Supply Chain Integration in the Swedish Wooden House Industry

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Abstract

Supply Chain Integration (SCI) has been found by previous research to be correlated with increased business performance. However, the rate of implementation of the concept is dependent on the industry, implying that this is determined by industry-specific factors. The purpose of this study was therefore to investigate how the Swedish wooden house industry approaches SCI, and thereby identify industry-specific factors that influence integration. To accomplish this, an exploratory multiple case study was conducted, in which Swedish wooden house manufacturers and associated actors were interviewed. The study confirmed that the wooden house industry is affected by factors limiting SCI implementation, and that companies in the industry are not integrated to any significant degree. Further, two industry-specific factors were discovered to be inhibiting integration. First, the degree of product customization granted to customers by house manufacturers determines how much control over procurement decisions is retained, and thereby potential for integration with suppliers. Customer orientation was found to inhibit SCI in the wooden house industry due to its effect on product customization, in spite of previous literature classifying it as a driver. Secondly, the fragmentation of the contractor market was found to force house manufacturers to deal with a multitude of small actors to perform the on-site construction function, limiting investments in relationships for any one given actor. The study also found that levels of internal integration was generally not at a level at which the benefits of SCI can be fully realized.
Acknowledgements

With these few words, we would like to express our gratitude to all those who in some way were involved in this study, without whose help the study would have never been completed. A very special thank you goes to Anders Melander, who has been invaluable with his insight and feedback, helping us to focus and refine our study. To Suzanne Hertz, who has led the thesis seminars, and all participants who provided feedback, goes another special thank you. Finally, to our interviewees, who have provided their time and their knowledge to make this study possible, we express our utmost gratitude. Thank you.

Jönköping, 21st of May 2018

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1 INTRODUCTION

This chapter aims to provide the reader with a background of the Swedish wooden house industry and introduce the concept of Supply Chain Integration. The introduction also includes the purpose, scope and structure of the thesis.

The real-estate market serves a critical role in the economy, Sweden far from being an exception, with the subject of housing diligently being debated and discussed. A sustained population increase is contributing to an already existing housing shortage (Brege, Nord, & Stehn, 2017; Boverket, 2017a), with 95% of Swedish municipalities reporting a deficit in housing (Boverket, 2017b). As a result, construction of housing has increased in attempt to cover the gap (Boverket, 2017c), and can be expected to remain at significantly higher levels than previously in the years to come (Brege et al., 2017). While apartment buildings make up the bulk of new construction, and are generally constructed in concrete, the market for small houses\(^1\) in Sweden is dominated by wooden constructions (IVA, 2014).

The wooden house industry itself is a fragmented one, with a wide range of business models catering to an equally diverse range of customers (Melander, Achtenhagen, Andersson, & Björling, 2017). The market thus provides everything from completely unique houses to finished templates, with varying degrees of prefabricated elements, from walls to finished rooms. This fragmentation is visible not only in marketing strategy, but in the differing approaches to Supply Chain Integration\(^2\), companies having different takes on how to control and manage supply chain processes.

The wooden house industry is not unique in its adherence to a multitude of integration strategies, with a majority of companies in cross-industry studies indicated as tending to lesser degrees of integration (c.f. Frohlich & Westbrook, 2001; Schoenherr & Swink, 2012). This is in spite of strong indications that integration has been shown to positively impact the operational and financial performance of supply chains through the internalization of outside resources, leveraging supplier capabilities and market insight from customers (Schoenherr & Swink, 2012; Rai, Patnayakuni & Seth, 2006; Flynn, Huo, & Zhao, 2010). The resulting increase in operational performance drives improved customer relations and, in turn, revenue growth. This poses the question of why so few companies have moved towards more integrated supply chains.

Integration strategies have been categorized before (c.f. Frohlich & Westbrook, 2001), with recognition that different industries have different distributions of integration strategies, corresponding to industry conditions (Wong, Wong, & Boon-itt, 2017). Previous studies have defined both the barriers to and drivers for integration (c.f. Richey, Roath, Whipple & Fawcett,

\(^1\) This definition follows that of småhus by Trä- och Möbelföretagen (TMF), the Swedish branch organization for wood and furniture, and covers single family houses, detached or conjoined into terraced houses; and detached double family houses (TMF, 2018a).

