). CFA provides the same conclusions, however, the assumptions behind this process follow a particular set number of factors, as it is used in scale development, testing for the latent structure of the instrument.

Given the nature of this section, where the constructs are measuring the competence of people, regardless of the context, a pilot study was conducted with a sample of 35 participants, members of the student population within the University of Tennessee. This pilot survey included 130 items (questions) corresponding to the instruments identified in section 3.2 (Table 9). Given the mathematical nature of the test, factor analysis could not be performed with the sample size and the set of survey items. In this approach, to obtain the best possible subset of variables, a two-step process was followed: Principal Component Analysis (PCA) for selecting individual construct items, and FA with all the factors, to confirm the association of variables.

Table 9 Scales for Measurement of Human Requirements

Reference	Instrument	Original No. Items	Likert Scale Points	Factors to Measure In this Study
(Ployhart & Bliese, 2006)	I-ADAPT-M	55	5	Flexibility Problem solving
(Moorman & Blakely, 1995)	Personal Industry	4	7	Attention to Detail
(Dwyer & Ganster, 1991; Smith, Tisak, Hahn, & Schmieder, 1997)	Job Control	17	5	Empowerment
(Glickman, 2002; Zacharias, 2013)	Optimal Communication	25	5	Communication
(Morrison & Phelps, 1999)	Taking Charge	10	5	Initiative
(Goldberg et al., 2006)	IPIP	10	7	Self-Efficacy
(Bailey et al., 2002; Denison, Janovics, Young, & Cho, 2006)	Team Orientation	9	5	Team Orientation
Total		**130**		

The first step was to analyze each instrument through PCA to find the best subset in relation to the desired factors. The purpose of PCA is a reduction of the dimensions of the observation space, obtained by creating new linear combinations of variables characterizing the objects studied. These are called principal components (Maćkiewicz & Ratajczak, 1993).

In order to find the principal components that best represent a particular construct, five particular indicators become of interest. The first is the number of items that describe the component (Gaskin & Happell), the component loadings (Costello & Osborne), the sample adequacy (Kaiser, 1974), and the variance explained (Kim & Mueller, 1978). The software used for analysis is IBM SPSS Statistics for Windows, Version 25.0 (2017b), which provides the tests for each one of these elements. The search for the best subset of items follows an iterative process, where the requirements specified are the following:

- Three to six items to explain latent variable – provided the economy of items (the less, the better), maintaining reliability.
- Items loading greater than ".6" -
- Sample adequacy measured by the Kaiser-Meyer-Olquin (KMO) test greater than ".7"
- Variance explained with the component greater than ".5"

The algorithm to find the initial subsets follows these steps:

- Perform PCA extraction for one component with PROMAX (oblique) rotation.

- Select values over ".6".
- Perform KMO test
- If values are greater than .6, then check adding the variables that were below the value (from greater to smaller), verify KMO if increases or decreases.
- Eliminate smallest value in the loadings for PCA, verify KMO if increases or decreases.
- Verify by context the common theme on the questions (face validity), and determine the set of items that are components of the construct.

After several iterations for each of the scale instruments, each of the eight scales reduced dimensionality to provide measurements within four items. All items were subject to a reliability test using Chronbach's Alpha (Kim & Mueller, 1978), considering a value of or around ".7". With the desire to reduce even further, the item with lowest loading principal component or with the perceptive odd association within the context of the rest of the items was removed, and the construct was tested for a recalculated reliability (Figure 16). Only where the case seemed to provide a substantial improvement, including all the prior indicators, the choice was for the case with the least number of items (three).

		4 ITEMS					3 ITEMS				
Factor In this Study	**Subset-Items**	**Cronbach's Alpha**	**PCA (4)**	**KMO**	**Variance %**	**Remove**	**Adjusted Cronbach's Alpha**	**PCA (3)**	**KMO**	**Variance %**	**Final No. Items**
Flexibility	Fl23-Unc1*	0.692	0.525	0.724	59.14	Fl23-Unc1	0.812	[redacted]	0.694	72.89	3
	Fl42-Int6		**0.881**					**0.891**			
	Fl43-Unc6		**0.849**					**0.851**			
	Fl54-Unc9		**0.769**					**0.818**			
Problem solving	Fl16-Cre2*	0.79	0.812	0.731	61.9	Fl16-Cre2	0.722	[redacted]	0.672	64.8	3
	Fl24-Cre3		**0.834**					**0.812**			
	Fl36-Cre4		**0.761**					**0.835**			
	Fl37-Cre5		**0.736**					**0.767**			
Attention to Detail	**AttDet1**	0.742	**0.761**	0.78	58.49	AttDet3	0.684	**0.795**	0.675	62.95	4
	AttDet2		**0.786**					**0.804**			
	AttDet3*		0.768					[redacted]			
	AttDet4		**0.744**					**0.781**			
Autonomy	**JC8-12**	0.708	**0.724**	0.557	54.61	JC13-18*	0.731	**0.842**	0.672	65.3	3
	JC9-13		**0.848**					**0.768**			
	JC13-18*		0.607					[redacted]			
	JC17-22		**0.757**					**0.813**			
Communication	Comm3*	0.775	0.685	0.717	59.94	Comm3	0.772	[redacted]	0.667	68.66	3
	Comm4		**0.833**					**0.822**			
	Comm5		**0.826**					**0.877**			
	Comm6		**0.744**					**0.784**			
Initiative	**Ini2**	0.867	**0.849**	0.802	72.02	Ini4	0.829	**0.876**	0.699	75.16	3
	Ini3		**0.825**					**0.822**			
	Ini4*		0.849					[redacted]			
	Ini9		**0.872**					**0.901**			
Self-Efficacy	**SE1**	0.906	**0.958**	0.782	78.21	SE3	0.909	**0.959**	0.683	84.72	3
	SE2		**0.909**					**0.923**			
	SE3*		0.823					[redacted]			
	SE6		**0.841**					**0.877**			
Team Orientation	Team1*	0.781	0.643	0.713	60.96	Team1	0.799	[redacted]	0.634	71.51	3
	Team3		**0.889**					**0.912**			
	Team7		**0.849**					**0.854**			
	Team8		**0.717**					**0.764**			

Figure 16 Survey Item Selection for Human Requirements

The total number of items derived from this analysis is 25, compared to the initial 130, for a reduction of 105 items. However, two items, which were reverse coded (negative connotation), were added to *Team Orientation* and *Self-Efficacy* as safety measures to control for inattentive responses (outliers).

Provided the substantially reduced data set, FA became mathematically feasible given that the number of responses was now larger than the number of items. Nonetheless, the ratio of responses-to-items was not the ideal (1.4:1) as reflected by a poor sampling adequacy indicator (.457), the results could provide a hint for each of the latent variables and the validity of the second-order variable (Figure 17).

Rotated Factor Matrix[a]

	Factor							
	1	2	3	4	5	6	7	8
SE2	.874							
SE1	.854							
SE6	.789							
Ini2		.827						
Ini9		.804						
Ini3		.669						
Comm5			.866					
Comm6			.715					
Comm4			.630					
Team3				.851				
Team7				.817				
Team8				.633				
FI42-Int6					.802			
FI43-Unc6					.783			
FI54-Unc9					.520			
AttDet1						.613		
AttDet4						.586		
AttDet2						.573		
JC8-12*							.808	
JC17-22							.771	
JC9-13							.559	
FI36-Cre4								.751
FI37-Cre5								.654
FI24-Cre3								.583

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.

Figure 17 SPSS Output of Rotated Factor Matrix for Human Requirements

The test used Principal Axis Factoring and a VARIMAX (orthogonal) rotation, removing scores below ".5". It is important to mention that Item AttDet3, corresponding to *Attention to Detail* was included after this test due to the reliability and KMO statistics as illustrated in Figure 16. However, when included in FA, the item loaded into a different factor. The reason to leave the item within the final set was to provide further testing with the data collection.

3.6.2 Items for Environmental Appraisal as National Culture

The items included of National Culture strictly remained from the original constructs, according to the variable selection detailed in section 3.3. Provided that three different instruments were used in this set of variables, the characteristics and item calculation are illustrated in Figure 18.

These instruments have been widely used in literature, for which the constructs were left unchanged, keeping both the text of the questions and the response types. In the cases for Hofstede's VSM and GLOBE, the items are in Likert scale, where VSM uses 5 points and GLOBE, 7 points. Where VSM uses specific formula calculations to compute the scores, GLOBE uses means of the responses.

In the case of Trompenaars and Hampden-Turner instruments, the questions were diverse in nature, as explained, in the format of direct questions or case scenarios. In the first case, a simple yes or no would provide the answer, computing the percentages among the total respondents from a particular country. In the case scenarios, two responses were requested. Depending on the combination of the answers, a percentage was computed as illustrated in the previous table. This structure was left untouched.

The survey included 39 questions, where 36 are considered as individual measurement items, provided the 3 cases to measure the factor of *Universalism vs. Particularism* from Trompenaars and Hampden-Turner.

CULTURAL FACTOR SCALES	No. of questions				SCALE SELECTED	ITEMS IN ORIGINAL INSTRUMENT	CALCULATION
	GLOBE Values	Hofstede	Trompenaars	Schwartz			
Power Distance	5	4	N/A	5	Hofstede's VSM	2, 7, 20 & 23	PDI = 35(07 – 02) + 25(20 – 23) + C(pd)
Masculinity vs. Feminity	5	4	N/A	N/A	Hofstede's VSM	3, 5, 8 & 10	MAS = 35(05 – 03) + 35(08 – 10) + C(mf)
Status by Ascription vs. Status by Achievement	N/A	N/A	2	4	Trompenaars'	pg. 128	High 4 or 5 (disagree) = Achievement
Universalism vs. Particularism	N/A	N/A	3	8	Trompenaars'	pgs. 45, 48 & 49	High C or B+E = Universalist
Uncertainty Avoidance	5	4	N/A	N/A	Hofstede's VSM	15,18,21 & 24	UAI = 40(18 - 15) + 25(21 – 24) + C(ua)
In-group Collectivism	4	N/A	N/A	N/A	GLOBE	11, 23, 29 & 34	Mean of 11, 23, 29 & 34, Higher Collectivist
Assertiveness	3	N/A	N/A	N/A	GLOBE	2, 10 & 14	Mean of 2, 10 & 14, Higher Assertive
Performance Orientation	4	N/A	N/A	4	GLOBE	15, 18, 20 & 32	Mean of 15, 18, 20 & 32, Higher Performance Orientation
Individualism-Communitarianism	N/A	4	3	5	Trompenaars'	pgs. 65, 70 & 71	1&2, High B = Individualism, 3 High A = Individualism
Emotional vs. Neutral	N/A	N/A	1	N/A	Trompenaars'	pg. 88	High B = Neutral
Future Orientation	4	4	N/A	N/A	GLOBE	3, 4, 8 & 30	Mean of 3, 4, 8 & 30

Figure 18 National Culture Scale Items From The Original Instruments

3.6.3 Items for Lean Management Practice

The last component of the survey consisted of the elements extracted from the assessments described in Table 7 Relevant Assessments for Leanness. Using the cluster structure provided in section 3.4, every element for each of the assessments was mapped against the content of the clusters. In other words, the assessments were compared individually to:

- Review the question items that measured any element from the clusters.
- Consider the amount of information captured by the question.
- Cluster the questions respectively with their corresponding classification.
- Discriminate question items outside the previous analysis.

In an effort to build a comprehensive measurement instrument, that at the same time did not extend dramatically the total number of items included in the final survey, some of the questions were combined to meet the purpose of the desired information. The ruling criteria for the final set of questions was to capture with the least number of question items, by selecting the more robust ones, at least each one of the elements for each of the clusters. If a question captured more than one element, as long as it belonged to the same cluster, the question item was considered. An initial set of 64 items from the three instruments mapped into the six clusters. Then they were categorized according to their individual element within the cluster (e.g. in the cluster of *consistency*, a question item captured the information regarding *total preventive maintenance*, the first element of the cluster).

The final set of question items included in the survey were 25. Following as a rule of thumb of having minimum of three items per factor, only the cluster of *consistency* met this criteria, having the rest of the clusters with four items, except for *foundation & prerequisites* which included six items. Face validity and reliability can only be confirmed through performing the corresponding tests (FA and Chronbach's Alpha), which will be tested upon the final data set. Table 10 illustrates the clusters and the items included.

Table 10 Items per Cluster Lean Management Practice

Cluster	Item within	Source
Foundation & Prerequisites	Product Families	Shah & Ward (2007)
	Teamwork	SAE International - J4001
	Teamwork and Quality Circles	SAE International - J4001
	Value Stream Mapping	SAE International - J4001
	Kaizen Culture	Kobayashi (1995)
	Kaizen Culture	Shah & Ward (2007)
Workplace Design	5's	Kobayashi (1995)
	Visual Management	SAE International - J4001
	Ergonomics and Layout (Cell)	SAE International - J4001
	Multifunctional Worker	Kobayashi (1995)
Standard Operations	Standard Operating Routine	SAE International - J4001
	Standard Operating Routine	SAE International - J4001
	Work Content	SAE International - J4001
	Standard Operating Routine	SAE International - J4001
Flow	SMED	Kobayashi (1995)
	SMED	Shah & Ward (2007)
	One Piece Production	SAE International - J4001
	SMED	SAE International - J4001
Consistency	TPM	Kobayashi (1995)
	Jidoka	Kobayashi (1995)
	Quality Assurance	Kobayashi (1995)
	Quality Assurance	SAE International - J4001
Scheduling and Sequencing	Heijunka	Kobayashi (1995)
	Pull	Shah & Ward (2007)
	Pull (Kanban)	Shah & Ward (2007)

3.6.4 Survey Characteristics

The final version of the survey instrument, based on the literature and the corresponding selection methods, included four sections (in order): Human Requirements, Environmental Appraisal as National Culture, Lean Management Practice Assessment, and Demographic Information. In total, 99 questions were included (Table 11). The questions were in majority in a Likert scale, ranging from two points to seven points. Only specific cases in the Environmental Appraisal as National Culture (as mentioned before), and Lean Management Practice Assessment included answers either with less than four points, or not following Likert scale. Given the characteristics of the study, in particular, the intended population (further explained in section 3.7.1), the instrument was translated into Spanish, using the electronic translation tool available within the software Qualtrics (2018), which also contains the instrument in the two languages (File 1, File 2).

Table 11 Summary of Items in the Survey Instrument

Section	Total Items	Concept	Items
Human Requirements	27	Attention to Detail	4
		Autonomy	3
		Communication	3
		Flexibility	3
		Initiative	3
		Problem Solving	3
		Self-Efficacy	4
		Team Orientation	4
National Culture	39	Assertiveness	3
		Emotional vs. neutral	1
		Future Orientation	4
		Individualism vs Communitarianism	3
		In-group Collectivism	4
		Masculinity vs. Feminity	4
		Performance Orientation	4
		Power Distance	4
		Status by Ascription vs. Status by Achievement	2
		Uncertainty Avoidance	4
		Universalism vs. Particularism	6(3)
Lean Management Practice	25	Consistency	4
		Flow	4
		Foundation & Prerequisites	6
		Scheduling and Sequencing	3
		Standard Operations	4
		Workplace Design	3
Demographics	8		8
Total			**99**

As a final step, the questionnaire text was subject of a readability test using Microsoft Word's embedded tool. The indicator used is Flesch-Kincaid Grade Level (Kincaid, 1975), based on the readability test created by Flesch (1974). The results provide a grade level of 9.2, which means that a person that has completed a small portion of grade 9 at school (or equivalent) should be able to read and clearly understand the questions. This requires people to have completed elementary school and junior high-school.

