THE RELATIONSHIP BETWEEN LEAN SUPPLY CHAIN STRATEGY AND SUPPLIER INTEGRATION AND COMPETITIVE CAPABILITIES IN THAILAND’S AUTOMOTIVE SUPPLIERS

Suntichai Kotcharin, Thammasat Business School, Thammasat University
2 Prachan Rd., Phra Borom Maha Ratchawang, Phra Nakhon, Bangkok 10200, Thailand
Tel: +66 2 613 2273, email: suntichai@tbs.tu.ac.th

Steve Eldridge, Management School, Lancaster University, Bailrigg, Lancaster, LA1 4YX, UK, email: s.eldridge@lancaster.ac.uk

James Freeman, Manchester Business School, University of Manchester, Booth Street West, Manchester, M15 6PB, UK, email: jim.freeman@mbs.ac.uk

ABSTRACT

In order to improve its competitive capabilities, a firm can exploit not only its internal resources but also those of its supply chain partners. One such way of doing so is for the firm to adopt a lean supply chain strategy. This paper examines the relationship between lean supply chain strategy and supplier integration and explores the relationship between supplier integration and competitive capabilities. The findings indicated that a lean supply chain strategy has a positive relationship with supplier integration and that supplier integration can improve the firm’s competitive capabilities.

Key Words: Lean supply chain strategy, Supplier integration, Competitive Capability, Automotive Industry, Survey Research

1. INTRODUCTION

It is suggested that lean may soon become a “order qualifier” (Hill, 1995; Boyle et al., 2011) for a firm and that implementing a lean supply chain strategy affects all partners within the supply chain (Yusuf & Adeleye, 2002). In particular, visibility of supply chain information such as demand forecasts can help manufacturers reduce supply costs and improve buyer-supplier relationships (Ryan, 2001). At the operational level, the use of lean supply chain techniques such as a kanban can help to control material flows and extend the reach of manufacturers from upstream suppliers through to downstream customers (Black, 2007). Exchanging and sharing information between supply chain partners provides the opportunity to improve supply chain performance. Furthermore, prior studies of the impact of programs or practices of integrated product-process design and lean manufacturing demonstrate positive relationships with time performance in first tier automotive suppliers (Jayaram et al., 1999). For example: design standardization has a strongly positive impact on delivery speed (Handfield & Pannesi, 1992); supplier development is positively related to delivery speed (Roth et al., 1989); and lean production practices (e.g. JIT manufacturing, JIT purchasing,
set-up reduction, and/or standardization) can enhance delivery speed and delivery dependability. These integrated practices have influence across the value chain in term of the value delivery cycle (Jayaram et al., 1999). In summary, a lean supply chain strategy requires the alignment of business processes as well as information sharing between partners in the supply chain but there is relatively little empirical evidence that focuses on a lean supply chain strategy and its impact on competitive capabilities. A prior study suggests that a lean supply chain strategy should be applied with the upstream supply chain (Hallgren & Olhager, 2009) and, consequently, the role of supplier integration also needs to be considered. Therefore, the purpose of this study was to examine the relationship between lean supply chain strategy and supplier integration and explore the relationship between supplier integration and the competitive capabilities of product quality, delivery speed, low cost and process flexibility.

The study is described below, beginning with the theoretical background and the development of the research hypotheses. The research methodology is described next prior to the presentation of the findings and analyses. These are discussed and managerial implications identified. The paper concludes with a review of the limitations of the study and recommendations for further research are provided.

2. THEORETICAL BACKGROUND

This section outlines the theoretical perspective adopted for the study and then describes the constructs that were used as a basis for the subsequent development of the research model and hypotheses. The definitions of the variables and the supporting literature are summarized in Table 1.

### Table 1: Variables Definition and Supporting Literature

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Supporting literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean supply chain strategy</td>
<td>A lean supply chain strategy is to reduce cost and enhance efficiency or in other words, focus on continuous improvement by eliminating all type of wastes in both inter- and intra-organizational processes or across the chain.</td>
<td>(Naylor et al., 1999; Vonderembse et al., 2006; Hallgren &amp; Olhager, 2009; Qi et al., 2009; Lo &amp; Power, 2010; Qi et al., 2011)</td>
</tr>
<tr>
<td>Supplier integration</td>
<td>The degree to which a firm can partner with its key customers to structure their inter-organizational strategies, practices procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfill customer requirements.</td>
<td>(Frohlich &amp; Westbrook, 2001; Narasimhan &amp; Kim, 2002; Flynn et al., 2010; Zhao et al., 2011)</td>
</tr>
</tbody>
</table>
## 2.1 The resource-based view of the firm

