

Lean Practices, Warehouse Performance & Customer Satisfaction - A Study on Electrical & Electronics Manufacturing in China

¹Edmund Koh Chung Hui, ²WANG QINGHAI, ³Amiya Bhaumik,

Abstract- Literatures have recognized lean production and lean warehouse as a prominent manufacturing philosophy that is based on customer-focused process improvements. To further enhance customer satisfaction performance, many electrical & electronics manufacturers are turning to lean manufacturing practices to increase their business performance. However, numerous studies argued that the theory and practice show inconsistent results between lean practices and warehouse performance. In China context, few researches have been conducted on lean warehouse practices in electrical & electronics manufacturing. Therefore, this study seeks to establish the inter-relationship of lean warehouse practices of standardization, supplier network, quality at source and inventory management and customer satisfaction, in China electrical & electronics manufacturing and underpinned by the Resource-Based View (RBV). A quantitative and a cross-sectional research design were adopted, and one hundred and fifty two research questionnaires were administered to managers/executives in China. A valid response of 129 questionnaires was obtained and the data was analyzed using the SPSS and Smart PLS. From the research outcome, the hypothesized relationship between lean practices of standardization and warehouse's customer satisfaction was supported. Secondly, the hypothesized relationship between lean practices of supplier network and warehouse customer satisfaction was supported. Thirdly, the hypothesized relationship between lean practices of quality at source and warehouse's customer satisfaction was also supported. Finally, the hypothesized between lean practices of inventory management and warehouse's customer satisfaction was not supported. Research limitations, future research and conclusion were discussed in this study.

Keywords: Lean practices, warehouse performance, customer satisfaction, electrical & electronics manufacturing, China

Introduction

Lean production and its derivative lean warehouse is a prominent manufacturing philosophy that is based on customer-focused process improvements (Richardson, 2018). The key idea is to increase value to customers while reducing the number of resources consumed and cycle times via waste elimination (Ramunè & Milita, 2012). Thus, the essence of lean production and lean warehouse are all about customer satisfaction (Ramunè & Milita, 2013). "Lean" was defined by Howell (2001) as "Give customers what they want, deliver it instantly with no waste". In this study, the researcher operationalizes customer satisfaction as primarily based on four attributes, namely: (i) quality, (ii) delivery lead time, (iii) response to sales enquiries, and (iv) products' competitive prices (Nawanir et al., 2013). The trend of fast-response, fast delivery has put many electrical & electronics manufacturers in the uncomfortable position of having to conform or lose business to a competitor who has developed short cycle time capabilities (Vinas, 2013). IBM through its Global Business Consulting Services (2015), reported that, in 2014, there were decrease in customer satisfaction in warehouse management due to the lack of available-to-promise (ATP), low commitment towards delivery of products and services on time among the manufacturers, excess and obsolete inventory leading to incurred cost pressured and decreases in profits, and finally, lack of e-procurement and not being able to deliver as per promise of value. In addition, the report signifies there the lack of

¹,^{2,3} Lincoln University College, Malaysia

lean warehouse practices in the context of electrical & electronics manufacturers in China. The above statement can be further validated with many studies concentrating on lean manufacturing and Small & Medium Enterprises (SMEs), but only scanty research on lean warehousing of electrical & electronics manufacturers in China (Fang & Guo, 2013).

Theory & hypotheses

This study seeks to establish the inter-relationship of lean practices of standardization, lean practices of supplier network, and lean practices of quality at source and inventory management in warehouse with multinationals corporations' (MNC) customer satisfaction in electrical & electronics manufacturing, China. The specific objectives of this study are:

1. To investigate the most relevant lean warehouse practices associated with customer satisfaction,
2. To establish theories or frameworks associated with the ways in which warehouse's customer satisfaction is formed, and
3. To explore the potential causal relationships associated with the most significant lean warehouse practices arising from Objective 1.