3.6.5 Institutional Review Board Approval

The instrument passed through a thorough review by the Institutional Review Board (IRB) at the University of Tennessee, Knoxville (Appendix). For this purpose, guidelines observed are from the Code of Conduct for Ethical Research, including the participant recruitment process, the confidentiality of responses, the level of risk involved with their response, the safety of data, and the liability from the stakeholders in the research project.

The method of distribution for the questionnaire was electronically, requiring special considerations. The initial screen for the responders included the informed consent form and guidelines, requesting individuals to answer voluntarily with assurance that their individual responses, besides not being traceable, would not be shared as raw data outside of the research team. Subjects were able to decide within the initial screen their acceptance or declination of participation.

The data collected through the survey reflects a quantitative response for qualitative items. In this regard, the instrument for analysis remains in the quantitative domain. Results manifested the factors relevant for the elements of the framework, and were clustered among groups from different nationalities. Further identification from the analysis as for internal groups (production lines/areas) within the organization or specific job position (level) is not included, for protection of the subjects.

3.7 Data Collection

3.7.1 Population

The intended population for this study are employees of small and medium enterprises (SME's) with transnational operations. SME's provide a fertile ground having the characteristic of a weaker organizational culture, and a bigger need for improvement. Hence the Lean Management Practice finds a fertile ground within this particular group. The samples to be collected for the comparison are targeted Mexico and United States.

Within the organization, the survey was mainly intended for personnel involved with the production system, including shop-floor associates, supervisors and managers that are directly related with the production process. Their perspective in this design is relevant for the validation of the model, capturing their perspective on cultural attributes as well as the operation of the system, with their personal appreciation of the activities and results for the organization.

3.7.2 Sample Size

Flynn et al. (1990) observed that in Operations Management (OM) studies, medium to large sample sizes are important when the objectives are building and verifying theory, as well for reliability and validity, with the use of their corresponding statistical methods. As addressed in Section 2, most cultural studies contain large sample sizes. In other words, the purpose of the study, along with the statistical method are the main considerations when deciding the size of the sample population.

From the perspective of the statistical method, Structural Equation Modeling (or path analysis) falls within the medium to large sample sizes (Flynn et al., 1990), using as a reference the estimation method selected for the fitting of parameters. Most estimation methods have strict rules regarding the sample size requirement. A general rule of thumb considers sample size of 200 in most cases (Haenlein & Kaplan, 2004). In cross-cultural research (Cheung & Au, 2005) the size is determined by the number of countries under study times 100 (in-group) samples (e.g. two countries would derive in a sample size of 200). With

PLS estimation, the sample size follows the "10 times" rule of thumb (Peng & Lai, 2012) as illustrated in equation 1:

$$Sample\ Size = 10 * Max\left\{\begin{pmatrix} Largest \\ Measurement \\ Equation \end{pmatrix}, \begin{pmatrix} Largest \\ Structural \\ Equation \end{pmatrix}\right\} \quad (1)$$

in which the largest measurement equation is the construct with the largest number of formative indicators (given that there are any formative constructs), and the largest structural equation is the dependent latent variable with the largest number of independent latent variables influencing it. Considering that the model has eight independent latent variables pointed at the higher order latent variable in *Human Requirements* as formative indicators, this is considered both the largest measurement equation and the largest structural equation. Therefore, this model requires a minimum sample size of:

$$Sample\ Size = 10 * Max\{(8), (8)\} = 10 * (8) = 80$$

Marcoulides and Saunders [as cited in Peng and Lai (2012)] suggest that the statistical power would be a better indicator for sample size adequacy. Cohen made an extensive analysis to determine sample size recommendations with statistical power of 80 percent for different significance levels (α of .01, .05 and .1) within PLS-SEM [as cited in Hair Jr, Hult, Ringle, and Sarstedt (2016)] where Human Requirements, Environmental Appraisal as national Culture and Lean Management Practice would consider the first order latent variables to provide this conclusion.

In addition, the questionnaire plays an important role in the determination of the sample size. Peng and Lai (2012) suggest that a large number of survey items (questions) can be used for reflective constructs when using PLS as the estimation method. However, they warn the risk included in the tradeoff of the response rate against the length of the instrument (i.e. high number of survey items returns low response rates).

Hence, the sample size determined for this study is 80, following the recommendations to satisfy power, minimum R^2 and α=.05.

3.7.3 Data coding

The survey was conducted electronically, therefore the data is stored electronically using the "cloud" service from the company Qualtrics (2018). Data required processing and filtering in order to keep the confidentiality and to improve its usefulness. Hence, the coding of data considers three aspects: deletion of unnecessary data (not to confuse with data screening), reconfiguration of composite scores and reconfiguration of reverse-coded responses.

The characteristics of the responses in most cases followed a Likert scale. The answer point differences are due to preservation of the items in the original constructs. Where majority of the answers in this format consist of a 5-point scale, few constructs have 7-point scales. The few cases where the responses followed multiple choice, the response items varied from two to five options, except for the demographic items (Table 12). Appendix 2 illustrates the labeling and sequence of the survey items.

Most of the recoded items were due to reversed scales. The purpose of this reconfiguration was solely to provide the highest score to the item describing the construct. In cases where the construct measures an opposed dichotomy (e.g. *Status by Ascription vs. Status by Achievement*), the higher score intends to reflect the first element (e.g. scores of 5 reflect *Status by Ascription,* and scores of 1 reflect *Status by Achievement*).

Some special cases had a different reconfiguration of the scores. Items 19 and 25 were included as measures for unengaged responses, which will be furtherly explained in section 4.2.1. Items 67 and 73 were extracted from the standards J4000 and J4001 from SAE International (1999a, 1999b), for which the responses request presence (with a score of 3) or absence (with a score of 1) of a particular element within the *Lean Management Practice*.

Lastly, the only construct that used a more complex process was *Universalism vs. Particularism.* The responses of this construct included a combination of answer items between two questions. Three different scenarios propose a dilemma where the first question asks for three possible outcomes (scoring 1,2 or 3 respectively) regarding what should be expected from the respondent, and the second question just asked for the actual course of action, having only two possible responses (scoring 1 or 2). The item scores were calculated by a simple multiplication of the scores from the two responses for each particular scenario. The only adjustment made to the result is changing the score in the scale when the multiplication is 6 (the result of 3*2), where for continuity purposes the score was recoded to 5 (given that in this case there is no possible multiplication resulting in this score). With this simple transformation, responses ranged from 1 (in favor of *Particularism*) to 5 (in favor of *Universalism*).

Table 12 Item Scales and Recoding Summary

Concept	Item Sequence	Answer type	Points	Recoding Observations
Attention to Detail	20-23	Likert	5	Reverse
Autonomy	1-3	Likert	5	
Communication	4-6	Likert	5	Reverse
Flexibility	10-12	Likert	5	Reverse
Initiative	7-9	Likert	5	Reverse
Problem Solving	13-15	Likert	5	Reverse
Self-Efficacy	16-19	Likert	5	Reverse, (19) Engaged response item
Team Orientation	24-27	Likert	5	Reverse, (25) Engaged response item
Assertiveness	52, 56 & 58	Likert	7	Reverse
Emotional vs. neutral	49	Dichotomous	2	Reverse
Future Orientation	53, 54, 55 & 64	Likert	7	Reverse
Individualism vs Communitarianism	46, 47 & 48	Dichotomous	2	(46) & (48) Reverse
In-group Collectivism	57, 62, 63 & 66	Likert	7	Reverse
Masculinity vs. Feminity	29, 30, 32 & 33	Likert	5	(29) & (33) Reverse
Performance Orientation	59, 60, 61 & 65	Likert	7	Reverse
Power Distance	28, 31, 36 & 38	Likert	5	(28) & (38) Reverse
Status by Ascription vs. Status by Achievement	50 & 51	Likert	5	
Uncertainty Avoidance	34, 35, 37 & 39	Likert	5	(34) & (39) Reverse
Universalism vs. Particularism	40 (41), 42 (43) & 44 (45)	Multiple choice & Likert	3+2	Formula recoded
Consistency	77, 83, 84 & 85	Multiple choice & Likert	(77) has 4, rest have 5.	
Flow	76, 78, 82 & 89	Multiple choice & Likert	(76) & (78) have 4, rest 5.	
Foundation & Prerequisites	67, 68, 69, 80, 87 & 88	Multiple choice & Likert	(67) has 2, (68) & (69) 4, rest 5.	(67) values 1 or 3
Scheduling and Sequencing	86, 90 & 91	Likert	5	
Standard Operations	72, 73, 74 & 75	Multiple choice	(73) has 2, rest 4.	(73) values 1 or 3
Workplace Design	70, 71, 79 & 81	Multiple choice	Differs	
Demographics	92-99	Multiple choice	Differs	

3.8 Theoretical Approach of Hypothesis

In aims to explain how National Culture integrates in the design of Lean Systems, as a management practice, this project addresses two research questions: whether National Culture mediates personal requirements and lean practices, given the variables described; and, whether moderation at the country level exists, given the existing mediation. In practical terms, the 11 variables of National Culture test for each of the mediation paths in the model, and the moderation considers the context of the sampled countries.

3.8.1 Notation

The initial model is the one considered within section 3.5. Before establishing the particular hypothesis, the model requires the mathematical notation to simplify explaining the set of comparisons. The first element is to define the notation of variables, factor loadings, regression weights, and error terms (Table 13). These correspond to one element of the initial model, where mediation occurs within second-order variables. Variable *X* defines the observed exogenous (independent) variables; *Y* corresponds to the observed endogenous variables, specifically in the relationship determined for the mediation model; and *Z* expresses the mediation variables. In the initial model, these variables only connect in the path model through their second-order variable ξ. Similarly, each variable and path that connect through the branches of the aforementioned variables are identified with a subscript index *i* taking the value of only those three variables.

Table 13 Structural Equations Notation for Higher Order Model

Type	Notation	Meaning
Variable	ξ_x	Second-order exogenous latent variable for "η_{xm}" latent variables
	ξ_y	Second-order endogenous latent variable for "η_{ym}" latent variables
	ξ_z	Second-order mediating latent variable for "η_{zm}" latent variables
	η_{xm}	First order latent variable for "X_{mn}" observed variables.
	η_{ym}	First order latent variable for "Y_{mn}" observed variables.
	η_{zm}	First order latent variable for "Z_{mn}" observed variables.
	X_{mn}	Exogenous (independent) "n" observed variables for latent variable (factor) "m"
	Y_{mn}	Endogenous (dependent) "n" observed variables for latent variable "m"
	Z_{mn}	Mediating (dependent-independent) "n" observed variables for latent variable "m".
Path coefficient	Γ_{yx}	Direct effect regression coefficient between exogenous second-order latent variable "ξ_x" and second-order endogenous variable "ξ_y".
	Γ_{yz}	Direct effect regression coefficient between mediating variable, which in this relationship is an exogenous second-order latent variable "ξ_z", and second-order endogenous variable "ξ_y".
	Γ_{zx}	Direct effect regression coefficient between second-order exogenous variable "ξ_x", and the mediating variable, which in this relationship is an endogenous second-order latent variable "ξ_z".
Factor loading	γ_{in}	Factor loading for path "m" between second-order latent variable "ξ_i" and first order latent variable "η_{im}", where i = x,y,z.
	λ_{imn}	Factor loading for path "mn" between first order latent variable "η_{im}" and observed variable "i", where i = x,y,z.
Error Term	ε_{imn}	Error term for observed variable "i", where i = x,y,z.
	ζ_{in}	Error term for first-order latent variable variable "i", where i = x,y,z.
	Δ_i	Error term for second-order latent variable "i", where i = x,y,z.

3.8.2 Higher-Order Variables

When exploring relationships and factors using Structural Equation Models, especially in the context of Operations Management, few studies reflect the use of higher-order variables (Koufteros et al., 2009). These become relevant when certain phenomena can be explained from a higher level of "aggregation", without leaving aside the unique characteristics of each measurement variable, such as the variance.

Higher-order constructs become useful if the theory behind supports the logic to create them. In the case of this study, an initial exploration of the relationships suggest that each of the concepts described as elements of the model, should fit in a greater order of classification. In specific, a second order type of variables. In this context, as defined in the previous section, three second order variables have been identified, corresponding to the elements in the framework.

The initial set of hypothesis correspond to testing the membership of the first order variables within their groups, for then exploring in that higher-order level, mediation and moderation. Subsets or individual relationships would be explored in subsequent models, provided that hypothesis do not hold for the entire second-order model.

Henceforth, the first set of hypothesis correspond to membership:

H1: Whether a set of first-order variables identified within a particular theme create a second-order latent variable

$$H1_0: \gamma_{in} = 0$$
$$H1_1: \gamma_{in} \neq 0$$

where $n \in i, i = \{x, y, z\}$ — *n* is a subset of *i*, where *i* can be *x*, *y* or *z;*

$$\therefore \begin{cases} 1 \leq n \leq 8 & i = x \\ 1 \leq n \leq 6 & i = y \\ 1 \leq n \leq 11 & i = z \end{cases}$$

n corresponds to values from 1 to 8 when *i=x;*
n corresponds to values from 1 to 6 when *i=y;*
n corresponds to values from 1 to 11 when *i=z.*

H1a: Whether a set of first-order variables identified within Human Requirements create a second-order latent variable

$$H1a_0: \gamma_{xn} = 0 \text{ for all n}$$
$$H1a_1: \gamma_{xn} \neq 0 \text{ for all n}$$

H1b: Whether a set of first-order variables identified within Lean Management Practice create a second-order latent variable.

$$H1b_0: \gamma_{yn} = 0 \text{ for all n}$$
$$H1b_1: \gamma_{yn} \neq 0 \text{ for all n}$$

H1c: Whether a set of first-order variables identified within Environmental Appraisal as National Culture create a second-order latent variable.

$$H1c_0: \gamma_{zn} = 0 \text{ for all n}$$
$$H1c_1: \gamma_{zn} \neq 0 \text{ for all n}$$

Interpretation: When a set of variables corresponds to a higher order variable, this can affirm that the whole set provide a meaning for the context. This is strictly depending on the relationship at teach level (formative vs. reflective). In a formative context, the variables provide a "balanced" and significant meaning to the entire context, independently of their covariance. On the contrary, in a reflective context, the variables explain (statistically) a higher-order variable (observed to first latent, first to second, etc.) from their latent factor, this becoming the variable itself.

3.8.3 Mediation

Mediation analysis explains the causal sequences of the variables when an indirect effect is present in the phenomena under study (Cheong & MacKinnon, 2012). A mediator is a third variable that connects between the endogenous and exogenous variables, causing this influence in the endogenous variable (Baron & Kenny, 1986).

In testing mediation, the particular case approached initially in this study is the indirect effects on second-order variables (Figure 19). Using the notation described above, equations 2 and 3 (Gunzler, Chen, Wu, & Zhang, 2013; Raykov & Marcoulides) express this interaction:

$$\xi_z = \Gamma_{zx}\xi_x + \Delta_z \quad (2)$$
$$\xi_Y = \Gamma_{yx}\xi_x + \Gamma_{yz}\xi_z + \Delta_y \quad (3)$$

where the structural equation 2 represents the second-order mediator, and 3 represents the endogenous second-order variable. The elements of both equations consist of the products of the path coefficients preceding the second-order variable plus the error terms.