\(^2\) For the uninitiated, Supply Chain Integration (SCI) is generally defined as the extent to which companies are strategically interconnected with its supply chain partners in collectively managing processes (Schoenherr & Swink, 2012; Flynn, Huo, & Zhao, 2010). This is not the same as vertical integration, which is defined as ownership of a supply or distribution channel (Harrigan, 1985). SCI is part of the wider concept of Supply Chain Management (SCM), which can be defined as the philosophy of managing the total flow of a distribution channel from suppliers to end users (Cooper, Ellram, Gardner, & Hanks, 1997).
2010; Richey, Chen, Upreti, Fawcett, & Adams, 2009), and found the fragmentation of the construction industry in general to inhibit SCI (Briscoe & Dainty, 2005). It would seem, therefore, considering the differences in the levels of integration in different industries found by Wong et al. (2017), that drivers and barriers are affecting industries to different degrees, and that there may be industry-specific factors that are yet to be identified.

As the Swedish wooden house industry is quite distinct in its operations, being a mixture of manufacturing and pure construction (c.f. Melander et al., 2017), it appears an appropriate subject for study if one is to find distinct industry-specific factors influencing business behaviours, specifically SCI.

1.1 PURPOSE
The purpose of this thesis is to conduct an exploratory study of Supply Chain Integration strategies in the Swedish wooden house industry. This study will therefore investigate how companies in the industry approach SCI, and in doing so, identify the factors that influence SCI in the wooden house industry. It is hoped that this will provide a deeper understanding of why industries have differing degrees of integration.

1.2 SCOPE AND DELIMITATIONS
This thesis covers the Swedish wooden house industry, specifically producers of small houses, as defined above. This means there might be a cultural aspect to the findings that are not accounted for, considering the limitation to one country. The focus on a specific industry also may limit some of the applicability to other companies. Also, since companies in this industry are overwhelmingly small and medium enterprises, larger companies may have additional characteristics limiting applicability.

1.3 STRUCTURE OF THE THESIS
The first chapter being the introduction to the thesis and its purpose, chapter two further introduces the reader to the concept of Supply Chain Integration, the factors influencing its implementation as found by previous literature, and provides an understanding of the Swedish wooden house industry. The third chapter describes the methodology and assumptions used in conducting the study, and how empirical material was procured and analysed. The fourth chapter presents the empirical material, providing a description of industry conditions and behaviours. The fifth chapter analyses the empirical material, comparing it with findings in previous literature, and makes a contribution by fulfilling the purpose of the thesis. The sixth and final chapter summarize the findings of the study and provides managerial implications, suggestions for future research, and discusses the limitations of the study.
2 LITERATURE REVIEW

The first section of this chapter will present the concept of Supply Chain Integration and the framework that will be the basis for this thesis. The second section will then cover the factors that influence the motivations behind whether or not to pursue integration. Finally, the third section will introduce construction and the Swedish wooden house industry as it relates to the topic.

2.1 SUPPLY CHAIN INTEGRATION

The concept of Supply Chain Integration (SCI) is generally defined as the extent to which companies are strategically interconnected with its supply chain partners in collectively managing processes (Schoenherr & Swink, 2012; Flynn et al., 2010). The resulting interactions enable companies to create a smooth flow of products and information, and to leverage external capabilities. This in turn has been empirically associated with higher performance levels by a multitude of studies (c.f. Frohlich & Westbrook, 2001; Ragatz, Handfield & Petersen, 2002; Rai et al., 2006; Flynn et al., 2010; Gianni, Gotzamani, & Tsiotras, 2017). SCI has been studied from a variety of perspectives, with researchers focusing on and highlighting different aspects of the concept.

Integral to SCI is the concept of flows, the most recognized of which are the flow of material and information, the integration of which having a significant effect on operational performance (Prajogo & Olhager, 2012; Roldán, Basagoiti & Coelho, 2017). Managing the production and transportation of physical goods has long presented the challenge of ensuring products reach their destination in time and the right quantities (Gelinas & Bigras, 2004). The integration of these activities across actors ensures inventory can be sufficiently tracked to avoid stock-outs (Mistry, 2005), while decreasing the need for costly safety stocks (Silvestro & Lustrato, 2014; Eltantawy, Paulraj, Giunipero, Naslund & Thute, 2015). In addition, collaboration facilitates the upstream movement of defective or used products, from end customer to manufacturer, so that they may be recycled or disposed of (Saccani, Johansson & Perona, 2007).