The resource-based view of the firm (RBV) is employed to understand supply chain integration as a source of competitive advantage (Barney, 1991). Based on the RBV, a firm can obtain a sustained competitive advantage by harnessing resources and capabilities that are valuable, rare, imperfectly imitable, non-substitutable and imperfectly mobile (Barney, 1991). Furthermore, a firm realizes this competitive advantage when its resources are combined in unique ways that its competitors are unable to replicate (Dyer & Singh, 1998b; Cao & Zhang, 2011; Nyaga & Whipple, 2011). For example, “idiosyncratic inter-firm linkages may be a source of relational rent and competitive advantage” (Dyer & Singh, 1998b). A firm which is lacking in internal competitive resources can overcome this deficiency by using inter-firm linkages (Ahuja, 2000; Zacharia et al., 2009) and, particularly, integrating with suppliers can yield linkages which exclude competitors from forming the same connections with the same critical supplier for the same purpose (Eltantawy, 2008). Supplier integration can yield a rare resource as it is, typically, an asymmetry which is difficult for competitors to imitate at a cost that affords economic rent (Rungtusanatham et al., 2003). Supplier integration results in an imperfectly mobile resource which causes a unique links (Eltantawy, 2008) and restricted competitor access to valuable information about these linkages (Hoopes et al., 2003).

## 2.2 The relational view of strategic management

The relational view (RV) of the firm (Dyer & Singh, 1998a) is complementary to the RBV and enables an improved framing of the relationship of research constructs, such as supplier integration and competitive capability, to the outcomes of integration. In particular, Zacharia et al. (2009) indicate that the RV can be used to support the role of collaboration in the sense of exploiting complementary capabilities in gaining competitive advantage. The RV places emphasis on inter-organizational behavioral phenomena which was interpreted in this study as meaning integrative behavior-driven firm performance and it explains how relational capabilities establish the advantages among supply chain partners (Dyer & Hatch, 2006). Dyer & Singh, (1998a) suggest that partnership can generate joint outcomes that cannot be

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product quality</td>
<td>The extent to which the manufacturing firm is capable of offering product quality that would fulfill customer expectations.</td>
<td>(Koufteros et al., 2002; Rosenzweig &amp; Roth, 2004)</td>
</tr>
<tr>
<td>Delivery speed</td>
<td>The extent to which the manufacturing firm is capable of delivering products in a short time</td>
<td>(Lau et al., 2007; Kristal et al., 2010)</td>
</tr>
<tr>
<td>Low cost</td>
<td>The extent to which the manufacturing firm is capable of competing on cost</td>
<td>(Lau et al., 2007; Kristal et al., 2010)</td>
</tr>
<tr>
<td>Process flexibility</td>
<td>The extent to which the manufacturing firm is capable of adjusting or modifying the operational processes to speedily accommodate changes</td>
<td>(Lau et al., 2007; Kristal et al., 2010)</td>
</tr>
</tbody>
</table>
generated by either firm in isolation. This close inter organizational relationship can succeed through investment in relation-specific assets, knowledge-sharing routines, complementary resources and capabilities and effective governance.

2.3 Lean supply chain strategy

A lean supply chain focuses on physical efficiency to ensure cost minimization by developing a value stream to eliminate all waste, including time, and to ensure a level schedule (Naylor et al., 1999). The main objective of a lean supply chain strategy is to focus on cost reduction and efficiency. Additionally, a lean strategy leads to the development of competitive capabilities such as cost efficiency resulting in improved operational performance. From an operational perspective, the lean concept emphasizes a set of shop floor tools or techniques to eliminate waste within the firm and along the supply chain. However, for this study, the definition of a lean supply chain concept was broadened based upon a philosophical perspective which relates to guiding principles or overarching goals (Boyle et al., 2011). The philosophy of lean involves the interrelationship of practices (e.g. kanban and just-in-time supply systems) to achieve overall levels of quality, productivity and waste reduction (Shah & Ward, 2007; Boyle et al., 2011). Shah and Ward (2007) also indicate that the lean concept is an integrated socio-technical system which includes the minimizing of supplier and internal variability by the use of long term supply contracts with a small number of key suppliers and the measured use of time-based manufacturing with such suppliers. Additionally, a lean manufacturer aims to achieve one piece flow, a pull system that cascades back from customer demand (Liker, 2004). This reflects that a lean supply chain strategy involves not only the firm but also its supply chain partners. Similarly, continuous improvement efforts are implemented in order to eliminate waste along the chain (Vonderembse et al., 2006).