By definition (Gunzler et al., 2013), the effects are direct (*DE*) and indirect (*IE*) with respect of the endogenous variable. The *DE* is the path from the exogenous to the endogenous variable, in this case represented by Γ_{yx}. The *IE* is represented by the interaction between the paths interceded by the mediator, or (Γ_{zx})(Γ_{yz}). In this reasoning, total effects (*TE*) are expressed in equation 5:

$$TE = DE + IE \tag{1}$$

$$TE = \Gamma_{zx} + \Gamma_{yx}\Gamma_{yz} \tag{2}$$

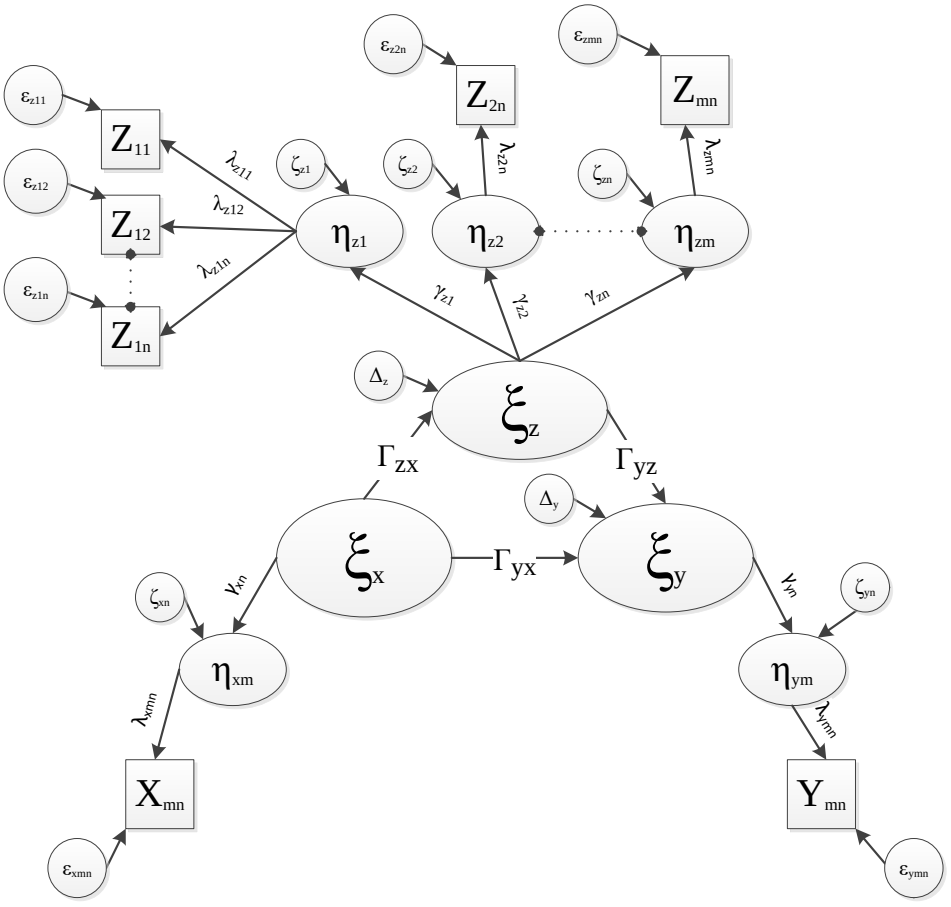


Figure 19 Path Model of Second-Order Mediation

Additionally, direct relationships in the model when no other path has been described (i.e. direct path between exogenous and endogenous variable without any other incoming or outgoing path) by the prime term Γ', which in the case of comparison for the second-order variables ξ_x and ξ_y, would be represented by Γ'_{yx}. Based on the previous definitions, the following hypothesis correspond to mediation analysis:

H2: Whether there is a direct relationship between second-order endogenous and exogenous variables ($\Gamma'_{yx} \neq 0$)

$$H2_0: \Gamma'_{yx} = 0$$
$$H2_1: \Gamma'_{yx} \neq 0$$

H3: If a relationship exists (reject $H2_0$), whether there is a full mediation ($\Gamma_{yx} = 0$) effect relationship between second-order variables

$$H3_0: \Gamma_{yx} = 0$$
$$H3_1: \Gamma_{yx} \neq 0$$

The case of subsets for second-order variables emerges when the hypothesis H1a, H1b and H1c hold true for at least one *n*. A necessary modification for the notation is to add the subscript *j* to each element, as an indication of the subgroup identified as a second-order latent variable. The case of multiple second-order variables is illustrated in Figure 20.

In this reasoning a generalized formulation represents the postulations in H2 and H3:

H2a: Whether there is a direct relationship between second-order *Human Requirements* and *Lean Management Practice* ($\Gamma'_{yjxj} \neq 0$)

$$H2a_0: \Gamma'_{yjxj} = 0$$
$$H2a_1: \Gamma'_{yjxj} \neq 0$$

H2b: Whether there is a direct relationship between *Human Requirements* and *Environmental Appraisal as National Culture* ($\Gamma'_{yx} \neq 0$)

$$H2b_0: \Gamma'_{zjxj} = 0$$
$$H2b_1: \Gamma'_{zjxj} \neq 0$$

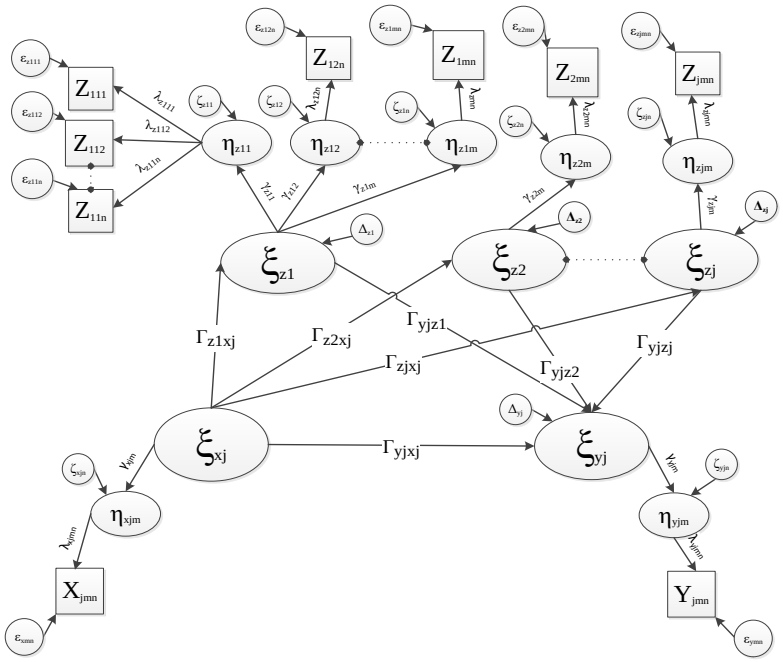


Figure 20 Full Model of Mediation With *j* Second-Order Variables

H2c: Whether there is a direct relationship between *Environmental Appraisal as National Culture* and *Lean Management Practice* ($\Gamma'_{yx} \neq 0$)

$$H2c_0: \Gamma'_{yjzj} = 0$$
$$H2c_1: \Gamma'_{yjzj} \neq 0$$

Lower order mediation hypothesis are formulated where the relationships of interest derive given no higher order variables.

H4: Whether there is a direct relationship between *Human Requirements* and each element of the *Lean Management Practice* ($\gamma'_{\text{yjmxj}} \neq 0$)

$$H4_0: \gamma_{\text{yjmxj}} = 0$$
$$H4_1: \gamma_{\text{yjmxj}} \neq 0$$

Where m represents all possible latent variables within the construct.

For practical purposes, the operationalization of hypothesis is as follows:

> H4: Whether the path between *Human Requirements* and any of the six latent variables of *Lean Management Practice* are mediated by a variable of *Environmental Appraisal as National Culture.*

The total number of hypothesis is 66. [(1)*(6)*(11)=66].

3.8.4 Multi-Group Analysis (MGA)

The variable of interest for the categorical moderation in this case is primarily the countries where the study is being conducted. The interest is in detecting the differences (if any) between the groups, establishing the relevance of the interactions for design of the effectiveness of the *Lean Management Practice.*

Partial Least Squares Multi-Group Analysis (Joseph F. Hair, Sarstedt, Ringle, & Gudergan, 2018) is a non-parametric significance test for the difference of group-specific results that builds on PLS-SEM bootstrapping results. A result is significant at the 5% probability of error level, if the p-value is smaller than 0.05 or larger than 0.95 for a certain difference of group-specific path coefficients.

The hypothesis of interest is whether there are any differences in any of the mediation interactions (all latent variables involved) between the groups. In this particular case, two groups, where 66 hypothesis are tested, for which in practical terms, the definition becomes:

> H5: Whether there are differences between groups for the path between *Human Requirements* and each of the six latent variables of *Lean Management Practice* with some mediation effect by a variable of *Environmental Appraisal as National Culture.*

An additional 66 hypothesis correspond to this statement.

Chapter 4: Analysis and Results

4.1 Introduction

This chapter presents the results of the analysis based on the case study. As the sample possesses unique characteristics, the results provide insights only over the specific context of analysis. The first element in this section provides the descriptive statistics, running initially through some data "purification" to present later a summary of the results with the "clean" data. Next, an evaluation of the model for this particular case is presented in two steps commonly used in these types of projects: evaluation of the measurement model and evaluation of the structural model. Lastly, the hypotheses formulated in section 3.8 are tested, providing the conclusions and key findings.

4.2 Descriptive Statistics

The population of the case study represents groups from two different locations: Mexico and United States. These groups are employees of a manufacturer with operations in both East Tennessee and the North East border of Mexico. The name of the company is kept confidential due to the nature of this study and its ethical considerations as presented in section 3.6.5.

The data was collected in one day at both locations, with a setup of 10 computers and support from the production managers to coordinate. Company associates were allowed to leave their work area to sit in the allocated rooms and respond to the survey. All employees within both locations associated with the operation received the opportunity to respond the survey. A brief summary of the demographics of the respondents prior to data screening is presented in Table 14.

Table 14 Frequencies of Responses per Location

			Location		Total
			Mexico	U.S.	
Consent	Consent granted	Count	48	79	**127**
		percent within Location	92.3%	79.0%	**83.6%**
	Consent denied	Count	4	21	**25**
		percent within Location	7.7%	21.0%	**16.4%**
Total		**Count**	**52**	**100**	**152**

4.2.1 Data Screening

Before the data analyses were conducted, it was important to carefully inspect the data gathering process since all further data analyses depernds on the clean and accurate reporting of information. This is specifically important when dealing with structural equation modeling as is the case with the present study. The specific steps taken included reviewing unengaged responses, incomplete responses, missing data, skewness, kurtosis and multicollinearity (performed during the evaluation of the structural model).

The identification of **unengaged responses** follows two procedures: questions that represent opposite meanings to those within the same construct (negative connotation), and standard deviation from subgroups of responses from the same subject.

In the first case, survey items (19) – "Don't understand things", and (25) - "I generally prefer to work alone than with others", have a negative connotation opposite to the rest of the items within the construct. Item (19) presented a confusing term, not a clear opposition to the preceding items in the construct, for which it was disregarded for this purpose, and instead the second method was used on this subgroup. Item (25) presents an obvious opposition to arguments (24) – "If given the choice, I'd choose to work in a team rather than by myself", and (27) – "I like working in groups". The criteria applied in this case was to take an average of the score between items (24) and (27), and subtract item (24). If the absolute value of the result was less than half, then the response was reviewed, given that it is not violating any other criteria. The response was considered unengaged, when there was no clear opposed or different response between items (24) and (27) against (25). For the calculations and analysis of unengaged responses, see File 3.

The second case considered groups of items that presented a comparable five-point scale along different portions of the survey with low standard deviations. Three groups were identified: 25 items corresponding to *Human Requirements* (except for the two opposed meaning items mentioned before), at the beginning of

the survey; 15 items corresponding to GLOBE's constructs (*Assertiveness, In-group Collectivism, Future Orientation and Performance Orientation*), in the middle of the survey; and 13 items corresponding to *Lean Management Practice* from the instruments proposed by Kobayashi (1995) and Shah and Ward (2007) at the end of the survey. The rule considered for identification was any response that had a within group standard deviation lower than .5 [Gaskin, J. (2012) as cited in (Thakur, 2016)]. Table 15 presents a summary of the cases identified.

The subsequent step was to detect **incomplete responses**. In this case, the threshold considered was to remove both, cases and survey items, that were below 90 percent of completion [Gaskin, J. (2012) as cited in (Thakur, 2016)]. Therefore, from the 98 survey items (the last question item 99 corresponds to a demographic conditional response if a different nationality from place of birth), those cases with 10 percent or more missing were removed. The number of cases left were 97 (34 for Mexico sample and 63 for the U.S. sample). The threshold of 90 percent was considered again over the total cases left, and this time considering variables (survey items), where only the demographic question D4 (survey item 95) "What is your current job?" showed 82 percent of completion (80 out of 97 cases answered this question). Given that this item was intended for demographic purposes, it was not deleted, nor will be using any additional imputation methods.

For the cases with nine or less missing responses, the **missing data** was calculated using the median of the variable within the corresponding group as the imputation method (Lynch, 2007) using SPSS from IBM Corp. (2017b), only for variables of a construct (not demographic questions). Most questions were in the format of a Likert scale or multiple choice, for which this was the most appropriate method. A summary of the cases is presented in Table 16, identified per case and variable item.

Table 15 Identification of Unengaged and Incomplete Responses

Criteria	Cases	Count
Unengaged responses*	2, 9, 10, 11, 13, 15, 20, *33*, 35, 44, *47*, 50, 58, *73*, 77, 80, 81, 87, *88*, 92, 94, 95, 115, 117 & 125	25
σ<.5, group 1	3, *33*, 57, 64, *73*, *88*, 109 & 123	8 (3**)
σ<.5, group 2	None	0
σ<.5, group 3**	1, *47* & 122	3
Completion < 90%	14, 126 & 127	3
	Total eliminated	**30**

*Four cases overlap within the criteria, 33, 47, 73 & 88, the count is not duplicated. **Only 3 were eliminated after review.

Table 16 Missing Data by Cases and Variables

Complete percent	*Per Case (Case No.)**	*Frequency*	*Per Variable Item (Survey Item No.)**	*Frequency*
95%	121	1	SOP2(73)	1
96%	12	1		0
97%		0	D5(96)	1
98%	18, 24, 34 & 99	4	FLO4(89), SCH2(90), SCH3(91)	3
99%	6, 21, 22, 23, 25, 27, 31, 32, 36, 37, 41, 45, 46, 56, 60, 84 & 109	17	TPS1(67), TPS3(69), SOP1(72)	3
Total		**23 cases**		**8 items**

*The results consider only the 97 cases found after the initial screening.

Table 17 Skewness and Kurtosis Issue Items

Issues with skewness	**Issues with kurtosis**	**Observation**
AD3 & COL2	IN1, FL1, FL2, SE1, SE2, AD1, AD2, AD3, PD2, MAS2, MAS4, IND3, COL2, PE1	Review for bimodality AD3 and COL2, the rest might are considered non-normal in any case.

The steps considering the shape of the distribution of each variable test for normality of the responses. Two of the most important indicators from a univariate perspective are **skewness and kurtosis.** In the use of PLS-SEM, is important to consider this analysis, as it justifies the non-normality assumption that is easier to handle with this estimation method, but also supports important implications when running the procedures (J. F. Hair, Ringle, & Sarstedt, 2013). The criteria used to identify issues is the one proposed by (Sposito, Hand, & Skarpness, 1983) where the threshold ranges from -2 to +2. Any item identified outside might be a problem for analysis, or a relevant element for moderation. The items identified among these criteria are shown in Table 17.

4.2.2 Data Summary

Following the identification of the useful cases and the imputation of the missing variables, the number of cases for the complete analysis was 97 out of 127 responses indicating that 30 cases were removed. Sample sizes for PLS-MGA (moderating) effects remain valid considering the rule of thumb of larger or equal than 30, with 34 for the location in Mexico and 63 for U.S.