Over the years customer satisfaction has dramatically changed in terms of the customers' requirements from the manufacturers/suppliers (Smith, Maull, & Ng, 2014). In the past customer satisfaction was more focused on requirements such as quality and reliability reducing costs of poor quality (Griffin et al., 1995). However, the conformance quality of products is just one dimension of customer satisfaction and manufacturing companies have learnt that customer requirements are bound to other factors such as shipment, delivery and packaging. In response, over time, manufacturers have down-streamed customer satisfaction requirements through their production, warehouse and logistics processes including the external supply chain (Chiarini & Douglas, 2015). Management systems and principles related to agile and leanness has affected more and more manufacturing and logistics solutions because of their connections with customer satisfaction (Khurana & Sohal, 2011). Zhang et al. (2005) demonstrated by means of a quantitative inquiry carried out in US manufacturing organizations that warehousing flexibility is a fundamental requirement for responding to changing customer needs. Flexible competence and flexible capability are critical to customer satisfaction and according to their results they have to be combined. In addition, Lun et al. (2015) analyzed and highlighted how flexibility for the supplier is mainly a matter of acquiring the right skills and the organizational capability in order to follow better the evolution of customer's requests. In the nutshell, the literature emphasized the importance of the customer in the entire lean process. It became evident that the customer should be the ultimate beneficiary of the lean implementation project in the warehouse service.

Lean Practice of Standardization and Customer Satisfaction

Lean focuses on the appreciation of the customers the organization has to satisfy (Bortolotti & Romano, 2012). Process standardization or standard operating procedures (SOPs) is the lean practice proposed as the part of waste control lean construct and achieve customer satisfaction. Standardized practices allow operators and workers to perform tasks the same way every time by using a set standard and clearly defined process which combines and uses different resources effectively such as time, technology, tools on shadow boards and raw materials (Gergova, 2010). As described by Sobanski (2009), standard operating procedures (SOPs) are the specific, written work instructions and steps that are required to complete a specific job, function, or task. The importance of this attribute belongs to its significance as very useful lean practices. The process standardization has been unanimously described as the fundamental principal of lean manufacturing by Ohno (1986), Shingo (1989), Womack and Jones (1996). The process standardization can be a useful lean application for waste control in warehousing operations as it provides well defined work instructions that can help to reduce waste in warehousing operations and achieve customer satisfaction (Costantino, Dotoli, Falagario, Fanti & Mangini, 2012). Researchers like Alsmadi, Almani, & Jerisat, R. (2012), Anvari, Zulkifli, & Yusuff, (2012) and Arumugam, Antony & Douglas (2012) have postulated that organizations could achieve savings of up to fifty per cent through the standardization application of lean. Based on the above narration, this study hypothesizes:

H₁: Lean practices of standardization in warehouse positively influence customer satisfaction

Lean Practice of Supplier Network and Customer Satisfaction

Supplier network is very important for delivering good and quality parts (Kaufmann et al, 2012; Yan, Yang, & Dooley, 2017). Factories are working on partnership with supplier to ensure a good understanding of quality to ensure customer satisfaction (Carnovale et al, 2017). When the supplier delivering a bad parts/not following spec, it will end up with additional cost of headcount to rectify the issues, corrective action plans, causing line down or unable to meet the delivery quantity to customer (Carnovale et al, 2017). It will indirectly impact the delivery schedule. End up, supplier and customer

need to work overtime to overcome the issues with additional resources which is also the cost incurred (Yan, Yang & Dooley, 2017). Manufacturing organizations may identify customer satisfaction in terms of on-time delivery as well as meeting customer specification needs (Eckert, 2007). Variables such as customer needs, vendor partnerships and data integrity (Lee & Kleiner, 2001) often define customer satisfaction among the manufacturing sector. Customers' expectations according to Zerbini et al. (2007) are largely dependent on the flexibility of the supplier network. Lean tradition promotes the kind of cooperation where suppliers will be involved in the focal organizations' product design and development and the focal organizations will invest in the suppliers and help them to develop (supplier development) and view them as their extension (supplier integration) rather than a competitor (So & Sun, 2010). Efficient processes and high productivity rates suggest that the manufacturer value their company and the service they provide to their customers. If the warehouse is running on inefficient processes and suffering from poor quality, the manufacturer may be sending the wrong message to their customers. Poor quality can lead to shipping delays, processing errors, and more complications that could negatively impact the customer satisfaction rates (Stewart, 2015). Based on the above narration, this study hypothesizes:

H₂: Lean practices of supplier network in warehouse positively influence customer satisfaction

Lean Practice of Quality at Source and Customer Satisfaction

Quality at the source (QATS) has been used well before lean manufacturing became so popular (Mayrson, 2012). Many people in the quality function have applied the principles especially at critical work areas to detect nonconforming items and prevent them from moving forward in the process. If not given proper planning it can increase appraisal costs and disrupt material flow but as part of a lean initiative, QATS can produce dramatic quality improvements relatively quickly and enhance customer satisfaction (Smith, 2017). QATS is one of the building blocks of lean manufacturing concepts as well as in lean warehousing (Bozer, 2012a). The basic assumption is that an organization doesn't want to produce non-quality product at any work centre (Smith, 2017). If manufacturer want to prevent poor quality from causing more problems, increasing costs, and reaching customers, they should implement the techniques of QATS (Smith, 2017). In its purest form QATS defines that quality output is not only measured at the end of the production line but at every step of the manufacturing process and being the responsibility of each individual who contributes to the production of on-time delivery of a product or service (Smith, 2017). Based on the above narration, this study hypothesizes:

H₃: Lean practices of quality at source in warehouse positively influence customer satisfaction

Lean Practice of Inventory Management and Customer Satisfaction

Under intensifying of competition environment, more and more attentions have been paid or concentrated on the needs or importance of managing a supply chain, on how the supply chain management may affect the performance of an organization in the current economic climate (Gifu, Ionescu, & Teodorescu, 2014). Indeed, consistent with such a business environment, issues such as to match supply with demand, to ensure stock availability for customers, the performance of goods delivery as well as the effective inventory management program are becoming some of the common objectives for a firm (Hariga, Gumus, Daghfous & Goyal, 2013). To cope with the various challenges as mentioned above, as such, it is witnessed about the rise and increasing popularity of vendor-managed inventory (VMI) – a system that is characterized by the sharing of information, close collaboration and vendor-managed supply chain; which is itself lean practices. The benefits of adopting lean inventory management practices are clear: reduced stock keeping unit (SKU) counts and inventory levels, increased use of standards in processes and materials, improved collaborations and a general reduction in cost of goods sold when compared to companies that do not use lean principles (Gifu, Ionescu, & Teodorescu, 2014). A lean supply chain and inventory management contributes to the bottom line, thus enhanced customer satisfaction (Gander & Snyder, 2011). These demands for example include product diversification as well as pricing which must be considered in order to remain competitive (Mutua, 2010). Based on the above narration, this study hypothesizes:

H₄: Lean practices of inventory management in warehouse positively influence customer satisfaction

Underpinning Theory - Resource-based View (RBV)

Drawing support from literature, lean manufacturing with a set of practices has been widely believed to be the most powerful manufacturing strategy in enhancing companies' performance throughout the world concerning waste elimination in all parts of a production system. The current study focuses on the development and selecting of the most important resources that could improve company's performance significantly by considering the lean manufacturing concept. Some of the literature

have been presented so far has shown that the resource based view (RBV) can complement lean manufacturing strategy strongly in helping the company to enhance the performance and competitive advantage (Forrester, 2010). The principles of RBV and lean manufacturing strategy serve as guidelines to help in understanding and determining the best practices that can maximize company's performance through the implementation of the strategy. As depicted in figure 1.1, the research model includes four lean practices namely; standardization, supplier network, quality at source and inventory management as the independent variables and customer satisfaction as the dependent variable. Specifically, the research framework suggests that lean practices have a direct impact on customer satisfaction of warehouse performance.