2.4 Supplier integration

Supplier integration relates to the aligning of business processes between manufacturers and their suppliers by sharing information, synchronizing business process and contractual collaboration with selected suppliers for risk sharing (So & Sun, 2010). Furthermore, “just-in-time (JIT) manufacturing requires implementing pull systems and supply management based on information sharing which form the basis of SCI” (Zhou & Benton, 2007). The information shared when integrating suppliers includes demand forecasts, inventory level and production planning decisions (So & Sun, 2010). Supplier integration also represents the behavioral aspect of collaborative relationship management between manufacturers and suppliers in the operational context (Bowersox et al., 2010). Long term supplier relationships lead to co-designing products which is considered as strategic supplier integration (Swink et al., 2007). Prior research suggests that manufacturers can cope with rapid innovation and upgrading performance in the market by exploiting their suppliers’ design and technical expertise (Bozarth & Handfield, 2008). For this study, supplier integration was defined as “the degree to which a firm can partner with its key supply chain members (suppliers) to structure their inter-organizational strategies, practices, procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfill customer requirements” (Yeung et al., 2009; Flynn et al., 2010).
2.5 Product quality

Quality of conformance, quality of design and reliability are used to measure the product quality capability (Lau et al., 2007). Conformance in product quality means the degree to which the product meets product design and operating specifications (Garvin, 1987). Reliability of product is measured by the consistency of performance over time and the rate of failure (Chase et al., 2001). In this study, the definition of product quality from Kristal et al (2010) was adopted in which product quality capability is a manufacturer’s capability to consistently achieve conformance to specifications and fitness for use.

2.6 Delivery

Speed, dependability and production lead time are used to measure the delivery capability (Chase et al., 2001). Delivering products to customers quicker than competitors is used to refer to the ability to secure supply. Delivery dependability is the ability to supply the product consistently on the promised delivery due date. Production lead time is used to refer the ability to deliver the product faster because of a quicker manufacturing speed (Lau et al., 2007).

2.7 Low Cost

If a firm has a low cost capability then it has the opportunity to win orders by offering price reductions when the price is driven by cost (Giunipero et al., 2006). If a firm wants to offer lower prices then it needs the capability of efficient manufacturing and a low-cost development process (Fisher, 1997). Furthermore, customers often demand more customization at the lower price (Hammel & Kopczak, 1993). The definition adopted in this study for low cost capability was “a manufacturer’s capability to compete on cost” (Kristal et al 2010).

2.8 Process Flexibility

Process flexibility was defined in this study as “a manufacturer’s capability to adjust or modify the operational processes to speedily accommodate changes” (Kristal et al 2010). These changes can be, for example, in production volumes or product mix and should be responded to with minimal penalties in efficiency (Rosenzweig et al., 2003; Menor et al., 2007; Kristal et al., 2010).

3. HYPOTHESE DEVELOPMENT

The research model is summarized in Figure 1 and the hypotheses are described below.
3.1 The relationship between lean supply chain strategy and supplier integration

A lean strategy aims to systematically integrate all activities involved in providing products and services to the customers and these activities are, performed by firm itself or by external suppliers or channel members (Jayaram et al., 2008). Thus, the importance of the linkages between a firm’s value chain and the value chains of its supplier and channel members is recognized in a lean supply chain strategy (Mason-Jones et al., 2000; Yusuf & Adeleye, 2002; Jayaram et al., 2008). In addition, a lean supply chain strategy is focused on continuous improvement by eliminating non-value-added processes along the chain and waste associated with all aspects of the supply chain (Qi et al., 2009). A lean supply chain strategy is suggested to apply upstream of the customer order decoupling point for operations (Hallgren & Olhager, 2009). Prior studies point that lean production is strongly associated with the integration of information flows with the external suppliers (Cagliano et al., 2006). Thus, the following hypothesis was proposed:

H1: a lean supply chain strategy has a positive association with supplier integration

3.2 The relationship between supplier integration and competitive capabilities

It is suggested that, as a result of integration, a firm’s capability can be enhanced through resource pooling and the exploitation of complementary skills and information (Rickey et al., 2010). The relationships between integration and competitive capabilities have been extensively studied (Lau et al., 2007; Kim, 2009; Kristal et al., 2010) and these findings confirm that integration can be transformed into competitive capabilities. Based on the work of Rosenzweig et al. (2003), the resources-capabilities-performance relationship was adopted in this study. These authors suggest that manufacturers can identify and eliminate non-value added activities and subsequently strengthen product quality, delivery reliability, process flexibility and cost leadership capabilities because the manufacturers have developed a high level of supply chain integration. Other studies (Droge et al., 2004; Swink et al., 2007) provide further understanding of the competitive advantages can be derived from combining resources.