The demographics (Table 18) of the useful data reflect a required modification in the data presented, specifically for the cases of nationality, where it was reported as outside of any of the two locations in this study. Other identifiable information is protected by providing only the general breakdown of the 97 useful cases, and not revealing the demographics of eliminated cases. Demographic item 6 (item 97 - "Do you consider yourself a religious or spiritual person?") was removed from this analysis as did not provide information that could be of further use in this study, given the number of subjects that preferred not to answer.

Table 18 Frequencies of Demographic Information

Concept	Variable	Frequency	Percent	Valid Percent	Cumulative Percent
Location	Mexico	34	35	35	35
	United States	63	65	65	100.0
Gender	Male	30	30.9	30.9	30.9
	Female	67	69.1	69.1	100.0
Age	Under 24	5	5.2	5.2	5.2
	25-29	9	9.3	9.3	14.4
	30-34	12	12.4	12.4	26.8
	35-39	15	15.5	15.5	42.3
	40-49	27	27.8	27.8	70.1
	50-59	18	18.6	18.6	88.7
	60 or over	11	11.3	11.3	100.0
Education	6 years or less (primary/elementary)	7	7.2	7.2	7.2
	7-9 years (junior high)	15	15.5	15.5	22.7
	10-12 years (high, technical education)	50	51.5	51.5	74.2
	13-15 years (vocational, technical education, college, truncated university)	19	19.6	19.6	93.8
	16-17 years (university, bachelor's degree, associate degree)	3	3.1	3.1	96.9
	18 years or more (graduate degree)	3	3.1	3.1	100.0
Position	Administrative- Management	1	1.0	1.3	1.3
	Administrative- Not management	8	8.2	10.0	11.3
	Production- Management	6	6.2	7.5	18.8
	Production- Not Management	44	45.4	55.0	73.8
	Production support (maintenance, engineering, material handling, warehouse)- Management	9	9.3	11.3	85.0
	Production support (maintenance, engineering, material handling, warehouse)-Not Management	12	12.4	15.0	100.0
	Missing	17	17.5	Excluded	
Experience with Lean	No experience	37	38.1	39.4	39.4
	1-2 years	11	11.3	11.7	51.1
	3-5 years	10	10.3	10.6	61.7
	6-10 years	7	7.2	7.4	69.1
	More than 10 years	29	29.9	30.9	100.0
	Missing	3	3.1	Excluded	
Nationality	Mexico	34	35.1	35.1	35.1
	United States of America	59	60.8	60.8	95.9
	Others	4	4.1	4.1	100.0

The case study performed presents several important considerations. The initial and most evident is the fact that the operations in both locations consisted of a different size of fleet (total number of employees). The U.S. location employs 112 people, from which 100 (including non-consent responses) participated in the survey, for a response rate of 89 percent. The Mexican location employs 52 people, with a participation rate of 100 percent. Total participation rate accounts for 93 percent of all employees.

After the data screening and filtering, 63 useful cases remained for U.S., and 34 for Mexico. In overall terms, the U.S. useful participation was of 63 percent over total participants from this location, 65 percent over the total useful participation cases and 38 percent over total population of the organization. For the Mexico's operation, useful participation was of 65 percent, 35 percent and 20 percent, respectively.

The subsequent indicators were not dissected by location to prevent any potential identification of subjects. From the useful cases, the population is predominantly female, with 69 percent, compared to a 31 percent of male cases. This is representative in comparison with the population. In regard to age, 42 percent is below 40 years, and the highest cluster is within 40 to 49 years, showing a relatively spread distribution following a normal pattern of responses among all age clusters. Approximately 74 percent of the people reported having as a maximum educational level of high school or an equivalent, with 52 percent of them indeed completing high school, supporting the literacy expected from the readability test. About 63 percent of participants are directly related with production operations, with the rest working in supporting and administrative activities. All Mexican participants were nationals, compared to a 94 percent of U.S. respondents being nationals. Conclusions made regarding national culture, from the standpoint of the location, can be considered valid as part of their representation in this survey.

As a final observation with regard to demographics, the reported cases with some sort of experience in the Lean Management Practice account for 61 percent of the total useful responses. The survey focused on perceptions rather than actual knowledge, which based on the case organization, employees have experienced training in the subject 3 years before the study was conducted, and having multiple elements of the system implemented within the organization. The 39 percent that reported no experience would still be operational in some of the activities, which would not have the full awareness of technical terms, but still are in use. Hence, the results presented in this study reflect their preferences and perceptions.

4.3 Evaluation of Measurement Model

The framework introduced in section 3.5 presents the proposed model of this study. The model presents two initial second-order variables for *Human Requirements* and *Lean Management Practice*, each composed of 8 and 6 first-order variables respectively. *Environmental Appraisal as National Culture* does not consider a higher order model, given that the mediation nature is tested with each element of the model. The relationship of the observed variables with their corresponding first-order variables follow a reflective nature for *Human Requirements,* given that the observed items within the constructs can be replaceable and interchangeable, as the theories that supported the design of the instrument allowed this to happen. In the case of *Lean Management Practice,* the observed variables represent a unique characteristic of the construct.

On the case of second-order variables, *Human Requirements* and *Lean Management Practice* follow a formative measurement model, as the first-order factors are not interchangeable within the effects they represent. Moreover, the elements described in those factors describe the theory and logic to follow a holistic set of characteristics required or a strict sequential implementation, respectively.

On the contrary, the elements for the *Environmental Appraisal as National Culture*, are proposed from a diverse set of theories that, per se are not replaceable; they would represent a characteristic of a national culture, which might be similar or different within the counterparts. In essence, they reflect the national culture. This mainly prevents this subset of variables to be accounted for a higher order variable.

These configurations of a structural model are known as *Hierarchical Component Models* (HCM), which depending on the relationship between the first-order and second-order variables, receive a particular classification for treatment and analysis (Becker, Klein, & Wetzels, 2012; Joseph F. Hair et al., 2018), as illustrated in Table 19.

Table 19 Classification of Hierarchical Component Models for the CSLM

Domain	Observed variable to 1st order variable	1st order variable to 2nd order variable	Classification
Human Requirements	Reflective	Formative	Type II
Lean Management Practice	Formative	Formative	Type IV

Hence, three perspectives are assessed: goodness-of-fit of the measurement model for observations of reflective nature (using covariance based tests as a reference), common PLS-SEM analysis of reflective measurements and analysis of formative measurements, with their corresponding techniques described in each section.

The first model evaluated is *Human Requirements*, followed by *Lean Management Practice*, and lastly the *Environmental Appraisal as National Culture*, with respective analyses for each section (4.3.1, 4.3.2 and 4.3.3). The results henceforward present the tests of the models after data "purification".

PLS-SEM is more flexible compared to estimation methods based on covariance, (such as ML used in AMOS 25). For example, the measurement properties can consider constructs consisting of one or two items (Joseph F. Hair et al., 2011). In this case, SEM-PLS provides the option of reducing constructs before removing them completely from the instrument. Therefore, as a result of all conducted tests, the eliminated items with their corresponding reason are presented in Table 20.

Table 20 Observed Items Eliminated from the Model

2nd-Order Factor	1st Order Factor	Item Eliminated	Item	Software used	Criteria
Human Requirements	Attention to Detail	AD1	20	SPSS 25, SmartPLS 3	Loading <.5
		AD2	21	SmartPLS 3	Loading <.5, crossloading
	Autonomy	AU1	1	AMOS 25	Low Significance (T-Test < 1.65)
	Communication	CO1	4	SPSS 25	Loading <.5
		CO2	5	AMOS 25	Low Significance (T-Test < 1.65)
		CO3	6	AMOS 25, SmartPLS 3	Loading <.5
	Flexibility	FL1	10	SPSS 25, SmartPLS 3	Loading <.5
	Problem Solving	PS1	13	SPSS 25, SmartPLS 3	Loading <.5, crossloading
		PS2	14	SmartPLS 3	Loading <.5, crossloading
	Self-Efficacy	SE1	16	SmartPLS 3	Loading <.5
		SE2	17	SmartPLS 3	Low Significance (T-Test < 1.65)
		SE3	18	SmartPLS 3	Loading <.5
		SE4_N	19		Engaged response item
	Team Orientation	TO_N	25		Engaged response item
Lean Management Practice	Consistency	CON2	83	SmartPLS 3	Low Significance (T-Test < 1.65)
	Flow	FLO4_1	89	SmartPLS 3	Low Significance (T-Test < 1.65)
	Foundation & Prerequisites	TPS2	68	SmartPLS 3	Low Significance (T-Test < 1.65)
		TPS5_1	87	SmartPLS 3	Low Significance (T-Test < 1.65)
	Scheduling & Sequencing	SCH2_1	90	SmartPLS 3	Low Significance (T-Test < 1.65)
	Standard Operations	SOP1_1	72	SmartPLS 3	Low Significance (T-Test < 1.65)
		SOP4_1	75	SmartPLS 3	Low Significance (T-Test < 1.65)

4.3.1 Goodness-Of-Fit

Most models in PLS-SEM are generally not tested for goodness-of-fit, as these methods are generally covariance based. However, they provide a good reference for the constructs that can simplify and improve the accuracy of the PLS-SEM model.

The criteria to assess the measurement model considers the steps in Confirmatory Factor Analysis, by first exploring the data in SPSS Statistics 25 (IBM Corp., 2017b) inspecting the factor loadings highlighting those with less than .5, crossloadings with differences less than .2, and pattern loadings, through PROMAX rotation and Principal Axis Factoring. Secondly, using AMOS 25 Graphics (IBM Corp., 2017a) the test corresponds for goodness-of-fit of the model using the criterion described in Table 21 (Joseph F Hair, Black, Babin, Anderson, & Tatham, 2010). The final pass for the model was through a final exploration using Smart PLS 3 (Ringle et al., 2015) to confirm the factor loadings and t-statistics (greater than 1.96) for the models. This could only be used for formative constructs given the restrictions that the estimation method of ML sets in the AMOS 25 software.

The indicators considered for goodness-of-fit are comprehensively described by Joseph F Hair et al. (2010) begin with the chi-square statistic (χ^2) over degrees of freedom (df) ratio, which is expected to be below 5. This indicator as is influenced by the sample size. The Tucker Lewis Index (TLI) is a comparison of the normed chi-square for the null and specified model, whose values range from 0 to 1, aiming at 1 for a the best fit, and with a threshold of .92 desired. The Comparative Fit Index (CFI) is similar to the previous, with a relative insensitivity to model complexity, using the same threshold. The Standardized Root Mean Residual, based on the residuals derived from the errors in the predicted covariances, with a desired threshold below .05, but with an acceptable one at .08. The last indicator used in this study is the Root Mean Square Error of Approximation (RMSEA) which represents the fitting of a model within a population with values below .08 as a threshold for a good fit. After this initial analysis, each construct is assessed from the appropriate methods in PLS-SEM based on the nature of the constructs.

Table 21 Goodness of Fit Criteria and Results

Criteria	Desired Threshold	Human Requirements (1st order reflective)
χ^2/df	<5	1.367
TLI	>.92	.911
CFI	>.92	.935
SRMR	<.08	.071
RMSEA	<.08	.061

4.3.2 Reflective Measurement Models

Reflective constructs are those whose items are a result of the factor considered as a latent variable. These items are replaceable, interchangeable and could be highly correlated. As proposed by Joseph F. Hair et al. (2011) the assessment of reflective measurement models considers both reliability and validity. Table 22 presents the criteria used to evaluate PLS-SEM reflective models.

Internal consistency reliability is captured by composite reliability, which is a measure similar to Chronbach's Alpha, but it does not assume equal reliability within all indicators of a construct. Values around 0.60 to 0.70 are acceptable in exploratory research (Joseph F. Hair et al., 2011). In addition, indicator loadings (outer loadings) are suggested to be higher than .7. However, if an indicator has a value greater than of .4, it can be kept, considering removal only if composite reliability increases. Loadings below .4 should always be removed. In this study, the minimum value for loadings considered is .5.

The validity of the reflective measurement model considers two aspects: convergent validity and discriminant validity. Convergent validity is measured with average variance extracted (AVE), where the suggested value is .5 or higher. Discriminant validity is measured considering two methods: the Fornell–Larcker criterion and crossloadings.

Table 22 Criteria for Evaluation of Reflective Measurement Models in PLS-SEM (Joseph F. Hair et al., 2011)

Type of Test or Indicator	Criteria
Internal consistency reliability	Composite reliability should be higher than 0.70 (in exploratory research, 0.60 to 0.70 is considered acceptable).
Indicator reliability	Indicator loadings should be higher than 0.70. (although values of .5 are useful)
Convergent validity	The average variance extracted (AVE) should be higher than 0.50.
Discriminant validity	The AVE of each latent construct should higher than the construct's highest squared correlation with any other latent construct (Fornell–Larcker criterion). As well, an indicator's loadings should be higher than all of its crossloadings.

Note: Adapted from Hair, J. F., et al. (2011). "PLS-SEM: Indeed a Silver Bullet." Journal of Marketing Theory and Practice 19(2): 139-152.

Table 23 Summary of Reflective Measurement Model Test Results

Type of Test or Indicator	Human Requirements (original)	Human Requirements (adjusted)
Internal consistency reliability	.835	.819
Indicator reliability (values < .5)	AD1, AD2, CO3, FL1, PS2, SE1 & SE3.	Only AD4 (with .479)
Convergent validity	AVE of .186 for 2nd order, only Initiative and Team Orientation > .5, low AVE for all 6 elements.	AVE of .265 for 2nd order, only Initiative and Team Orientation > .5, but higher AVE for other 3 elements.
Discriminant validity – Fornell-Larcker Criterion	Violation of Attention to Detail, Flexibility, Initiative, Problem Solving & Self-Efficacy	Violation of Attention to Detail (by a difference of .004).
Discriminant validity – Crossloadings	AD2, AD3, AD4, CO3, PS1, PS2 & PS3	No crossloadings

The Fornell-Larcker criterion (Fornell & Larcker, 1981) indicates that the AVE of the latent variable should be greater than the latent construct's highest squared correlation with any other latent construct. This item shows in the diagonal value presented from the output in the software Smart PLS Ringle et al. (2015). The crossloadings criterion indicates that the loading of an indicator with the corresponding latent variable should be higher than any of the crossloadings.

With all these considerations, the initial construct for the reflective measurement of *Human Requirements* presents several elements that need further review, resulting in an adjusted model with the considerations to fulfill all the tests. The final reflective measurement model for this case study removed three constructs that were non-compliant: *Communication, Problem Solving and Self-Efficacy*. Three more received further modifications: *Autonomy* remained measured by two items (AU2 and AU3); *Flexibility* is measured by two items (FL2 and FL3); and *Attention to Detail* included a crossloaded element from *Problem Solving* (PS3), that along with the last two items (AD3 and AD4), provided the face validity of the construct. Two latent variables (*Initiative* and *Team* Orientation) remained with no changes. A summary of the analysis is presented in Table 23.

4.3.3 Formative Measurement Models

Formative constructs are those whose items are not interchangeable, hence might not show any correlation with the other items measuring a construct. The reason for this is that the theory behind the construct supports the observations creating a measurement for a particular factor, which is unique. From this definition, the formative constructs constitute the latent factors for all first-order measures of *Lean*

Management Practice, and the *Human Requirements* as second order construct. For the purpose of this test, both models were considered as individual higher order models.

The tests that formative measures follow are related to relevance of the items and constructs as well as collinearity issues. For testing relevance, T-Tests provide the significance of items; for collinearity, the indicator use dis the variance inflation factor. The creation of higher-order (in this case, second-order) constructs represent a possible solution when a violation in the previous indicators occur. Table 24 present the criteria for these tests.

Multicollinearity can create problems when the second-order factors are created within the first-order factors (as they reflect the measurement of the prior), but they support the "easiness" of study of the relationships by the separation of constructs (Koufteros et al., 2009).