Equally as important is the flow of information between actors, such that an increase in the integration of information systems correlate with an increase in performance due to the facilitation of supply chain processes (Rai et al., 2006; Devaraj, Krajewski, & Wei, 2007; Zhou & Benton Jr., 2007; Su & Yang, 2010). While IT thus enables companies to integrate processes despite large geographical distances due to the immediate sharing of information (Stock, Greis & Kasarda, 2000; Johnson & Whang, 2009), IT has an even more significant effect on information quality (DeGroote & Marx, 2013). This enables a company to sense and respond to market changes, which in turn improves operational and financial performance (Wang & Wei, 2007; DeGroote & Marx, 2013). Hence, by sharing forecasts, production schedules, and current inventory levels, companies can match production with demand and limit stock-outs and inventory costs, and achieve shorter lead times and timely delivery (Devaraj et al., 2007; Gunasekaran, Lai & Cheng, 2008). This counteracts the bullwhip-effect, the oscillation of orders throughout the supply chain due to independent forecasting done at each level, causing production to be based off the projected demand on an actor’s immediate partners rather than end consumer demand (Lee, Padmanabhan & Whang, 1997; Croson & Donohue, 2006). The supply chain as a whole can then achieve economies of scale (Swafford, Ghosh & Murthy,
2008), and benefit from effective reverse logistics flows (Kulp, Lee & Ofek, 2004). An inability to share information with supply chain partners therefore represents a loss of competitive advantage (Gunasekaran & Ngai, 2004; Gunasekaran et al., 2008).

2.1.1 Internal integration
Taking a general view, integration can be considered as having internal and external dimensions, the latter having an upstream supplier direction, and a downstream customer direction (Schoenherr & Swink, 2012). Internal integration refers to the linking of internal activities to provide optimization from a firm-wide perspective, supporting customer requirements with the full capabilities of the company at the lowest possible cost (Stank, Keller & Closs, 2001). By having all departments working cohesively to satisfy customer demands, internal integration helps facilitate an effective flow of information throughout all organizational business operations, ensuring all those involved are properly informed (Yu, Jacobs, Salisbury & Enns, 2013). Having thus linked departments in the sharing of information, companies can improve logistics performance, delivering goods with more spatial and time precision, eliminate redundant processes, and better manage inventory by tracking the flow and quantities of material (Stank et al., 2001; Schoenherr & Swink, 2012). The optimization of internal processes acts to lower overall business expenses, in turn increasing general business performance (Droge, Jayaram, & Vickery, 2004; Lee, Kwon & Severance, 2007; Flynn et al., 2010).

The achievement of internal integration largely depends on the ability of managers to understand business goals and the requirements of external actors, so that an appropriate plan for internal integration may be designed and implemented (Turkulainen, Roh, Whipple, & Swink, 2017). Managers must therefore ensure all departments are aligned in working towards the same goals, rather than in a state of internal competition. This also involves the consideration and evaluation of organizational structure and culture, and the amount of formal and informal communication across functions, consensus on the decision to cooperate being crucial to successful integration (Pagell, 2004). In achieving consensus, managers can develop cross-functional teams within the organization to merge operations and simplify management (Stank et al., 2001).

2.1.2 External integration
The interorganizational links created with customers and suppliers in the supply chain are referred to as external integration (Vickery, Jayaram, Droge & Calantone, 2003; Gianni et al., 2017). After having adequately integrated internal processes, a company may design a supply chain so as to integrate with key actors, ensuring efficient resource usage and the effective creation of customer value (Sezen, 2008; Lee et al., 2007). In this context, customer integration refers to close collaboration with key customers who provide insight into market conditions and opportunities (Wong, Boon-itt & Wong, 2011), while supplier integration refers to close collaboration with suppliers, providing information on upstream capabilities and constraints (Ragatz et al., 2002).

These collaborations ultimately lead to better meeting customer demands on the one hand, and improving planning and forecasting, along with product and process design on the other. Creating a transparent supply chain enables suppliers to create higher quality products (Rosenzweig, Roth & Dean Jr., 2003), as downstream actors provide feedback and insight on cost and quality, lowering production flaws and, in turn, costs (Cousins & Menguc, 2006;
Kaynak & Hartley, 2008). Hence, the sharing of information enables the utilization of and learning from the business capabilities of other actors (Ellinger, 2000; Turkulainen et al., 2017; Zhu, Krikke & Caniëls, 2018; Gianni et al., 2017), and the ability to more effectively resolve and prevent conflict as relationships improve (Zhao, Huo, Selen & Yueng, 2011; Dias and Ierapetritou, 2017). Further, integration is an opportunity for improved inventory and distribution management, increasing the efficiency and effectiveness of logistics operations (Roldán et al., 2017). This is achieved by sharing information on orders, inventory and transportation status, achieving economies of scale which ultimately saves time and resources (Rosenzweig et al., 2003; Zhou & Zhang, 2017). Thus, external integration creates a coordinated manufacturing process which grants the supply chain a competitive advantage (Frohlich & Westbrook, 2001).