- 86606 -
In addition, lean supply and supplier performance are influenced by inter-firm relationships and supplier relationships can impact on cost, quality and delivery (Simpson & Power, 2005). The relational approach is relevant to the external linkages with supply chain members (De Toni & Meneghetti, 2000; Thomas, 2008). In particular, supply chain relationships play an important role in facilitating the flow of information and reducing cycle times (Thomas, 2008). Droge et al. (2004) also suggest that a boundary spanning initiative with supplier and customers can help to reduce cycle times and increase the responsiveness of the firm. In other words, close supplier relationships are strongly associated with the reduction of delivery cycle time. In summary, according to the relational approach, inter-firm relationships such as “supplier partnering,” “closer relationships,” or “boundary spanning activities facilitating integration” play significant roles in time-based performance (Thomas, 2008). Thus the following hypotheses were proposed:

H2: Supplier integration is positively associated with product quality
H3: Supplier integration is positively associated with delivery
H4: Supplier integration is positively associated with low cost
H5: Supplier integration is positively associated with process flexibility

4. RESEARCH DESIGN AND METHODOLOGY

4.1 Measures and questionnaire design

The use of dyadic relationship with a major customer and a major supplier is commonly practice in supply chain integration research (Zhao et al., 2011). Moreover, the use of a single informant is a common practice in survey research when key informants are likely to provide accurate information on supplier and customer integration because of their familiarity with their major suppliers and customers (Paulraj et al., 2008; Zhao et al., 2011). The unit of analysis was at the firm level. Thus, strategic positions such as president, vice president of purchasing, managing director, supply chain director, procurement manager and knowledgeable persons who can provide perceptions and information on the research constructs were prospective respondents. The adapted items of supply chain integration were taken from previous studies such as Narasimhan and Kim (2002), Koufteros et al (2005) and Flynn et al (2010) and the measured items of combinative competitive capabilities were adapted from Koufteros et al (2002), Rosenzweig et al (2003) and Flynn et al (2010) and Kristal et al (2009). A 7-point Likert scale was used with “1” for “strongly disagree” and “7” for “strongly agree”.

To ensure content validity of the questionnaire this study employed the Q-sorting technique which comprises three separate stages: (1) item creation; (2) structured interview and Q-sort; and (3) large scale testing (Moore & Benbasat, 1991). A total of 14 participants provided input including four academics and ten practitioners (two managing directors, one VP, two general managers, two plant managers, two supply chain directors and one manufacturing director). Based on the sorting technique, two indices were used to measure the level of inter-judge agreement: Cohen’s Kappa and the ‘Hit Ratio’. Inter-judge raw agreement score can be calculated from the number of items that both judges agree to place into a certain category.
divided by the total number of items (Cao & Zhang, 2010). The placement score (i.e. “Hit Ratio”) means that the item was put into the correct pool or construct. If the placement scores higher than 70% then the content validity is considered acceptable (Moore & Benbasat, 1991). Three Q-sort rounds were completed prior to distributing the final questionnaires to prospective respondents for a large-scale survey. Detailed Q-sort results are available from the authors.

4.2 Sample and data collection

The sample frame was the list of members of Thailand Automotive Industry 2011 which comprises 1,858 companies. The study was aimed at both tier 1 and tier 2 automotive suppliers having least 100 employees. After screening for unrelated business operators, firms unwilling to participate in the survey and invalid addresses, 698 firms remained as potential participants to answer the questionnaires. There were 261 usable samples and the response rate was 37.39%. The profile of the respondents to the survey and their companies are summarized in Table 2 and Table 3.

Table 2: The Sample Profile

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>President/CEO</td>
<td>22</td>
<td>8.43</td>
</tr>
<tr>
<td>Vice president/Director</td>
<td>21</td>
<td>8.05</td>
</tr>
<tr>
<td>General manager</td>
<td>35</td>
<td>13.41</td>
</tr>
<tr>
<td>Manager (plant manager, supply chain, logistics, purchasing/procurement</td>
<td>118</td>
<td>45.21</td>
</tr>
<tr>
<td>and operations)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (engineering, manufacturing/production, project, sales and</td>
<td>65</td>
<td>24.90</td>
</tr>
<tr>
<td>marketing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>261</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2 provides a profile of the respondents to the survey. The majority of respondents (i.e. 45.21%) were plant, supply chain, logistics, purchasing/procurement and operations managers, 29.89% were senior level (president/CEO, vice president/director, general manager) and the remaining 24.90% included engineering, manufacturing/production, project, sales and marketing managers.