Within *Lean Management Practice*, which is a Type IV model, the measurement only considers the tests described in this section. The six elements described as first-order factors in this construct presented significance problems with eight observed variables, which were eliminated. In the remaining items, only one (SCH3_1) presented a p-value between .05 but below .1. Regarding multicollinearity, no issues emerged.

Table 24 Criteria for Evaluation of Formative Measurement Models in PLS-SEM (Joseph F. Hair et al., 2011)

Type of Test or Indicator	Criteria
T-Test	Significance of weights and loadings using bootstrapping (5,000 samples). Critical t-values for a two-tailed test are 1.65 (significance level = 10 percent), 1.96 (significance level = 5 percent), and 2.58 (significance level = 1 percent). – When all the indicator weights are significant, there is empirical support to keep all the indicators. – If both the weight and loading are nonsignificant, there is no empirical support to retain the indicator and its theoretical relevance should be questioned.
Multicollinearity	Each indicator's variance inflation factor (VIF) value should be less than 5.
Separation of constructs	When many indicators are used to measure a formative construct, with some being nonsignificant, establish two or more distinct constructs, provided there is theoretical support for this step.

Note: Reprinted from Hair, J. F., et al. (2011). "PLS-SEM: Indeed a Silver Bullet." Journal of Marketing Theory and Practice 19(2): 139-152.

4.4 Evaluation of Structural Model

The structural model represents the theory under study through an empirical approach, in pursuit of predictability of phenomena, through the different elements that compose the model. At this stage, the results from the previous sections support prediction capabilities of the model. PLS-SEM follows a particular set of tests, as illustrated in Table 25. The primary evaluation criteria considered are Coefficient of Determination R^2 and *T*-tests for significance. In addition, Predictive Relevance and Collinearity Assessments provide insights in the model.

Table 25 Criteria for Evaluation of Structural Models in PLS-SEM (Joseph F. Hair et al., 2011)

Type of Test or Indicator	Criteria
Coefficient of Determination R^2	Values of 0.75, 0.50, or 0.25 for endogenous latent variables in the structural model can be described as substantial, moderate, or weak, respectively.
T-Tests	Use bootstrapping to assess the path coefficients' significance. The minimum number of bootstrap samples is 5,000, and the number of cases should be equal to the number of observations in the original sample. Critical t-values for a two-tailed test are 1.65 (significance level = 10 percent), 1.96 (significance level = 5 percent), and 2.58 (significance level = 1 percent).
Predictive relevance	Use blindfolding to obtain cross-validated redundancy measures for each construct. Make sure the number of valid observations is not a multiple integer number of the omission distance d. Choose values of d between 5 and 10. Resulting Q^2 values of larger than zero indicate that the exogenous constructs have predictive relevance for the endogenous construct under consideration.
Heterogeneity	If theory supports the existence of alternative groups of data, carry out PLS-SEM multi-group or moderator analyses. If no theory or information about the underlying groups of data is available, an assessment of unobserved heterogeneity's existence must be conducted by means of the FIMIX-PLS method, which is available in the SmartPLS software package.

Note: Reprinted from Hair, J. F., et al. (2011). "PLS-SEM: Indeed a Silver Bullet." Journal of Marketing Theory and Practice 19(2): 139-152.

4.4.1 Coefficient of Determination R^2

The coefficient of determination R^2 represents the squared correlation between the predicted values of the constructs and actual values. It is a measure to assess the predictive power of the model, through the explained variance of the endogenous variables (Peng & Lai, 2012). An acceptable level depends on the research context (J. F. Hair et al., 2013), however values can be considered beginning at .19 (Chin, 1998). Table 26 presents the results for the endogenous variables in the structural model.

The values in Table 26 for the latent variables seem low seem low indicating that further analysis is considered necessary to explain the results, especially from the perspective of the different groups.

4.4.2 Size and Significance of Path Coefficients

The path coefficients represent the relationships determined in the structural model. Their magnitude as well as sign determine the effect on the latent variables they connect to. Their directionality determine the status of the connecting variable as endogenous or exogenous. The significance of the path coefficients uses T-statistics. The assessment is performed using a bootstrapping method with 5,000 samples. Figure 21 illustrates the relationships of the model, including the corresponding significance with the corresponding p-values.

The significance of path coefficients draws in the borderline for two elements, *Human Requirements-> Workplace,* and *Human Requirements-> Scheduling and Sequencing*. For the rest of the relationships it remains significant (at a .1 level in a one-tailed test). All relationships established are positive, with the paths highlighting the stronger effects with thicker lines on the endogenous variable.

Table 26 Coefficients of Determination for Endogenous Variables

Endogenous Variable	R^2	R^2 Adjusted
Consistency	0.084	0.075
Flow	0.123	0.114
Foundation and Prerequisites	0.107	0.098
Scheduling and Sequencing	0.039	0.028
Standard Operations	0.122	0.112
Workplace Design	0.083	0.074

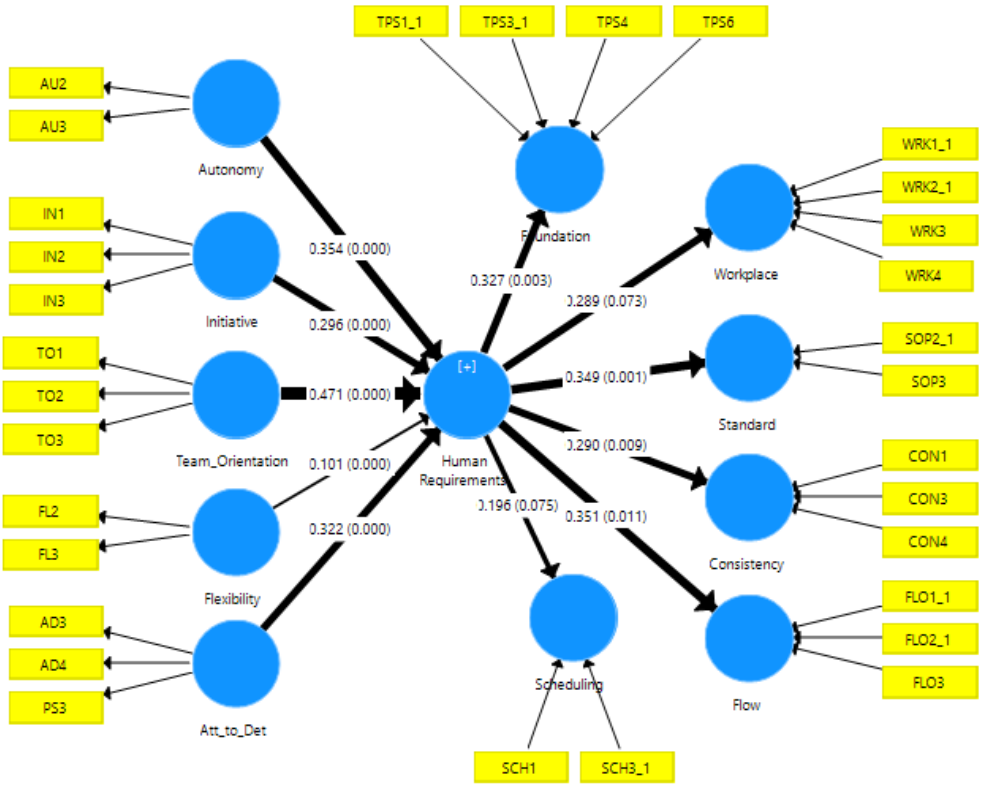


Figure 21 Structural Model and Path Coefficients (p-values)

As the elements are described from the perspective of a higher order construct, the relationships are determined by the combination of the *Human Requirements* over each one of the elements defined for the *Lean Management Practice* as follows:

- *Human Requirements* have a positive effect on the Foundation and Prerequisites of the *Lean Management Practice.* The higher the value of *Human Requirements*, the Foundation and Prerequisites are higher in practice and/or execution.
- *Human Requirements* have a positive effect on the Workplace Design of the *Lean Management Practice.* The higher the value of *Human Requirements*, the Workplace Design elements are higher in practice and/or execution.
- *Human Requirements* have a positive effect on the Standard Operations of the *Lean Management Practice.* The higher the value of *Human Requirements*, the Standard Operations elements are better in practice and/or execution.
- *Human Requirements* have a positive effect on the Consistency of the *Lean Management Practice.* The higher the value of *Human Requirements*, the Consistency elements are better in practice and/or execution.

- *Human Requirements* have a positive effect on the Flow of the *Lean Management Practice.* The higher the value of *Human Requirements*, the Flow elements are better in practice and/or execution.
- *Human Requirements* have a positive effect on the Scheduling and Sequencing of the *Lean Management Practice.* The higher the value of *Human Requirements*, the Scheduling and Sequencing elements are higher in practice and/or execution.

4.4.3 Predictive Relevance

Predictive relevance uses blindfolding, following the procedure in Table 25 Criteria for Evaluation of Structural Models in PLS-SEM (Joseph F. Hair et al., 2011), measured by Q^2. The assessment is made over each of the six elements of the *Lean Management Practice* as the endogenous variables. The omission distance (d) used is seven, which is not a multiple of the number of observations (97). Table 27 includes the results of the assessment, where Workplace Design shows no predictive relevance.

4.4.4 Collinearity Assessment

The assessment is performed over the structural model using the Variance Inflation Factor. Values should be less than five. The values of one are due to the repeated measures method for the higher order variable, given that the endogenous variables also follow a formative nature. Nonetheless, all values are within the defined threshold, showing no issues as in the formative measurement model (Table 28).

Table 27 Cross-validated Redundancy Measures for Predictive Relevance Q2

Endogenous Variables	SSO	SSE	Q^2 (=1-SSE/SSO)
Consistency	291	288.49	0.009
Flow	291	285.388	0.019
Foundation and Prerequisites	388	382.421	0.014
Human Requirements	1,261.00	904.67	0.283
Scheduling and Sequencing	194	193.728	0.001
Standard Operations	194	183.543	0.054
Workplace Design	388	388.044	0

Table 28 Collinearity Assessment of the Structural Model

Variable	VIF
Attention to Detail	1.905
Autonomy	1.46
Consistency	1
Flexibility	1.3
Flow	1
Foundation and Prerequisites	1
Human Requirements	1
Initiative	1.766
Scheduling and Sequencing	1
Standard Operations	1
Team Orientation	1.472
Workplace Design	1

4.5 Hypothesis Testing Influence of Culture – Mediation Within Groups and Differences

Provided that the software use facilitates the calculation of PLS-MGA with the model proposed, the following set of results focus in both the mediation of the cultural variables (*Environmental Appraisal as National Culture*) and the comparison of the groups.

The first group assigned is Mexico, identified numerically with the parameter *Location* as "1", and with the acronym "MX" for the analysis within the software Smart PLS. Respectively, United States is identified as "2" and "US".

The model uses individual mediation with the purpose of an easier and clearer analysis. The generic structural model of mediation is shown in Figure 22 as it connects each path with the mediator and directly with the endogenous variables. The *Environmental Appraisal as National Culture*, as mentioned previously, includes 11 variables presented as indexes, calculated with their corresponding method and based on the theory that supports them. The cases are reported per individual and not per country averages, leaving the conclusions for the MGA-PLS algorithm to provide the country differences.

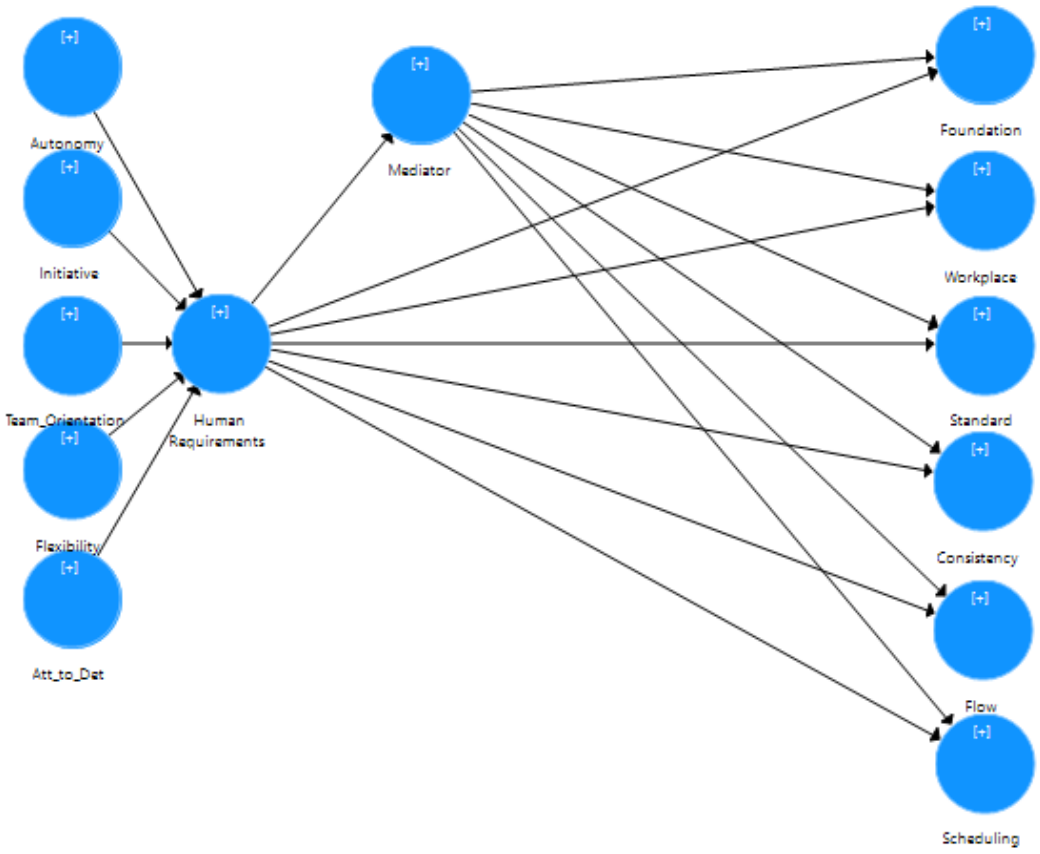


Figure 22 Mediation Structural Equation Model of the Culturally Sensitive Lean Model

4.5.1 Effect of Assertiveness

The assessment of the effect of assertiveness was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice*. The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 29 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Table 29 MGA-PLS through Mediation of Assertiveness

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.188	0.412	0.400	0.012**	0.006	-0.004	0.873	0.974	not significant	no mediation
Human Requirements -> Flow	-0.106	0.389	0.804	0.083**	0.020	0.004	0.813	0.950	not significant	no mediation
Human Requirements -> Foundation_	0.273	0.343	0.350	0.125	-0.003	0.001	0.802	0.946	not significant	not significant
Human Requirements -> Scheduling	-0.058	0.427	0.849	0.006***	-0.002	0.001	0.851	0.924	not significant	no mediation
Human Requirements -> Standard	-0.019	0.406	0.934	0.007***	0.007	-0.005	0.841	0.899	not significant	no mediation
Human Requirements -> Workplace	-0.052	0.321	0.693	0.138	0.006	0.003	0.766	0.970	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Assertiveness* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice*. However, when looking at the differences within the countries, one can appreciate that Mexico does not hold a significant path in any of the presented cases, whereas United States indeed has a significant effect within the direct (no mediation) relationships between *Human Requirements* and *Consistency, Flow, Scheduling and Sequencing* and *Standard Operations.* Table 30 confirms that there is no significant relationship between the *Human Requirements* and *Assertiveness.*

Table 30 Path Coefficients for Direct Effects for Assertiveness

	Path Coeff.		p-Values	
	MX	US	MX	US
Assertiveness -> Consistency	0.001	0.055	0.602	0.807
Assertiveness -> Flow	-0.202	-0.122	0.403	0.572
Assertiveness -> Foundation_	0.031	-0.074	0.450	0.585
Assertiveness -> Scheduling	-0.054	-0.099	0.581	0.453
Assertiveness -> Standard	-0.156	0.236	0.480	0.071*
Assertiveness -> Workplace	-0.162	0.089	0.336	0.771
Human Requirements -> Assertiveness	-0.06	-0.018	0.711	0.885

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

From the previous table only the path coefficient between Assertiveness and Standard Operations shows significance, and exclusively in the case of the United States. The implications will be furtherly explained in Chapter 5 for this and all the remaining elements.