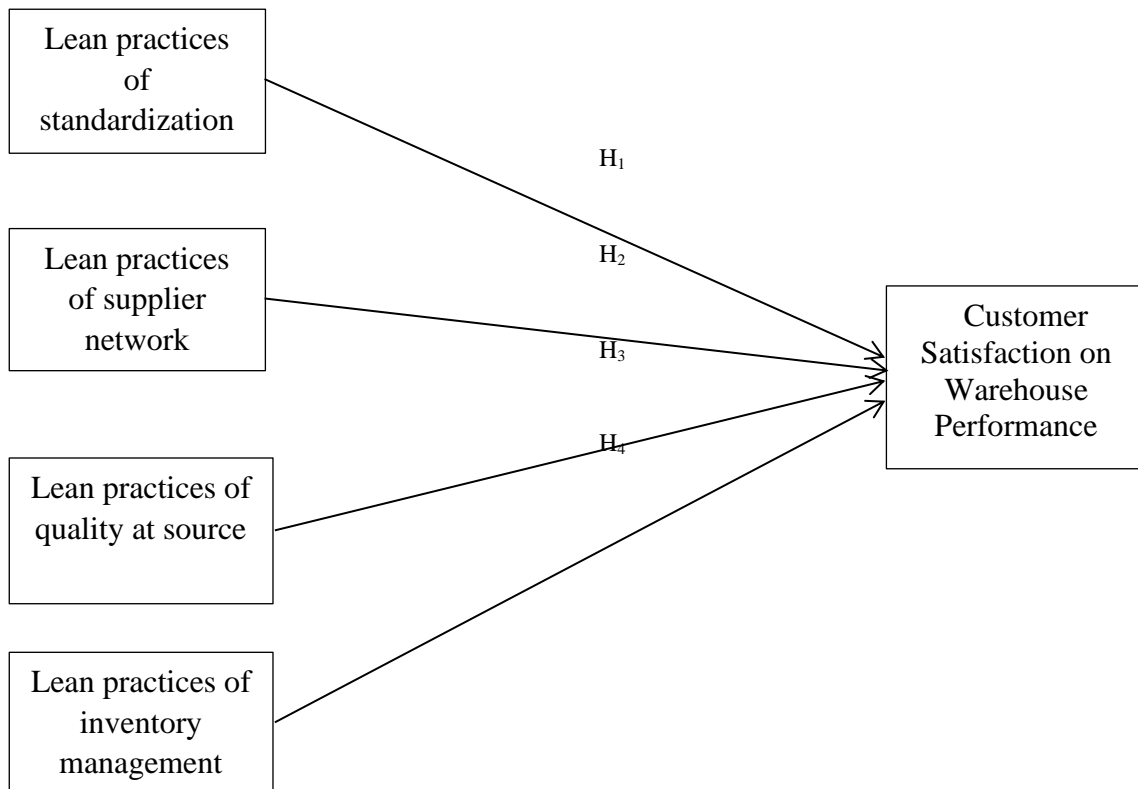


Figure 1.1 Research Frameworks

Methodology

Sampling and Data Collection Procedure

This research adopted a systematic probability technique in selecting 76 electrical & electronics firms in China. Based on this, 152 survey questionnaires were personally distributed to 76 electrical & electronics firms in China. Through these methods, a valid response rate of 88.82% was achieved; accounting for 135 successfully completed and returned questionnaires. Still, 17 questionnaires equivalent to 11.18% were excluded from the data analysis. Thus, the total valid sample for analysis is 129. The research data was analyzed using statistical package for social sciences (SPSS) version 24, considering that it is suitable for data screening and preliminary analysis, to establish clean and normal data, satisfy basic assumptions of multiple regression and determine goodness of instruments (Pallant, 2011); and running of multiple and hierarchical regression analysis to determine cause-and-effect relationships (Paura & Arhipova, 2012).

Results

In this study, the measurement model as depicted Figure 1.2 was assessed as a reflective-reflective model using two stage and repeated items indicators approach. Thus, suggesting that at each stage, both individual item reliability and internal consistency reliability, as well as convergent and discriminant validity of the latent variables have to be established (Rasoolimanesh et al., 2016).