Table 3: Company Profile

<table>
<thead>
<tr>
<th>Characteristics of firms</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 200</td>
<td>62</td>
<td>23.75</td>
</tr>
<tr>
<td>200-499</td>
<td>70</td>
<td>26.82</td>
</tr>
<tr>
<td>500-999</td>
<td>66</td>
<td>25.29</td>
</tr>
<tr>
<td>More than 1,000</td>
<td>63</td>
<td>24.14</td>
</tr>
<tr>
<td>Total</td>
<td>261</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
Table 3 provides a profile of the companies by number of employees, annual sales, type of firm ownership and position in supply chain. About 23.75% of the sample had less than 200 employees, 26.82% had 200-499 employees, 25.29% had 500-999 employees and 24.14% had more than 1,000 employees. About 18.77% of the sample firms had annual sales below 200 million baht (approx USD 6.48 million), 15.33% had 201-499 (approx USD 6.52-16.18 million), 13.41% had 500-999 (approx USD 16.21-32.39), 28.35% had 1,000-2,999 (approx USD 32.42-97.24 million) and 24.14% had above 3,000 (approx USD 97.28 million). With respect to ownership, 29.89% were 100% Thai owned, 34.48% were joint-venture and 35.63% were wholly foreign owned, accounting the highest percentage of the sample companies. Three quarters of the sample companies were tier 1 suppliers with the remainder being tier 2 suppliers.

5. DATA ANALYSIS AND RESULTS

Structural equation modeling (SEM) was used to analyze the data and its relationships (Hair et al., 1998) and then a two step approach was carried out to test the hypotheses. Firstly, the measurement model was tested to check the validity and reliability of the item scales and then the structural model was tested (Anderson & Gerbing, 1988).

5.1 Measurement model, validity and reliability

The assumptions of linearity, additivity model specification, multicolinearity and homoscededasticity were checked through the correlation analysis (Berry & Feldman, 1985). Table 4 shows details of the summary statistics for each construct with mean, standard deviation and correlation matrix of the measured variables.
Table 4: Mean, Standard Deviations, AVE and Correlations of the Construct

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>AVE</th>
<th>LS</th>
<th>SI</th>
<th>PQ</th>
<th>DS</th>
<th>LC</th>
<th>PF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean supply chain strategy</td>
<td>5.93</td>
<td>0.92</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td>Supplier integration</td>
<td>4.92</td>
<td>1.28</td>
<td>0.57</td>
<td>0.365*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.72</td>
</tr>
<tr>
<td>Product quality</td>
<td>6.17</td>
<td>0.71</td>
<td>0.63</td>
<td>0.512*</td>
<td>0.290*</td>
<td></td>
<td></td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td>Delivery speed</td>
<td>5.92</td>
<td>0.87</td>
<td>0.66</td>
<td>0.496*</td>
<td>0.343*</td>
<td>0.663*</td>
<td></td>
<td></td>
<td>0.81</td>
</tr>
<tr>
<td>Low cost</td>
<td>5.12</td>
<td>1.15</td>
<td>0.68</td>
<td>0.384*</td>
<td>0.309*</td>
<td>0.454*</td>
<td>0.484*</td>
<td></td>
<td>0.84</td>
</tr>
<tr>
<td>Process flexibility</td>
<td>5.37</td>
<td>0.97</td>
<td>0.64</td>
<td>0.442*</td>
<td>0.378*</td>
<td>0.544*</td>
<td>0.600*</td>
<td>0.445*</td>
<td>0.78</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed). LS = lean supply chain strategy; SI = supplier integration; PQ = product quality; DS = delivery speed; LC = low cost and PF = process flexibility.

Note: Diagonal elements are the square root of the average variance extracted (AVE) shown in bold. Off-diagonal elements are the correlations among constructs. Although one correlation (shown in italic) between Process flexibility and Delivery speed construct is large, it is still less than its corresponding square root of AVE.

To evaluate the measurement model fit, it is recommended to check the goodness of fit index (GFI); comparative fit index (CFI); incremental fit index (IFI); normed fit index (NFI); incremental fit index (IFI); Tucker-Lewis index (TLI); root mean square error of approximation (RMSEA); standardized root mean square residual (SRMR) goodness of fit index and the Akaike information criterion (AIC) (Hu & Bentler, 1999; Hair et al., 2006; Shah & Goldstein, 2006). The overall fit indicates that $\chi^2 = 279.041$, df = 179, GFI = 0.912, CFI = 0.967, I FI = 0.967, NFI = 0.914, RMSEA = 0.046, SRMR = 0.086 and AIC = 427.041.

A value of 0.05 or less indicates a good fit of RMSEA though a value of less than 0.08 is acceptable (Kline, 2005). The values of IFI and CFI are close to 1.0, the preferred fit indices for small sample sizes (Shah & Goldstein, 2006). A value of AIC is used to compare the hypothesized sample model to a hypothetical random sample (saturated model) should be less than that of the saturated model (Kline, 2005). Values of all of the relative fit indices were above 0.9. Therefore, the model was judged to be satisfactory.