4.5.2 Effect of In-Group Collectivism

The assessment of the effect of In-Group Collectivism was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice*. The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 31 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

The first observation relevant is that *In-Group Collectivism* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Flow, Scheduling and Sequencing*, *Standard Operations* and *Workplace Design.* Table 32 confirms that there is no significant relationship between the *Human Requirements* and *In-Group Collectivism.*

Table 31 MGA-PLS through Mediation of In-Group Collectivism

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.215	0.315	0.393	0.111	0.001	0.015	0.897	0.958	not significant	not significant
Human Requirements -> Flow	-0.073	0.400	0.766	0.026**	-0.007	0.020	0.930	0.698	not significant	no mediation
Human Requirements -> Foundation_	0.344	0.300	0.209	0.134	0.000	0.016	0.976	0.865	not significant	not significant
Human Requirements -> Scheduling	-0.049	0.403	0.881	0.007***	0.004	0.019	0.914	0.636	not significant	no mediation
Human Requirements -> Standard	0.022	0.396	0.731	0.008***	-0.011	-0.004	0.959	0.910	not significant	no mediation
Human Requirements -> Workplace	-0.120	0.348	0.615	0.098*	-0.010	0.005	0.935	0.932	not significant	no mediation

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 32 Path Coefficients for Direct Effects for In-Group Collectivism

	Path Coeff.		p-Values	
	MX	US	MX	US
In-Group Collectivism -> Consistency	0.031	-0.114	0.509	0.902
In-Group Collectivism -> Flow	0.064	-0.247	0.658	0.162
In-Group Collectivism -> Foundation_	0.000	-0.153	0.878	0.670
In-Group Collectivism -> Scheduling	0.079	-0.282	0.570	0.008***
In-Group Collectivism -> Standard	0.043	0.049	0.772	0.771
In-Group Collectivism -> Workplace	0.184	-0.078	0.593	0.827
Human Requirements -> In-Group Collectivism	-0.014	-0.082	0.832	0.609

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

From the previous table, only the path coefficient between In-Group Collectivism and Scheduling shows significance, and exclusively in the case of the United States.

4.5.3 Effect of Future Orientation

The assessment of the effect of Future Orientation was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice*. The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 33 presents the path coefficients and the indirect effects with their corresponding p-values and the effect of the mediation variable.

Table 33 MGA-PLS through Mediation of Future Orientation

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.168	0.374	0.424	0.019**	-0.006	0.033	0.936	0.616	not significant	no mediation
Human Requirements -> Flow	-0.074	0.494	0.945	0.021**	-0.007	-0.086	0.914	0.180	not significant	no mediation
Human Requirements -> Foundation_	0.310	0.253	0.232	0.320	0.011	0.056	0.968	0.423	not significant	not significant
Human Requirements -> Scheduling	-0.065	0.425	0.878	0.006***	0.017	0.013	0.966	0.741	not significant	no mediation
Human Requirements -> Standard	0.005	0.385	0.695	0.009***	-0.003	0.022	0.919	0.556	not significant	no mediation
Human Requirements -> Workplace	-0.146	0.302	0.572	0.141	0.000	-0.001	0.965	0.749	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 34 Path Coefficients for Direct Effects for Future Orientation

	Path Coeff.		p-Values	
	MX	US	MX	US
Future Orientation -> Consistency	-0.056	0.109	0.535	0.575
Future Orientation -> Flow	-0.189	-0.286	0.360	0.103
Future Orientation -> Foundation_	-0.009	0.185	0.750	0.401
Future Orientation -> Scheduling	-0.003	0.044	0.728	0.734
Future Orientation -> Standard	-0.013	0.087	0.449	0.552
Future Orientation -> Workplace	-0.062	-0.001	0.736	0.750
Human Requirements -> Future Orientation	0.043	0.303	0.888	0.007***

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Future Orientation* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Same as the previous cases, when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency, Flow, Scheduling and Sequencing*, and *Standard Operations* . Table 34 displays that the only significant relationship is between the *Human Requirements* and *Future Orientation* within the United States.

4.5.4 Effect of Performance Orientation

The assessment of the effect of Performance Orientation was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice.* The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 35 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Table 35 MGA-PLS through Mediation of Performance Orientation

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.212	0.435	0.490	0.002***	-0.039	-0.042	0.596	0.512	not significant	no mediation
Human Requirements -> Flow	-0.222	0.363	0.629	0.135	0.223	0.000	0.310	0.730	not significant	not significant
Human Requirements -> Foundation_	0.094	0.326	0.878	0.135	0.197	-0.018	0.277	0.883	not significant	not significant
Human Requirements -> Scheduling	-0.158	0.399	0.713	0.008***	0.141	0.033	0.405	0.464	not significant	no mediation
Human Requirements -> Standard	-0.176	0.382	0.529	0.014**	0.190	0.010	0.215	0.900	not significant	no mediation
Human Requirements -> Workplace	-0.227	0.368	0.481	0.065*	0.070	-0.025	0.522	0.690	not significant	no mediation

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Performance Orientation* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency*, *Scheduling and Sequencing*, *Standard Operations* and *Workplace Design.* Table 36 illustrates that there is significant relationship between the *Human Requirements* and *Performance Orientation* in this case for Mexico, but it does not provide a mediating effect.

Table 36 Path Coefficients for Direct Effects for Performance Orientation

	Path Coeff.		p-Values	
	MX	US	MX	US
Performance Orientation -> Consistency	-0.056	0.109	0.535	0.575
Performance Orientation -> Flow	-0.189	-0.286	0.360	0.103
Performance Orientation -> Foundation_	-0.009	0.185	0.750	0.401
Performance Orientation -> Scheduling	-0.003	0.044	0.728	0.734
Performance Orientation -> Standard	-0.013	0.087	0.449	0.552
Performance Orientation -> Workplace	-0.062	-0.001	0.736	0.750
Human Requirements -> Performance Orientation	0.529	0.156	0.002***	0.330

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

4.5.5 Effect of Masculinity vs. Feminity

The assessment of the effect of Masculinity vs. Feminity was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice.* The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 37 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

The first observation relevant is that *Masculinity vs. Feminity* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency, Scheduling and Sequencing*, and *Standard Operations.* Table 38 illustrates that there is no significant relationship between the *Human Requirements* and *Masculinity vs. Feminity*, or any other path connected to the latter.

Table 37 MGA-PLS through Mediation of Masculinity vs. Feminity

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.229	0.413	0.387	0.013**	-0.057	-0.002	0.599	0.965	not significant	no mediation
Human Requirements -> Flow	-0.053	0.340	0.948	0.169	-0.020	0.008	0.574	0.970	not significant	not significant
Human Requirements -> Foundation_	0.395	0.352	0.201	0.113	-0.035	0.003	0.920	0.978	not significant	not significant
Human Requirements -> Scheduling	-0.038	0.431	0.993	0.003***	-0.024	0.008	0.569	1.000	not significant	no mediation
Human Requirements -> Standard	0.055	0.411	0.687	0.002***	-0.083	0.002	0.591	0.972	not significant	no mediation
Human Requirements -> Workplace	-0.007	0.327	0.647	0.145	-0.056	0.002	0.488	0.968	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 38 Path Coefficients for Direct Effects for Masculinity vs. Feminity

	Path Coeff.		p-Values	
	MX	US	MX	US
Masculinity vs. Feminity -> Consistency	0.216	-0.132	0.324	0.400
Masculinity vs. Feminity -> Flow	0.151	-0.007	0.373	0.595
Masculinity vs. Feminity -> Foundation_	0.081	-0.106	0.870	0.660
Masculinity vs. Feminity -> Scheduling	0.061	0.011	0.423	0.996
Masculinity vs. Feminity -> Standard	0.307	-0.058	0.174	0.584
Masculinity vs. Feminity -> Workplace	0.272	-0.128	0.203	0.499
Human Requirements -> Masculinity vs. Feminity	-0.246	-0.014	0.336	0.942

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

4.5.6 Effect of Power Distance

The assessment of the effect of Power Distance was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice*. The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 39 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Table 39 MGA-PLS through Mediation of Power Distance

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.360	0.384	0.228	0.012**	0.039	0.025	0.603	0.634	not significant	no mediation
Human Requirements -> Flow	-0.065	0.372	0.938	0.114	0.013	0.015	0.689	0.933	not significant	not significant
Human Requirements -> Foundation_	0.270	0.271	0.320	0.183	0.018	0.063	0.749	0.275	not significant	not significant
Human Requirements -> Scheduling	-0.071	0.429	0.988	0.005***	0.025	0.010	0.648	0.690	not significant	no mediation
Human Requirements -> Standard	0.002	0.409	0.874	0.005***	0.024	0.002	0.643	0.977	not significant	no mediation
Human Requirements -> Workplace	-0.103	0.309	0.606	0.173	-0.003	-0.005	0.619	0.897	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 40 Path Coefficients for Direct Effects for Power Distance

	Path Coeff.		p-Values	
	MX	US	MX	US
Power Distance -> Consistency	-0.170	-0.049	0.409	0.913
Power Distance -> Flow	-0.220	-0.330	0.520	0.061*
Power Distance -> Foundation_	-0.196	-0.060	0.305	0.597
Power Distance -> Scheduling	-0.243	0.001	0.212	0.971
Power Distance -> Standard	-0.037	0.036	0.336	0.860
Power Distance -> Workplace	-0.243	0.001	0.212	0.971
Human Requirements -> Power Distance	-0.118	-0.184	0.529	0.168

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Power Distance* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency, Scheduling and Sequencing,* and *Standard Operations.* Table 40 illustrates that there is no significant relationship between the *Human Requirements* and *Power Distance*.

With regard to *Power Distance* and other constructs, it provides a significance at the .1 level for *Flow.*

4.5.7 Effect of Uncertainty Avoidance

The assessment of the effect of Uncertainty Avoidance was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice.* The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 41presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Table 41 MGA-PLS through Mediation of Uncertainty Avoidance

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.191	0.407	0.434	0.012**	0.015	0.000	0.991	0.998	not significant	no mediation
Human Requirements -> Flow	-0.024	0.174	0.838	0.380	0.012	0.005	0.878	0.976	not significant	not significant
Human Requirements -> Foundation_	0.259	0.351	0.413	0.095*	0.017	-0.005	0.803	0.982	not significant	no mediation
Human Requirements -> Scheduling	-0.061	0.434	0.843	0.002***	0.012	0.003	0.901	0.985	not significant	no mediation
Human Requirements -> Standard	-0.042	0.400	0.807	0.005***	0.020	-0.002	0.822	0.979	not significant	no mediation
Human Requirements -> Workplace	-0.147	0.328	0.596	0.149	0.007	0.001	0.809	0.998	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Uncertainty Avoidance* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency, Foundation and Prerequisites*, *Scheduling and Sequencing*, and *Standard Operations.* Table 42 illustrates that there is no significant relationship between the *Human Requirements* and *Uncertainty Avoidance* or any other path connected.

Table 42 Path Coefficients for Direct Effects for Uncertainty Avoidance

	Path Coeff.		p-Values	
	MX	US	MX	US
Uncertainty Avoidance -> Consistency	-0.062	-0.036	0.965	0.929
Uncertainty Avoidance -> Flow	-0.177	0.118	0.551	0.323
Uncertainty Avoidance -> Foundation_	-0.335	0.207	0.270	0.244
Uncertainty Avoidance -> Scheduling	-0.047	0.104	0.634	0.420
Uncertainty Avoidance -> Standard	-0.259	0.214	0.279	0.091*
Uncertainty Avoidance -> Workplace	0.059	0.002	0.467	0.945
Human Requirements -> Uncertainty Avoidance	-0.080	-0.016	0.718	0.975

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The path indicated by Uncertainty Avoidance and Standard Operating Procedures provides a significance in United States at the .1 level.

4.5.8 Effect of Status by Ascription vs. Status by Achievement

The assessment of the effect of Status by Ascription vs. Status by Achievement was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice*. The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 43 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

The first observation relevant is that *Status by Ascription vs. Status by Achievement* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice*. Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency*, *Flow*, *Scheduling and Sequencing*, and *Standard Operations.* Table 44 illustrates that there is no significant relationship between the *Human Requirements* and *Status by Ascription vs. Status by Achievement*, or any other path connected.

Table 43 MGA-PLS through Mediation of Status by Ascription vs. Status by Achievement

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.234	0.407	0.375	0.010***	0.022	0.000	0.719	0.933	not significant	no mediation
Human Requirements -> Flow	-0.031	0.425	0.875	0.041**	-0.005	-0.002	0.560	0.961	not significant	no mediation
Human Requirements -> Foundation_	0.356	0.310	0.198	0.141	-0.012	0.009	0.944	0.918	not significant	not significant
Human Requirements -> Scheduling	-0.013	0.430	0.833	0.004***	-0.048	0.003	0.472	0.929	not significant	no mediation
Human Requirements -> Standard	-0.004	0.401	0.893	0.011**	-0.001	-0.002	0.553	0.970	not significant	no mediation
Human Requirements -> Workplace	-0.150	0.331	0.668	0.138	-0.036	-0.004	0.595	0.973	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 44 Path Coefficients for Direct Effects for Status by Ascription vs. Status by Achievement

	Path Coeff.		p-Values	
	MX	US	MX	US
Status by Ascription vs. Status by Achievement -> Consistency	0.098	0.088	0.612	0.532
Status by Ascription vs. Status by Achievement -> Flow	0.012	0.043	0.440	0.729
Status by Ascription vs. Status by Achievement -> Foundation_	-0.072	0.126	0.925	0.472
Status by Ascription vs. Status by Achievement -> Scheduling	-0.235	0.100	0.250	0.475
Status by Ascription vs. Status by Achievement -> Standard	-0.031	0.030	0.412	0.784
Status by Ascription vs. Status by Achievement -> Workplace	-0.158	0.031	0.464	0.815
Human Requirements -> Status by Ascription vs. Status by Achievement	0.220	0.026	0.221	0.876

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

4.5.9 Effect of Emotional vs. Neutral

The assessment of the effect of Emotional vs. Neutral was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice*. The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 45presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Table 45 MGA-PLS through Mediation of Emotional vs. Neutral

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.010	0.390	0.521	0.022**	0.024	0.016	0.548	0.685	not significant	no mediation
Human Requirements -> Flow	-0.022	0.352	0.829	0.118	-0.004	0.028	0.552	0.523	not significant	not significant
Human Requirements -> Foundation_	0.356	0.367	0.196	0.093*	-0.015	-0.017	0.843	0.694	not significant	no mediation
Human Requirements -> Scheduling	-0.056	0.398	0.763	0.016**	-0.002	0.031	0.528	0.614	not significant	no mediation
Human Requirements -> Standard	-0.014	0.378	0.743	0.022**	0.014	0.011	0.707	0.868	not significant	no mediation
Human Requirements -> Workplace	-0.055	0.343	0.738	0.135	0.018	0.003	0.562	0.983	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 46 Path Coefficients for Direct Effects for Emotional vs. Neutral

	Path Coeff.		p-Values	
	MX	US	MX	US
Emotional vs. Neutral -> Consistency	-0.233	0.087	0.307	0.494
Emotional vs. Neutral -> Flow	-0.014	0.155	0.389	0.323
Emotional vs. Neutral -> Foundation_	0.033	-0.115	0.775	0.523
Emotional vs. Neutral -> Scheduling	-0.091	0.157	0.352	0.358
Emotional vs. Neutral -> Standard	-0.116	0.056	0.543	0.788
Emotional vs. Neutral -> Workplace	-0.126	0.015	0.371	0.975
Human Requirements -> Emotional vs. Neutral	-0.142	0.169	0.414	0.275

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Emotional vs. Neutral* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, where United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency, Foundation, Scheduling and Sequencing*, and *Standard Operations.* Table 46 illustrates that there is no significant relationship between the *Human Requirements* and *Emotional vs. Neutral*, or any other path connected.