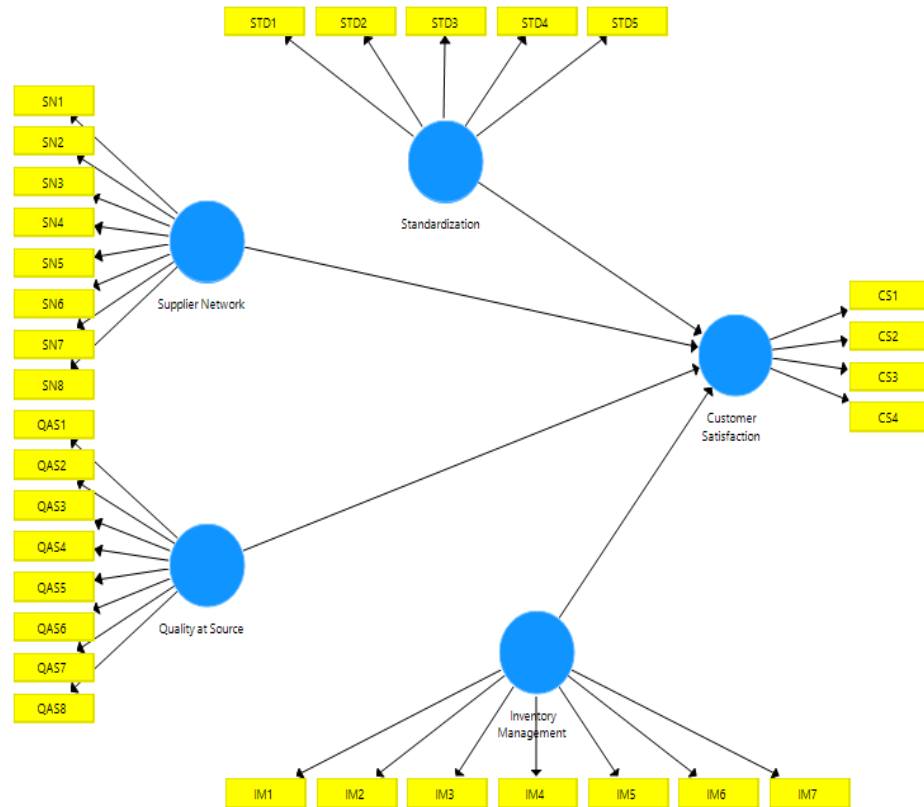


Figure 1.2 Research Model

According to Hair et al. (2014), standardized factor loadings are used in evaluating the reliability of individual items or indicators that measure research constructs. Henseler et al. (2009) argued that for a construct to explain 50% variance of individual items that measure it, the outer weight or factor loadings of each item or indicator in that construct must be 0.70. Based on this criterion, 18 items out of 32 items that measure the latent variables were deleted to achieve an AVE value of 0.5 and above as depicted in Figure 1.3 and Table 1.1.