In addition, convergent validity from the significance of the loading for an item on its posited underlying construct (Anderson & Gerbing, 1988) and reliability of the measured items (Nunnally & Bernstein, 1994) were checked. This study used a reliability test and exploratory factory analysis to purify the scale. The scale reliability of each construct was assessed by using Cronbach’s Alpha. The Alpha value of every factor was greater than 0.70, indicating that it was a very good statistical result (Johnson & Wichern, 1998). The instruments for the constructs were validated by exploratory factory analysis using principal axis factoring with oblique factor rotation and their result confirmed the structure of the constructs and confirmatory factor analysis.
The convergent validity was checked for construct validation by using a confirmatory factor analysis and standardized factor loading which was greater than 0.5, indicating good convergent validity among the instruments of each construct (Byrne, 2001). In this study, all loadings were greater than 0.5. The maximum standardized loading was 0.863 and the minimum standardized loading was 0.636. In addition, average variance extracted (AVE) of each construct was assessed and AVE should be at least 0.5 to be considered as adequately convergent. The estimates of average variance extracted (AVEs) for the six factors were 0.54, 0.52, 0.54, 0.65, 0.70 and 0.61 respectively which are greater than the critical value of 0.50. The composite reliabilities (CR) for the six factors were 0.78, 0.84, 0.85, 0.85, 0.82 and 0.86 respectively which are above the critical value of 0.70. The results of AVEs and CR showed evidence of good reliability for studied constructs. The t-value represents the estimate of regression weight divided by its standard error and should be above 2 (Droge et al., 2004). All t-values were greater than 2. The minimum t-value of the loadings was 9.120 and the maximum t-value was 14.627. These results are presented in Table 5.

Table 5: Assessment of Reliability and Construct Validity

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor loading</th>
<th>t-value</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Supply Chain Strategy (CR =0.78, AVE =0.54)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our primary supply chain purpose in dealings with partners is pursuing lowest total cost</td>
<td>0.784</td>
<td>a</td>
<td>.771</td>
</tr>
<tr>
<td>Our supply chain attempt to reduce any kind of waste as much as possible</td>
<td>0.738</td>
<td>9.921</td>
<td></td>
</tr>
<tr>
<td>Our supply chain reduces costs through ‘one piece flow’ production</td>
<td>0.685</td>
<td>9.622</td>
<td></td>
</tr>
<tr>
<td>Supplier Integration (CR =0.84 , AVE =0.52)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>We share our inventory levels with our major supplier.</td>
<td>0.636</td>
<td>9.130</td>
<td></td>
</tr>
<tr>
<td>We share our demand forecasts with our major supplier</td>
<td>0.668</td>
<td>9.405</td>
<td></td>
</tr>
<tr>
<td>We share our production plans with our major supplier.</td>
<td>0.639</td>
<td>9.256</td>
<td></td>
</tr>
<tr>
<td>Our major supplier shares their production capacity with us.</td>
<td>0.822</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>Our major supplier shares available inventory with us.</td>
<td>0.804</td>
<td>13.572</td>
<td></td>
</tr>
<tr>
<td>Product Quality (CR =0.85, AVE =0.54)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to offer conformance quality</td>
<td>0.723</td>
<td>11.499</td>
<td>.851</td>
</tr>
<tr>
<td>Ability to offer product durability</td>
<td>0.679</td>
<td>13.483</td>
<td></td>
</tr>
<tr>
<td>Ability to offer product reliability</td>
<td>0.784</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>Ability to produce consistently low-defect rate</td>
<td>0.791</td>
<td>12.557</td>
<td></td>
</tr>
<tr>
<td>Ability to offer high-performance products that meet customer needs</td>
<td>0.684</td>
<td>10.311</td>
<td></td>
</tr>
<tr>
<td>Delivery speed (CR =0.85, AVE = 0.65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to reduce production lead time</td>
<td>0.832</td>
<td>14.627</td>
<td>.819</td>
</tr>
<tr>
<td>Ability to fast delivery</td>
<td>0.857</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>Ability to provide on time delivery</td>
<td>0.731</td>
<td>12.203</td>
<td></td>
</tr>
</tbody>
</table>
Lean supply chain strategy, supplier integration, competitive capabilities

<table>
<thead>
<tr>
<th>Low Cost (CR = 0.82, AVE = 0.70)</th>
<th>.863</th>
<th>a</th>
<th>.814</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing similar products at a lower cost than our competitors</td>
<td>.811</td>
<td>10.502</td>
<td></td>
</tr>
<tr>
<td>Low manufacturing overhead cost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process Flexibility (CR=0.86, AVE = 0.61)</th>
<th>.815</th>
<th>11.584</th>
<th>.842</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to rapidly change production volumes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to rapidly modify methods for components</td>
<td>.797</td>
<td>13.564</td>
<td></td>
</tr>
<tr>
<td>Ability to rapidly modify methods for materials</td>
<td>.840</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>Ability to manufacture broad product mix within same facilities</td>
<td>.674</td>
<td>11.300</td>
<td></td>
</tr>
</tbody>
</table>