4.5.10 Effect of Individualism vs. Communitarianism

The assessment of the effect of Individualism vs. Communitarianism was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice.* The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 47 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Table 47 MGA-PLS through Mediation of Individualism vs. Communitarianism

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.136	0.403	0.424	0.013**	-0.009	-0.007	0.995	0.757	not significant	no mediation
Human Requirements -> Flow	-0.017	0.434	0.999	0.026**	-0.009	-0.015	0.890	0.632	not significant	no mediation
Human Requirements -> Foundation_	0.279	0.294	0.499	0.186	-0.007	-0.004	0.892	0.747	not significant	not significant
Human Requirements -> Scheduling	-0.035	0.421	0.845	0.002***	-0.011	0.014	0.914	0.612	not significant	no mediation
Human Requirements -> Standard	0.019	0.411	0.738	0.003***	-0.008	-0.005	0.951	0.875	not significant	no mediation
Human Requirements -> Workplace	-0.106	0.323	0.598	0.130	-0.010	-0.004	0.937	0.872	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

The first observation relevant is that *Individualism vs. Communitarianism* does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, whereas the United States has multiple significant effects within the direct (no mediation) relationship between *Human Requirements* and *Consistency*, *Flow*, *Scheduling and Sequencing*, and *Standard Operations.* Table 48 illustrates that there is no significant relationship between the *Human Requirements* and *Individualism vs. Communitarianism*. The path to *Flow* provides significance at the .05 level, but only for Mexico. The path to *Scheduling and Sequencing* is significant for the United States at the same level.

Table 48 Path Coefficients for Direct Effects for Individualism vs. Communitarianism

	Path Coeff.		p-Values	
	MX	US	MX	US
Individualism vs. Communitarianism -> Consistency	-0.081	-0.123	0.965	0.488
Individualism vs. Communitarianism -> Flow	-0.383	-0.224	0.047**	0.140
Individualism vs. Communitarianism -> Foundation_	-0.323	-0.080	0.217	0.519
Individualism vs. Communitarianism -> Scheduling	-0.061	0.233	0.475	0.036**
Individualism vs. Communitarianism -> Standard	-0.102	-0.048	0.638	0.750
Individualism vs. Communitarianism -> Workplace	-0.085	-0.036	0.567	0.757
Human Requirements -> Individualism vs. Communitarianism	0.019	0.061	0.878	0.553

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

4.5.11 Effect of Universalism vs. Particularism

The assessment of the effect of Universalism vs. Particularism was included as a mediator between the *Human Requirements* and each of the six elements of the *Lean Management Practice.* The MGA-PLS performed derived the significance values of the path coefficients as well as the effects. Table 49 presents the path coefficients and the indirect effects with their corresponding p-values, and the effect of the mediation variable.

Universalism vs. Particularism does not mediate the relationship between *Human Requirements* and the *Lean Management Practice.* Still when looking at the differences within the countries, Mexico does not hold a significant path in any of the presented cases, which was the trend during the entire study. This does not mean that doesn't have an effect, it is just that this is not significant compared with the scale. On the other hand, United States has the most significant effects in this analysis between *Human Requirements* and *Consistency, Flow, Foundation and Prerequisites, Scheduling and Sequencing*, and *Standard Operations.* Table 50 illustrates that there is no significant relationship between the *Human Requirements* and *Universalism vs. Particularism*.

Table 49 MGA-PLS through Mediation of Universalism vs. Particularism

Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
	MX	US	MX	US	MX	US	MX	US	MX	US
Human Requirements -> Consistency	-0.250	0.416	0.384	0.007***	-0.011	0.002	0.844	0.951	not significant	no mediation
Human Requirements -> Flow	-0.041	0.394	0.960	0.062*	-0.017	-0.007	0.508	0.807	not significant	no mediation
Human Requirements -> Foundation_	0.426	0.356	0.117	0.089*	-0.068	0.010	0.511	0.844	not significant	no mediation
Human Requirements -> Scheduling	-0.010	0.429	0.774	0.006***	-0.034	0.000	0.527	0.872	not significant	no mediation
Human Requirements -> Standard	0.010	0.412	0.957	0.003***	-0.045	0.003	0.597	0.951	not significant	no mediation
Human Requirements -> Workplace	-0.064	0.352	0.687	0.106	-0.047	0.002	0.511	0.988	not significant	not significant

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 50 Path Coefficients for Direct Effects for Universalism vs. Particularism

	Path Coeff.		p-Values	
	MX	US	MX	US
Universalism vs. Particularism -> Consistency	0.099	0.051	0.756	0.823
Universalism vs. Particularism -> Flow	0.129	-0.219	0.339	0.258
Universalism vs. Particularism -> Foundation_	0.363	0.157	0.111	0.373
Universalism vs. Particularism -> Scheduling	0.240	-0.061	0.233	0.555
Universalism vs. Particularism -> Standard	0.227	0.024	0.317	0.839
Universalism vs. Particularism -> Workplace	0.303	-0.002	0.206	0.960
Human Requirements -> Universalism vs. Particularism	-0.191	0.038	0.367	0.746

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

None of the relevant path coefficients in this rubric provide significant effect to the endogenous variables. Only the path leading to *Foundation and Prerequisites* approached a significant effect for Mexico.

4.5.12 Summary of Mediation through MGA-PLS

After the analysis of all the variables, the mediators did not provide full mediation effects in any of the cases, but seemed to provide change through the paths, although insignificant in most cases. Table 51 presents the summary of the relevant paths.

Table 51 Summary of Relevant Factors

Mediator	Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
		MX	US	MX	US	MX	US	MX	US	MX	US
Assertiveness	H. Reqs. -> Consistency	-0.188	0.412	0.4	0.012**	0.006	-0.004	0.873	0.974	N.S.	N. Med.
	H. Reqs. -> Flow	-0.106	0.389	0.804	0.083**	0.02	0.004	0.813	0.95	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.058	0.427	0.849	0.006***	-0.002	0.001	0.851	0.924	N.S.	N. Med.
	H. Reqs. -> Standard	-0.019	0.406	0.934	0.007***	0.007	-0.005	0.841	0.899	N.S.	N. Med.
	Assertiveness -> Standard	-0.156	0.236	0.48	0.071*						
In-Group Collectivism	H. Reqs. -> Flow	-0.073	0.4	0.766	0.026**	-0.007	0.02	0.93	0.698	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.049	0.403	0.881	0.007***	0.004	0.019	0.914	0.636	N.S.	N. Med.
	H. Reqs. -> Standard	0.022	0.396	0.731	0.008***	-0.011	-0.004	0.959	0.91	N.S.	N. Med.
	H. Reqs. -> Workplace	-0.12	0.348	0.615	0.098*	-0.01	0.005	0.935	0.932	N.S.	N. Med.
	In-Group Collectivism -> Scheduling	0.079	-0.282	0.57	0.008						
Future Orientation	H. Reqs. -> Consistency	-0.168	0.374	0.424	0.019**	-0.006	0.033	0.936	0.616	N.S.	N. Med.
	H. Reqs. -> Flow	-0.074	0.494	0.945	0.021**	-0.007	-0.086	0.914	0.18	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.065	0.425	0.878	0.006***	0.017	0.013	0.966	0.741	N.S.	N. Med.
	H. Reqs. -> Standard	0.005	0.385	0.695	0.009***	-0.003	0.022	0.919	0.556	N.S.	N. Med.
	H. Reqs. -> Future Orientation	0.043	0.303	0.888	0.007						
Performance Orientation	H. Reqs. -> Consistency	-0.212	0.435	0.49	0.002***	-0.039	-0.042	0.596	0.512	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.158	0.399	0.713	0.008***	0.141	0.033	0.405	0.464	N.S.	N. Med.
	H. Reqs. -> Standard	-0.176	0.382	0.529	0.014**	0.19	0.01	0.215	0.9	N.S.	N. Med.
	H. Reqs. -> Workplace	-0.227	0.368	0.481	0.065*	0.07	-0.025	0.522	0.69	N.S.	N. Med.
	H. Reqs. -> Performance Orientation	0.529	0.156	0.002***	0.33						
Masculinity vs. Feminity	H. Reqs. -> Consistency	-0.229	0.413	0.387	0.013**	-0.057	-0.002	0.599	0.965	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.038	0.431	0.993	0.003***	-0.024	0.008	0.569	1	N.S.	N. Med.
	H. Reqs. -> Standard	0.055	0.411	0.687	0.002***	-0.083	0.002	0.591	0.972	N.S.	N. Med.
Power Distance	H. Reqs. -> Consistency	-0.36	0.384	0.228	0.012**	0.039	0.025	0.603	0.634	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.071	0.429	0.988	0.005***	0.025	0.01	0.648	0.69	N.S.	N. Med.
	H. Reqs. -> Standard	0.002	0.409	0.874	0.005***	0.024	0.002	0.643	0.977	N.S.	N. Med.
	Power Distance -> Flow	-0.22	-0.33	0.52	0.061*						

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

Table 51 Continued

Mediator	Path (both direct and indirect)	Path Coeff.		p-Values		Indirect Effects		p-Values		Observation	
		MX	US	MX	US	MX	US	MX	US	MX	US
Uncertainty Avoidance	H. Reqs. -> Consistency	-0.191	0.407	0.434	0.012**	0.015	0	0.991	0.998	N.S.	N. Med.
	H. Reqs. -> Foundation_	0.259	0.351	0.413	0.095*	0.017	-0.005	0.803	0.982	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.061	0.434	0.843	0.002***	0.012	0.003	0.901	0.985	N.S.	N. Med.
	H. Reqs. -> Standard	-0.042	0.4	0.807	0.005***	0.02	-0.002	0.822	0.979	N.S.	N. Med.
	Uncertainty Avoidance -> Standard	-0.259	0.214	0.279	0.091*						
Status by Ascription vs. Status by Achievement	H. Reqs. -> Consistency	-0.234	0.407	0.375	0.010***	0.022	0	0.719	0.933	N.S.	N. Med.
	H. Reqs. -> Flow	-0.031	0.425	0.875	0.041**	-0.005	-0.002	0.56	0.961	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.013	0.43	0.833	0.004***	-0.048	0.003	0.472	0.929	N.S.	N. Med.
	H. Reqs. -> Standard	-0.004	0.401	0.893	0.011**	-0.001	-0.002	0.553	0.97	N.S.	N. Med.
Emotional vs. Neutral	H. Reqs. -> Consistency	-0.01	0.39	0.521	0.022**	0.024	0.016	0.548	0.685	N.S.	N. Med.
	H. Reqs. -> Foundation_	0.356	0.367	0.196	0.093*	-0.015	-0.017	0.843	0.694	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.056	0.398	0.763	0.016**	-0.002	0.031	0.528	0.614	N.S.	N. Med.
	H. Reqs. -> Standard	-0.014	0.378	0.743	0.022**	0.014	0.011	0.707	0.868	N.S.	N. Med.
Individualism vs. Communitarianism	H. Reqs. -> Consistency	-0.136	0.403	0.424	0.013**	-0.009	-0.007	0.995	0.757	N.S.	N. Med.
	H. Reqs. -> Flow	-0.017	0.434	0.999	0.026**	-0.009	-0.015	0.89	0.632	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.035	0.421	0.845	0.002***	-0.011	0.014	0.914	0.612	N.S.	N. Med.
	H. Reqs. -> Standard	0.019	0.411	0.738	0.003***	-0.008	-0.005	0.951	0.875	N.S.	N. Med.
	Individualism vs. Communitarianism -> Flow	-0.383	-0.224	0.047**	0.14						
	Individualism vs. Communitarianism -> Scheduling	-0.061	0.233	0.475	0.036**						
Universalism vs. Particularism	H. Reqs. -> Consistency	-0.25	0.416	0.384	0.007***	-0.011	0.002	0.844	0.951	N.S.	N. Med.
	H. Reqs. -> Flow	-0.041	0.394	0.96	0.062*	-0.017	-0.007	0.508	0.807	N.S.	N. Med.
	H. Reqs. -> Foundation_	0.426	0.356	0.117	0.089*	-0.068	0.01	0.511	0.844	N.S.	N. Med.
	H. Reqs. -> Scheduling	-0.01	0.429	0.774	0.006***	-0.034	0	0.527	0.872	N.S.	N. Med.
	H. Reqs. -> Standard	0.01	0.412	0.957	0.003***	-0.045	0.003	0.597	0.951	N.S.	N. Med.

*Two tail T-test at .1 significance. **Two tail T-test at .05 significance. ***Two tail T-test at .01 significance

4.6 Key Findings

The case study for this research addressed cultures of two countries, Mexico and United States. The case company, in the manufacturing sector, provided all support to conduct the research at their facilities in both locations. A survey questionnaire, designed from diverse prior theories and a pilot study (only for the *Human Requirements* portion), was implemented at the organization on a single day, totaling 152 participants with 127 consented responses. After screening the data, 97 valid responses were used to conduct the corresponding analyses. The method used for the validation was Partial Least Squares Structural Equation Modeling (PLS-SEM). Using this technique, the measurement models (reflective and formative) and the structural model were thoroughly validated. The method used to test the hypotheses for studying the effects on the groups (i.e. countries) involved answering the research questions known as mediation through Multi-Group Analysis Partial Least Squares (MGA-PLS).

The findings provide insights in both the relevant mediators including 11 cultural variables and the differences between both locations from the cultural and the Lean Management Practice standpoints. In addition, the method proposed tested the hypothesis for the creation of higher-order variables.

The conclusions drawn with respect to the hypothesis are the following:

- H1a: Whether a set of first-order variables identified within Human Requirements create a second-order latent variable. This hypothesis is accepted given that *Human Requirements* indeed was a second-order variable. However, not all the items through this case study were included.

- H1b: Whether a set of first-order variables identified within Lean Management Practice create a second-order latent variable. This hypothesis is accepted as thorough analysis indicated a higher order variable was created in *Lean Management Practice*. The implications of this simplify the initial assessment for organizations willing to get a quick glimpse of their effects.

- H1c: Whether a set of first-order variables identified within Environmental Appraisal as National Culture create a second-order latent variable. This hypothesis was rejected, as no higher order value was feasible with the defined subsets. Perhaps the reflective nature of the constructs derived this outcome.

- H2a: Whether there is a direct relationship between second-order *Human Requirements* and *Lean Management Practice.* This hypothesis was rejected because the *Lean Management Practice* was broken down into its first order latent variable to conduct further analysis.

- H2b, H2c and H3 were not feasible hypothesis given that they depended on H1c.

- H4: Whether the path between *Human Requirements* and any of the six latent variables of *Lean Management Practice* are mediated by a variable of *Environmental Appraisal as National Culture.* This hypothesis Is rejected as there is no mediation within the variables proposed.

- H5: Whether there are differences between groups for the path between *Human Requirements* and each of the six latent variables of *Lean Management Practice* with some mediation effect by a variable of *Environmental Appraisal as National Culture.* This hypothesis is accepted, as there are differences within some of the constructs, as explained in the previous section.