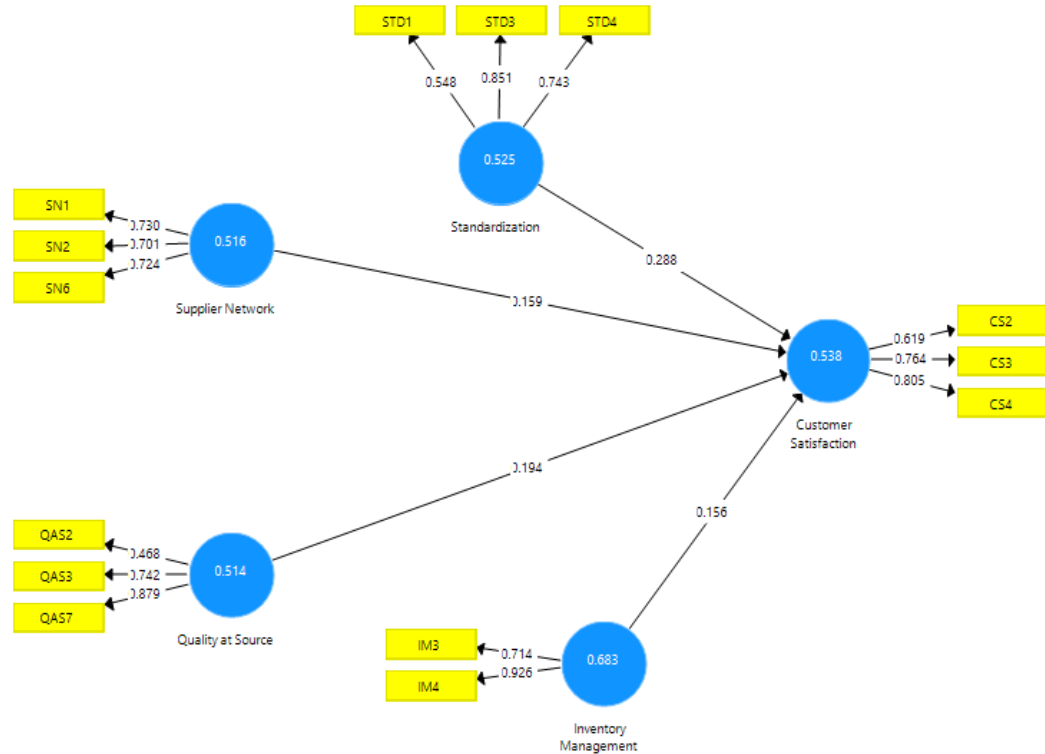


Figure 1.3 Assessment of Measurement Model

Table 1.1
Convergent Validity

	<i>Cronbach's Alpha</i>	<i>Composite Reliability</i>	<i>Average Variance Extracted (AVE)</i>
<i>Customer Satisfaction</i>	0.569	0.776	0.538
<i>Standardization</i>	0.578	0.763	0.525
<i>Supplier Network</i>	0.533	0.762	0.516
<i>Quality at Source</i>	0.527	0.750	0.514
<i>Inventory Management</i>	0.568	0.809	0.683

According to Hair et al. (2014), the purpose of structural model is to determine the predictive abilities of exogenous variables on endogenous variable, through path coefficient, t-value and p-value, as well as R square, f square and predictive relevance. Thus, in this study, a Bootstrapping function of PLS-SEM which is also a non-parametric technique of determining the robustness of the statistical package was utilized using 108 observations and 5000 sub-samples, at 0.05 level of significance (Hair et al., 2014). Similarly, in this study, the R square, f square and predictive relevance were assessed using Bootstrapping and Blindfolding procedures of SmartPLS3.0.