Note: “a” means that the regression weight was fixed at 1.00, not estimated. N = 261

Composite reliability

\[
CR = \frac{\left(\sum_{i=1}^{n} \lambda_i^2\right)}{\left(\sum_{i=1}^{n} \lambda_i^2 + \sum_{i=1}^{n} \delta_i \right)}
\]

Variance extracted

\[
VE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}
\]

The discriminant validity was assessed by checking that the modification indices in the confirmatory factory analysis for omitted paths showed no significant cross loadings among the instrument (Kline, 1998). This study also used the benchmark suggested that the square root of the AVE from the construct should be greater than the correlation shared between the construct and other constructs in the model (Fornell & Larcker, 1981; Lin & Chen, 2008). Table 4 shows the correlations among the constructs with the square root of the AVE on the diagonal. The correlation of any pair of constructs had a smaller value than the square root of the AVE, indicating discriminant validity was satisfied. The non-response bias was checked and the data did not have an indicator for early versus late responses (Armstrong & Overton, 1977).

5.2 Structural model

This study used AMOS 18.0 with the maximum likelihood estimation method to estimate the relationship among constructs and to test hypotheses. Normality, skewness and kurtosis were checked and found acceptable (Mentzer et al., 1999). Overall fit indices of the structural model indicated that the theoretical model fits the data (Bollen, 1989) \( \chi^2 = 246.439 \) with degrees of freedom = 176, \( p = 0.001 \); GFI = 0.921; CFI = 0.977; IFI = 0.977; NFI = 0.924; RMSEA = 0.039; SRMR = 0.82; AIC = 400.493). These indices indicated that all measures of fit exceeded their respective common acceptance levels. The ratio of chi-square to degrees of freedom was 1.401 and indicated a good fit (Segars & Grover, 1993). The results of the structural model are summarized in Figure 2. The results of testing the five hypotheses are listed below.

H1: Lean supply chain strategy is a positively associated with supplier integration. This hypothesis is supported, as the parameter estimate (0.554) is significant.
H2: Supplier integration is positively associated with product quality. This hypothesis is supported, as the parameter estimate (0.459) is significant.

H3: Supplier integration is positively associated with delivery speed. This hypothesis is supported, as the parameter estimate (0.479) is significant.

H4: Supplier integration is positively associated with low cost. This hypothesis is supported, as the parameter estimate (0.450) is significant.

H5: Supplier integration is positively associated with process flexibility. This hypothesis is supported, as the parameter estimate (0.553) is significant.

**Figure 2: Structural model**

![Structural model diagram]

*The path is significant at the 0.001 level.

### 5.3 Additional contextual analysis

Contextual factors such as firm size, local or foreign ownership and national economic development can affect performance outcomes (Yang et al., 2011). In this study, factors such as firm size and nature of ownership (i.e., Thai, joint-venture and wholly foreign owned) were included to test the construct relationships. The results suggested that all hypotheses were supported. Firms with less than 500 employees performed better than firms with more than 500 employees in all areas, especially the strength of relationship between lean supply chain strategy and supplier integration. Interestingly, Thai-owned firms had standardized path coefficient values above 0.5 in hypotheses 1 and 3 which suggest that Thai-owned firms could align their lean supply chain strategy to their suppliers better than joint-venture firms and this linkage could improve their delivery speed significantly. However, wholly foreign-owned firms had the highest standardized path coefficient value from lean supply chain strategy to supplier integration. This indicates that wholly foreign-owned firms adapted their lean supply chain strategy to their suppliers better than firms with other types of ownership. This could impact their product quality capability which had the highest regression weight value, 0.484, among the three types of ownership. Although joint-venture firms had the lowest standardized path coefficient values, the standardized coefficient path value from supplier integration to process flexibility was the highest.
as was the standardized coefficient path value from supplier integration to low cost. Overall, firms with less than 500 employees showed better statistical significance in all the relationships. Future studies are needed to explore the underlying causes of the different results for each of the hypotheses. The contextual analysis is shown in Table 6 and figure 3 and 4.

Table 6: Contextual Analysis (n=261)

<table>
<thead>
<tr>
<th>Path</th>
<th>Hypotheses</th>
<th>Firm size</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Aggregated sample (n=261)</td>
<td>&lt; 500 (n=132)</td>
</tr>
<tr>
<td>LS → SI</td>
<td>H1</td>
<td></td>
<td>0.554</td>
</tr>
<tr>
<td>SI → PQ</td>
<td>H2</td>
<td></td>
<td>0.459</td>
</tr>
<tr>
<td>SI → DL</td>
<td>H3</td>
<td></td>
<td>0.479</td>
</tr>
<tr>
<td>SI → LC</td>
<td>H4</td>
<td></td>
<td>0.450</td>
</tr>
<tr>
<td>SI → PF</td>
<td>H5</td>
<td></td>
<td>0.553</td>
</tr>
</tbody>
</table>

*p < 0.001 level (two-tailed).