Chapter 5: Conclusions and Discussion

5.1 Introduction

National Culture is evolving. Globalization, the advances in communication and information technologies, the opening of borders and the influence in general of all the modern popular culture, create a fading effect in the differences that once existed between geographical regions and perhaps countries.

Nonetheless, culture provides an influence over specific communities and probably work environments. Regardless of all technologies, evolution of societies and popularization of best practices, there are still some unique attributes to be accounted for when a subject, an individual or an organization adopts foreign elements into its own daily activities. This being the case of the *Lean Management Practice*.

From a business perspective, failure to understand the unique attributes of the adopted practices, along with the understanding of the self-culture, creates problems for the organization and the individual at work. As it relates to this study, these failures are considered a significant cause for the unsustainability of the *Lean Management Practice*.

This study provides a methodology for decision makers when the issue of culture and its sustainability is addressed. The central questions addressed are:

- *Does national culture mediate personal requirements and lean practices?*
- *If mediation occurs, are there any differences moderated at the country level?*

In the first question, the mediation was not significant in the cases for the Mexican subsidiary, and the U.S. counterpart found no mediation for the significant relationships. Therefore, in the case study, the cultural constructs did not mediate the relationships between personal requirements and lean practices. However, a difference is perceived in the relationships of the latent variables established by the direct paths (no mediation).

The second question is partially responded, given that mediation was not significant or not present in the cases for the two sampled countries. However, the construct reflects significant differences among the two countries. From the perspective of analysis, when the cultural construct is used, the significance varies among the two samples. In the U.S. sample, the significance varies by the influence of the cultural variables over the direct path between *Human Requirements* and each of the six sub-elements of the *Lean*

Management Practice. Universalism vs. Particularism is the most important cultural construct in this perspective, covering five of the six constructs; where *Standard Operating Proceedure* and *Scheduling and Sequencing* are influenced significantly by all the cultural constructs (Table 52). The Mexican sample did not receive significant direct paths in this relationship. The implication could have different interpretations, either by the expertise the employees had with the *Lean Management Practice* in both locations, or simply by the way the operations are conducted. Hence, from a cultural perspective, even though the mediation is not provided directly into the model, the effect the cultural constructs have on the relationship between the requirements and the practice remains relevant.

On the perspective of the non-mediated direct paths (i.e. the paths that connect the mediating variable), two significant relationships from the *Human Requirements* with the *Environmental Appraisal as National Culture,* and six from the *Environmental Appraisal as National Culture* with the *Lean Management Practice* were found. A less polarized result was encountered, as both locations result in different significance levels (Table 53). The Mexican location sample is affected significantly from *Human Requirements* with *Performance Orientation,* and *Individualism vs. Communitarianism* with *Flow*. These relationships were not present with the U.S. location sample.

Table 52 Human Requirements Significant Direct Paths for U.S. Sample (Two-tail T-Test)

Cultural Variable	Foundation	Workplace	Standard	Consistency	Flow	Scheduling
Assertiveness			0.01	0.05	0.05	0.01
In-Group Collectivism		0.1	0.01		0.05	0.01
Future Orientation			0.01	0.05	0.05	0.01
Performance Orientation		0.1	0.05	0.01		0.01
Masculinity vs. Feminity			0.01	0.05		0.01
Power Distance			0.01	0.05		0.01
Uncertainty Avoidance	0.1		0.01	0.05		0.01
Status by Ascription vs. Status by Achievement			0.05	0.01	0.05	0.01
Emotional vs. Neutral	0.1		0.05	0.05		0.05
Individualism vs. Communitarianism			0.01	0.05	0.05	0.01
Universalism vs. Particularism	0.1		0.01	0.01	0.1	0.01

Table 53 Significance Level for Non-mediated Direct Paths between U.S. and Mexico Locations

Direct Path	MX	US
Assertiveness -> Standard	Not significant	0.1
In-Group Collectivism -> Scheduling	Not significant	0.01
H. Reqs. -> Future Orientation	Not significant	0.01
H. Reqs. -> Performance Orientation	0.01	Not significant
Power Distance -> Flow	Not significant	0.1
Uncertainty Avoidance -> Standard	Not significant	0.1
Individualism vs. Communitarianism -> Flow	0.05	Not significant
Individualism vs. Communitarianism -> Scheduling	Not significant	0.05

The interpretations from these results provide a hint for further investigation, with emphasis on the constructs that seem to provide meaningful relationships with the locations in the study.

5.1.1 Theoretical Contribution

Results of this study seem to support a theory that provide a confirmation of a comprehensive set of items that define the requirements as competencies for a person in an environment of *Lean*. The measurement of these requirements derived from a comprehensive literature review, providing validated constructs from various theories in Industrial and Organizational Psychology and Human Factors and Ergonomics. The key findings in the case study suggest that these requirements depend on the strategy pursued by the organization and the level of implementation of the practice, particularly reflected in the employees experience in this area.

In the field of operational excellence methodologies, this research provides a re-definition of a robust framework for the implementation and interaction of the *Lean Management Practice*, as it considers the literature available and the different theories of implementation. The focus of this framework is only at the level of the internal factory, with the strategy sub-system known as “Just-in-Time”. The framework includes measurement elements with their corresponding constructs, enhancing the available assessments, as it is derived from an industry standard, a comprehensive academic study and a practical textbook. Both the framework and the associated metrics provide the precedence and implementation level within the sub-

system, which can be used as a guideline to assess the adequacy of the system or a roadmap to start the strategy, for organizations and future academic studies.

In the analysis and determination of National Culture constructs, as the core element of this research, a systematic semantic analysis, supported by literature, provides the constructs for measurement, widely validated from three mayor studies. This study is the first one in operations management that accounts for constructs from different sources for measurement and analysis of this dimension.

Perhaps the most important contribution is the development of the Culturally Sensitive Lean Systems Design Model, which integrates the relationships between each area, and their corresponding constructs: 8 for *Human Requirements*, 6 for *Lean Management Practice*, and 11 for *Environmental Appraisal as National Culture.* The relationships follow the framework of the strategic management planning process, as well as the theory of socio-technical systems, in order to establish the model for analysis using Structural Equation Modeling.

Lastly, this research explored different models that presented challenges new to academia in the field of PLS-SEM. One of them is the incorporation of higher order variables with changing directionalities (formative vs. reflective). Another is the procedure of initial insights through the analysis of simpler models based on their path loadings, that transform into more complex relationships of lower order, avoiding higher computational cost (i.e. the more complex the model, the longer the processing time).

5.1.2 Methodological Contribution

Among the most important contributions, this research study focused on a systematic approach to investigate the influence of culture in the *Lean Management Practice*. This was achieved through the definition of an assessment to quantify the culture gap among the different contexts in organizations pursuing the Lean Management Practice. A survey instrument was used to collect the information for the different constructs. The survey was developed following both an exploratory and a confirmatory approach. This approach should provide an excellent guide to future researchers interested in this area with no prior or limited knowledge in both survey methods and structural equation modeling.

Perhaps with some areas of opportunity, the validation of the model for the development of a localized strategy of the *Lean Management Practice* provided the opportunity for the analysis of different

perspectives in the pursuit of models of simpler computation in PLS-SEM, through the incorporation of higher order variables that represent a meaningful interpretation in this particular theory. The implications in this part would provide more significance for practitioners and managers trying to identify the relationships, without the complication of a deeper analysis, as the results from higher order variables can provide simpler, yet insightful conclusions about the current situation of the organization under study. This conclusion may be contradictory for researchers in academia, as the level of depth and complexity would seem more relevant to explain the phenomena within the analyzed context.

In summary, this research provides a systematic approach for the analysis of national culture in the design of the *Lean Systems* as a strategic management practice, with emphasis on those cultural constructs that have greater influence over the elements of the practice, and their corresponding levels of implementation (as assessed by the survey instrument).

5.1.3 Practical Implications

This research contributes to understanding the effect of *National Culture* and its relevance for the sustainability of the *Lean Systems*. The approach pursued in this study was with the intention of highlighting the differences among the countries and how these impact the sustainability of the strategy in each context, provided that the organizational culture is not dominating among different locations.

In terms of analysis, this research provides simplicity or ease of use for practitioners and managers, given that PLS-SEM is an easier and better approach for the case of moderation analysis, in particular with MGA-PLS, especially in exploratory studies (Lowry & Gaskin, 2014). Regardless of the prior theory used to design this study (for which you commonly follow a confirmatory analysis), the analysis of the context and relationships followed an exploratory approach. Further validation of the model is encouraged, fine-tuning the elements that comprise it.

With respect to the particular case study analyzed for validation of the theory, the conclusions reflect the influence that national culture possesses over the interaction of people and operations. The study primarily reflects, among other things, the opportunities the facility in Mexico has to enhance the capabilities of their people and their operations, and the influencing variables, as well as those that provide significant contributions for the U.S. counterpart (specifically in standard operations, and scheduling and sequencing).

5.2 Limitations and Future Opportunities

This approach looks at the accessibility to generate relevant information: the opportunity to address adequately a measurement method that captures data that is statistically valid and conceptually meaningful for the purpose of this study. This approach proved that from the number of indicators and latent variables, only the few resulted in valid arguments for the design of the system. Perhaps the opportunity is testing a broader range of variables in different contexts to define the consistency of results. It is possible as well that each different context would contribute with the variation in the constructs. An opportunity then is to assess the measurement validity to be consistent across replications.

The effect of time through training and experience of the people along with the maturity of the organization should be furtherly researched (longitudinal study). The cross-sectional nature of this project provides only a glimpse of the perceptions of the respondents. Perhaps an organization interested in the instrument could plan to incorporate the survey items during their annual or periodical reviews, analyzing improvements and significant changes. Whereas a utopian approach, given the cost it represents, it would be insightful for both members of business and academia.

A larger sample size incorporating more people per organization, more organizations per country and more countries should provide better results. With current sample sizes, controlling for additional variables of categorical nature (such as gender, position in the company, expertise with *Lean*, etc.) provides an singularity in the matrix represented with the model. These could provide a better understanding of the phenomena for specific groups within the same country. In addition, given that the minimum number of countries in cross-cultural analysis suggested by Hofstede is 10, and that the sample sizes per country should be around 100. The conclusions of such datasets could lead to better results, a higher set of significant relationships (paths), and insightful effects between the independent and dependent variables. In addition, increasing the number of participating organizations could provide a clear stratification to compare differences among sectors.

The quantity of variables (factors or constructs) involved in the study have a directly proportional requirement for the sample size (i.e. the more variables, the larger the sample size). This research provides a high number of variables, provided the exploratory nature of the design. As a result, even validated constructs have failed to provide significant results.

Lastly, biases might occur in any individual perception of the world. Therefore, the design of this study might be in complete influence of the designer's background. Cultures from opposite views (greater cultural

distances) could provide an interpretation of these biases. This could be addressed with a particular interest in comparing the companies that created the *Lean Management Practice*, within the context of their *National Culture,* and demonstrated opposite cultures.

5.3 Conclusion

The study of culture is not an easy task. This study was conceived to identify a robust instrument that could provide the industry and researchers with a tool to expand their portfolio when working in international contexts and dealing with the challenges of contextualizing to new environments. In specific, the challenge is in improving operations with the support or at the expense of the local traditions. This instrument is intended to provide an operational understanding when dealing with Lean in diverse contexts. It considers the characteristics of the people, especially to address the attributes expected that determine the success of the initiative.

The findings in this study show how the contextual differences create a significant impact in the implementation and operation of the *Lean Management Practice*. Perhaps the clearest difference was shown by the training the people have received in that particular context. It seemed to be slightly influenced by each of the cultural variables, but not in an explicit manner in most cases. *Assertiveness, In-group collectivism, Power Distance, Uncertainty Avoidance* and *Individualism vs Communitarianism* seemed to be *National Culture* constructs with characteristics relevant for the *Lean Implementation*. Only *Individualism vs. Communitarianism* provided relevance for Flow within the Mexican facility.

Perhaps the mediation analysis did not provide any enhancing effects or dependence for the *Lean Management Practice*. The few elements that were captured provide strong guidelines as for the direction that managers need to take in regards of development of the particular areas of the practice.

Definitively this project is still in its infancy, needing to take advantage of the Information Technologies and the new trends in data analytics, but is aimed at providing a foundation, and awareness for the need to address the topic. A better understanding of culture will definitively increase the morale of the workers; provide a natural growth and development of their own Lean System without overlooking the essential goal of creating a sustainable environment for continuous improvement.

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Appendices

Appendix 1: IRB Outcome Letter



February 19, 2018

Rupy S Sawhney,
UTK - College of Arts & Sciences - Biological Sciences

Re: UTK IRB-17-04168-XP
Study Title: Influence of National Culture on Lean Systems

Dear Rupy S Sawhney:

The UTK Institutional Review Board (IRB) reviewed your application for the above referenced project. It determined that your application is eligible for expedited review under 45 CFR 46.110(b)(1), Category 7.The IRB has reviewed these materials and determined that they do comply with proper consideration for the rights and welfare of human subjects and the regulatory requirements for the protection of human subjects.

Therefore, this letter constitutes full approval by the IRB of your application (version1.1) as submitted, including:
SURVEY OF PERSONAL, CULTURAL AND JOB PREFRENCES AND PERCEPTIONS v1.0
Welcome to the research study! (Lean pilot) v1.0
Survey_of_Personal_Cultural_and_Job_Preferences_and_Perceptions_English-

Appendix 2: Labeling of Survey Items

Construct	Name	No.
Autonomy	AU1	1
Autonomy	AU2	2
Autonomy	AU3	3
Communication	CO1	4
Communication	CO2	5
Communication	CO3	6
Initiative	IN1	7
Initiative	IN2	8
Initiative	IN3	9
Flexibility	FL1	10
Flexibility	FL2	11
Flexibility	FL3	12
Problem Solving	PS1	13
Problem Solving	PS2	14
Problem Solving	PS3	15
Self-Efficacy	SE1	16
Self-Efficacy	SE2	17
Self-Efficacy	SE3	18
Self-Efficacy	SE4_N	19
Attention to Detail	AD1	20
Attention to Detail	AD2	21
Attention to Detail	AD3	22
Attention to Detail	AD4	23
Team Orientation	TO1	24
Team Orientation	TO4_N	25
Team Orientation	TO2	26
Team Orientation	TO3	27
Power Distance	PD1	28
Masculinity vs. Feminity	MAS1	29
Masculinity vs. Feminity	MAS2	30
Power Distance	PD2	31
Masculinity vs. Feminity	MAS3	32
Masculinity vs. Feminity	MAS4	33
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Vita

Enrique Macias de Anda was born in Aguascalientes, Mexico, on July 8, 1980, to the parents Enrique Macias and Maria del Rosario de Anda. He attended Elementary, Middle and High School at the Aguascalientes' Institute, completing the last in the year 1998. In the same year, enrolled at the Monterrey Institute of Technology and Higher Education, Aguascalientes' Campus, for his bachelors in Industrial Engineering with a minor in Systems Engineering, graduating in 2003. He studied abroad English as a Second Language at the George Brown College in Toronto, Canada the same year, completing studies in 2004. He was offered an assistantship to study the Masters of Quality and Productivity Systems program at the Monterrey Institute of Technology and Higher Education in 2005, graduating in December 2007. After holding the position of Undergraduate Program Director and Academic Advisor in the Industrial Engineering Department for the same institution, he received the opportunity to join the Department of Industrial and Systems Engineering at the University of Tennessee, Knoxville to begin his PhD in August 2010. He served as a Graduate Teaching Assistant and Graduate Research Assistant in the department during his tenure as a PhD candidate, completing the degree in the Summer 2018.