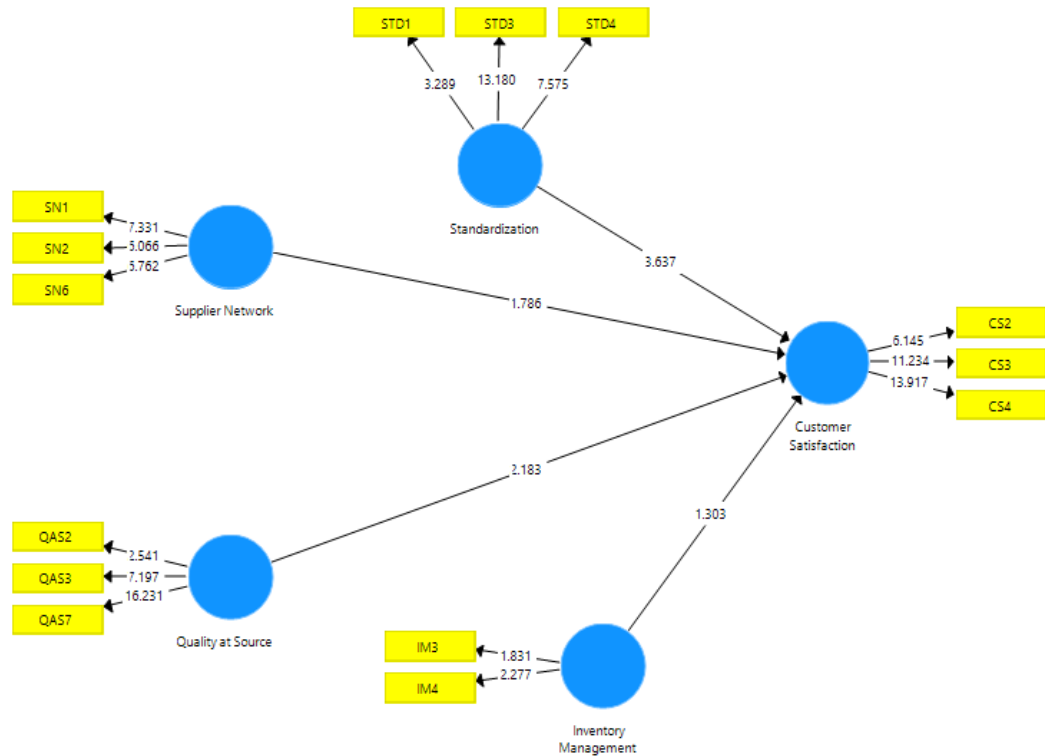


Figure 1.4 Assessment of Structural Model

Hypothesis 1 postulated that there is a significant relationship between lean practices of standardization and customer satisfaction in electrical & electronics manufacturing warehouse in China. Research outcome shows that lean practices of standardization has significant positive relationship with customer satisfaction in China's electrical & electronics manufacturers warehouse performance ($\beta = 0.079$; $t = 3.637$, $p < 0.000$). Therefore, providing a statistical support for H1. Hypothesis 2 postulated that there is a significant relationship between lean practices of supplier network and customer satisfaction in electrical & electronics manufacturing warehouse in China. Research outcome shows lean practices of supplier network has significant positive relationship with customer satisfaction in China's electrical & electronics manufacturers warehouse performance ($\beta = 0.089$; $t = 1.786$; $p < 0.037$). Therefore, providing a statistical support for H2. Hypothesis 3 postulated that there is a significant relationship between lean practices of quality at source and customer satisfaction in electrical & electronics manufacturing warehouse in China. Research findings showed that lean practices of quality at source has significant positive relationship with customer satisfaction in China's electrical & electronics manufacturers warehouse performance ($\beta = 0.089$; $t = 2.183$; $p < 0.015$). Therefore, H3 is supported statistically. Hypothesis 4 postulated that there is a significant relationship between lean practices of inventory management and customer satisfaction in electrical & electronics manufacturing warehouse in China. Research findings showed that lean practices of inventory management has no significant relationship with customer satisfaction in China's electrical & electronics manufacturers warehouse performance ($\beta = 0.119$; $t = 1.303$; $p < 0.096$). Therefore, H4 is not supported statistically.

From the R^2 value of this study, the four exogenous constructs; namely lean practices of standardization, lean practices of supplier network, lean practices of quality at source and lean practices of inventory management; explained 25.1% variance of endogenous construct, namely; customer satisfaction in China electrical & electronics manufacturers warehouse performance. Therefore, adopting the assessment criteria of Cohen (1988), the value of R^2 in this study is substantial.

As for the outcome of the blindfolding procedure, the endogenous variable of this study has a Q2 value of 0.099 as depicted in Table 1.2. As a conclusion, the predictive relevance of the model is described as medium because the value is far above 0.02.