Figure 3: Plot of Standardized Path Coefficients of Five Hypotheses Based on Types of Ownerships
6. DISCUSSION

The results confirm that a lean supply chain strategy has a positive relationship with the supplier integration. Being lean may not be sufficient for the firm to compete if the firm’s suppliers are not also encouraged to pursue a lean strategy themselves which requires them to integrate with their customers.

The results also confirm that supplier integration has a positive relationship with developing the competitive capabilities of product quality, delivery, low cost and process flexibility. This suggests that the supplier integration allows the firm access to valuable external resources in its upstream supply partners which can lead to the enhancement of its competitive capabilities. If there is a high degree of supplier integration then it is suggested that the firm’s competitive capabilities will be developed even further. The findings also suggest that the competitive capabilities of the manufacturing firms studied are not very strong because there is only a low level of supplier integration. It is possible that these manufacturing firms are inexperienced in integrating with their suppliers and is understandable from the perspective that firms should integrate its internal functions prior to integrating with its external supply chain partners.

It is interesting that the standardized coefficient path value from supplier integration to process flexibility is highest compared with the standardized coefficient path value for the other competitive capabilities. It is possible that the firms studied have developed this capability in response to their customer demand environment and that supplier integration has enabled them to focus resources on this medium term development by involving suppliers more in the day to day operations of the supply chain. Also, the standardized coefficient path value from the supplier integration to delivery speed capability is the second highest. This suggests that, under a lean supply chain strategy, delivery speed capability is relatively strongly developed through supplier integration compared with other capabilities such as product quality and low cost.
Adding contextual analysis provides an understanding of the effects of firm size and the nature of firm ownership. In this study, firms with less than 500 employees who adopted a lean supply chain strategy better improved their competitive capabilities through supplier integration than firms with more than 500 people. The findings are consistent with a prior study (Yang et al., 2011) in which smaller firms were observed to have better performance than larger firms. Perhaps, larger firms have moved slower than smaller firms in interacting with supply chain partners. In addition, larger firms, particularly wholly foreign-owned ones, might have focused on their short term objectives rather than invested in longer term sustainability when integrating with their suppliers. However, wholly foreign-owned firms seem to have paid more attention on achieving lowest total cost with their supply chain partners through supplier integration. This may reflect the main strategy and business direction of the wholly foreign-owned firms.

Overall, the findings are consistent with those of previous studies of integration and competitive capability relationships and with resource-based view of the firm and relational view of the firm theories. For example, Rosenzweig et al. (2003) suggest that integration is a strategy by which firms can acquire resources that they do not own from their supply chain partners in order to gain competitive advantages, such as improved flexibility and delivery in this study. This study provided further evidence for managers of a route to increasing a firm’s competitive capabilities through supplier integration, particular in process flexibility, when operating a lean supply chain strategy. In addition, capabilities such as process flexibility and delivery speed may be directly supported by a lean supply chain strategy. In turn, researchers need to consider if or how supplier integration mediates the relationship between lean supply chain strategy and competitive capabilities.

7. CONCLUSION AND FURTHER RESEARCH

Structural model testing indicates that a lean supply chain strategy has a significant direct positive effect on supplier integration and supplier integration has a significant positive effect on competitive capabilities. This study has several major contributions to the academic literature and provides crucial guidelines for supply chain practitioners or managers who are looking for implementing lean supply chain strategy and supply chain integration. It is a response to the call for researchers to examine the impact of supply chain strategy on supply chain activities or practices (Qi et al., 2011) and it is the first to attempt to test the relationship between a lean supply chain strategy and supplier integration. However, further research is required to understand the relationships between a lean supply chain strategy with those suppliers further upstream in the supply chain.

The findings contribute to operations and supply chain management knowledge by providing a further study of the alignment of supply chain strategy and supplier integration but in the context of Thailand by using empirical data from its the automotive supply bases. The results facilitate an improved understanding of implementing lean supply chain strategy and supplier integration in Thailand but the context may limit the generalizability of the findings. Consequently, a comparison of lean supply chain strategy and supplier integration in other Asian and western countries would be an interesting research opportunity. Furthermore, in
the context of a lean supply chain strategy, it would be appropriate to include other dimensions of supply chain integration such customer integration and internal integration in such studies.

REFERENCES