2.1.3 Integration strategy

In a seminal contribution to the topic of integration strategies, Frohlich & Westbrook (2001) describe the alternative approaches to integration as a combination (termed arcs) of customer and supplier integration at various levels. The approaches are classified as five general strategies, detailed in Figure 1A, with inward-facing being the least integrated and outward-facing the most, derived from the placement into quartiles of a company’s factor score for each facing. They concluded the most successful companies were those associated with more integrated supply chains, positing that companies should integrate in both directions to fully realize performance potential, as measured in categories of cost, quality, delivery, and flexibility. This relationship has been confirmed by later studies, with Schoenherr and Swink (2012) introducing internal integration as a moderating factor for delivery and flexibility performance, suggesting that an information processing infrastructure is needed to provide benefits to these measures from knowledge gained from external sources in an efficient and

---

3 In Frohlich and Westbrook’s (2001) study, companies were surveyed with questions on supplier and customer integration, each question consisting of a rating given, that would be weighted and contributing to a score for each respective arc. The higher the score for an arc, the more would it extend.
effective manner. Childerhouse and Towill (2011) also confirmed that integrating beyond the immediate first tier of supply chain partners will increase competitiveness.

The development of an integration strategy tends to follow one of two patterns [Figure 1B], in which a company first integrates internally, and then turns to integrate with suppliers or, although less likely, customers (Childerhouse & Towill, 2011). According to Zhao et al. (2011), it is not advisable to attempt both internal and external integration at the same time, as a company must ideally have successfully undergone system-, data-, and process integration before meaningful external integration can be achieved. That is, without effective management and operations, a company risks becoming overwhelmed when attempting to connect business activities with outside actors (Huo, 2012). Having achieved internal integration, a company most likely focuses on integrating with key suppliers, which likely entails the elimination of waste and inventory (Childerhouse & Towill, 2011). Companies, provided they are so inclined, thereafter complete the arc by integrating with customers, through activities such as collaborative planning and forecasting. Alternatively, a company might start their efforts through customer integration, although the study of value streams conducted by Childerhouse and Towill (2011) suggested that this was the less attractive route.

Interestingly, neither Frohlich & Westbrook (2001) nor subsequent studies have found evidence for significant rates of outward-facing strategies [Table 1], suggesting that integration as a concept is far from widely adopted. In providing evidence of different integration strategies being prevalent in different industries, Wong et al. (2017) also suggest that the different types of integration can have various configurations that achieve the same general result. That is, an emphasis on customer integration to achieve delivery and quality performance in one industry, might be supplanted by an emphasis on supplier and internal integration to achieve the same performance outcomes in another industry. It can therefore be surmised that companies could find certain arcs of integration more or less appropriate based on the industry and environment in which they operate.

<table>
<thead>
<tr>
<th>Integration type</th>
<th>Frohlich and Westbrook (2001) survey %</th>
<th>Childerhouse and Towill (2011) value stream sample %</th>
<th>Schoenherr and Swink (2012) survey %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inward-facing</td>
<td>In lower quartile for suppliers and customers</td>
<td>15.1</td>
<td>13</td>
</tr>
<tr>
<td>Periphery-facing</td>
<td>Above lower quartile for suppliers or customers, but below upper quartile for suppliers and customers</td>
<td>47.1</td>
<td>15</td>
</tr>
<tr>
<td>Supplier-facing</td>
<td>In upper quartile for suppliers, and below upper quartile for customers</td>
<td>13.4</td>
<td>40</td>
</tr>
<tr>
<td>Customer-facing</td>
<td>In upper quartile for customers, and below upper quartile for suppliers</td>
<td>14.4</td>
<td>13</td>
</tr>
<tr>
<td>Outward-facing</td>
<td>In upper quartile for suppliers, and in upper quartile for customers</td>
<td>10.0</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 1 Distribution of integration strategies
Determining factors for the extension of an arc are the integration practices in use, and the depth of integration with suppliers in different tiers (Childerhouse & Towill, 2011). Table 2 summarizes typical integration practices, sorted into practices at the strategic, tactical, and operational levels. These practices might be in used in isolation or as part of wider management philosophies. A well-known such philosophy is lean, derived from techniques used by Japanese manufacturers, and is focused on the elimination of waste (Arantes, Ferreira, & Costa, 2015; Wee, 2009; Womack, Jones, & Roos, 1990). The core of the lean philosophy is the definition of customer value, using pull systems to ensure an even product flow through activities deemed value-adding (Womack, 2002). The focus on value and the elimination of non-value adding activities is therefore synonymous with the elimination of waste in production. A foundation of lean is that of continuous improvement of processes, and the required standardization of processes (Berger, 1997). Kaizen, as it is referred to in the original Japanese, is not associated with any specific technique, but is rather embedded within all lean methods, as a way of thinking. An alternative philosophy is that of agile, in which the company focuses on meeting quickly changing demand that cannot easily be forecasted (Yusuf, Sarhadi & Gunasekaran, 1999). This entails utilizing a flexible manufacturing and distribution system that favours home-shoring over off-shoring, which may entail a loss of cost benefits as the price of responsiveness (Christopher & Towill, 2002). The application of these strategies for any given product line is seen as mutually exclusive, the appropriate strategy depending on product characteristics (Fisher, 1997). Figure 2 illustrates the hierarchy of the terms discussed above, in that the Supply Chain Integration strategy (the arcs) are the result and manifestation of a collection of practices, which may be part of a wider management philosophy.