Table 1.2
Construct Cross Validated Redundancy

	SSO	SSE	Q ² (=1-SSE/SSO)
Customer Satisfaction	387	348	0.099
Standardization	387	387	
Supplier Network	387	387	
Quality at Source	387	387	
Inventory Management	258	258	

Discussions

Firstly, the research findings concurred with the previous studies that established significant positive relationship between Lean practices of standardization and warehouse’s customer satisfaction. Researchers like Alsmadi, Almani, & Jerisat, (2012), Anand, & Kodali, (2010), Anvari, Zulkifli, & Yusuff, (2012) and Arumugam, Antony & Douglas (2012) have postulated that organizations could achieve savings of up to fifty per cent through the standardization application of Lean and improves customer satisfaction. Vitasek et al. (2005) explains process standardization enables robust continuous flow that implies consistent movement of products or services throughout company’s system and customer. Secondly, the research findings concurred with the previous studies that established significant positive relationship between Lean practices of supplier network and warehouse’s customer satisfaction. Zerbini et al (2007) asserts that customer satisfaction is one of a firm’s milestones towards profitability. Customers’ expectations according to Zerbini et al, (2007) are largely dependent on the flexibility of the supplier network. Siriwardena & Gillam (2013) stated that lean supplier network management is about identifying and eliminating waste as measured in time, inventory and cost across the complete supply chain. A Lean supply chain can take reduce time by 10 to 40%, inventories by 10% to 30% and costs by 10% to 25%, thus increase warehouse’s customer satisfaction (Simon & Canacari, 2012). Continuous improvements can take payback to the upper range-and beyond. This is a significant benefit to ROI and to the bottom line (Shamah, 2013). Thirdly, Past literatures suggested that implementing quality at source (QATS) will generate significant improvement in customer satisfaction in terms of quality, cost and delivery (Smith, 2017; Bozer, 2012a; Myerson, 2012). To capture improvement initiatives the manufacturer must have a system to continuously evaluate the quality and make even further improvements. The manufacturer may continue to see production stoppages, but it’s likely that they will be shorter that at the start of a QATS initiative. They will experience a constant improvement in quality and throughput which will be noticed by all including their customers (Myerson, 2012). Fourthly, Bozer (2012) has explained there was a paradox between lean practices and warehousing practice because lean practices does not support the storing of materials in between the processes and it strives at being just in time with a pull flow with no batching production and with preferably no inventory kept between the different processes. However, Bozer (2012) has further described that this type of situation (i.e. no inventory between the processes) can be an ideal scenario because there exist variations in

demand, uncertainty in lead time and longer lead times that cannot be fully predicted and it makes a warehouse necessary to provide items to the production, assembling or customer in time as needed.

Research Limitations

Notwithstanding the validation for many of the hypothesized relationships regarding the study variables, some limitations were acknowledged in this study. Initially, the cross-sectional design was adopted and this does not permit causal conclusions from the study population. Secondly, warehouse performance was assessed by means of self-report measures. While self-report methods are valid in measuring individual performance, self-reports are linked to common method bias variance as well as social desirability bias. This study tries to minimize these concerns by guaranteeing anonymity and scale items improvement; but it is still possible that the respondents could have over-reported their individual performance in the survey. Finally, this study provides limited generalizability because it primarily concentrated on executive and middle managers of electrical & electronics manufacturing warehouse in China only. In this study, the researcher has examined the interplay between lean practices and the use of operational lean tools and its relationship with warehouse customer satisfaction. However, future research into the interaction between lean practices, the use of lean tools and a culture of continuous improvement, environmental dynamism and lean leadership is needed in order to examine other possible additional moderating variables.

Conclusion

In realizing the objectives of the study and providing answers to the research questions, this study empirically tested 4 research hypotheses. Interestingly, the study found statistical support for H1, H2 and H3, on the significant positive relationship between lean practices of standardization, lean practices of supplier network and lean practices of quality at source on warehouse's customer satisfaction, but H4, the lean practices of inventory management had to be rejected. Likewise, to a greater degree, the study has empirically established the predicting influence of lean practices on warehouse customer satisfaction in China electrical & electronics manufacturing. The above narration, point to the pivotal role played by lean practices through (1) standardization, (2) supplier network and (3) quality at source (4) inventory management; in enhancing warehouse performance; that lead to increased customer satisfaction in China's electrical & electronics manufacturing warehouse performance.

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