2.2 FACTORS INFLUENCING INTEGRATION

Part of SCI research has been into the factors influencing implementation, i.e. the barriers and drivers. The unwillingness of businesses to change has been criticized (cf. Ireland & Webb, 2007; Frohlich, 2002), with companies stuck in early phases of the Supply Chain Integration process despite being aware of its benefits (Fawcett & Magnan, 2002).

2.2.1 Barriers to integration

A major factor inhibiting the willingness and ability to integrate is the cost associated with realigning culture, structures etc. (Pagell, 2004; Maloni & Benton, 1997; van der Vaart & van Donk, 2004). Further, there is a risk of damaging relationships (Wang & Chan, 2010), and a vulnerability to abuse of power by partners (Harland, Caldwell, Powell, & Zheng, 2007). Managers also tend to overlook the aspect of human relationships, focusing instead on systemic issues (Fawcett, Magnan & McCarter, 2008; Alfalla-Luque, Marin-Garcia, & Medina-Lopez, 2015). Not all people get along, a fact that also applies to employees of different organizations, which might cause resistance to change and mistrust (Ragatz, Handfield, & Scannell, 2003; Alfalla-Luque et al., 2015), incongruent business cultures (Fawcett et al., 2008), and incompatible goals (Yuen & Thai, 2017).
<table>
<thead>
<tr>
<th>Depth of integration</th>
<th>Typical integration practices</th>
<th>Description</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic</strong></td>
<td>Knowledge sharing</td>
<td>Actors share with one another certain knowledge in terms of skills and capabilities for mutual improvement (Schoenherr &amp; Swink, 2012).</td>
<td>Business can break free from internal knowledge boundaries and improve supply chain operations (Zhu, Krikke &amp; Caniels, 2018).</td>
</tr>
<tr>
<td>Long term partnership with shared goal and risk</td>
<td>Joint decision making</td>
<td>Actors jointly collaborate on decision making to make suitable choices and achieve mutual goals (Dias &amp; Ierapetritou, 2017).</td>
<td>Actors ensure they are going the right direction and avoid conflict (Dias &amp; Ierapetritou, 2017).</td>
</tr>
<tr>
<td>Mission alignment</td>
<td>Mission alignment</td>
<td>Actors focus on working to achieve the same purposes (Stock, Greis &amp; Karsada, 2000).</td>
<td>Actors avoid conflict, the company gains competitive advantage (Stock, Greis &amp; Karsada, 2000).</td>
</tr>
<tr>
<td>Joint investment</td>
<td>Joint investment</td>
<td>Actors jointly invest time or financial resources in common IT systems, physical facilities etc. to achieve common goals (Subramani, 2004).</td>
<td>Actors build strong relationships, increase trust, and motivation to achieve desired goals (Subramani, 2004).</td>
</tr>
<tr>
<td>Joint research and development</td>
<td>Joint research and development</td>
<td>Actors share knowledge and resources to improve existing processes and products (Schoenherr &amp; Swink, 2012; Hagedoorn, van Kranenberg, &amp; Osborn, 2003).</td>
<td>Actors pool resources, increase sales, improve customer service, and gain competitive advantage (Schoenherr &amp; Swink, 2012).</td>
</tr>
<tr>
<td><strong>Tactical</strong></td>
<td>Shared problem solving</td>
<td>Actors share knowledge and insight to jointly overcome issues (Schoenherr &amp; Swink, 2012)</td>
<td>Reduced time and resources required to overcome obstacles and maintain competitiveness (Schoenherr &amp; Swink, 2012).</td>
</tr>
<tr>
<td>Medium-term alignment of information and material flow</td>
<td>Collaborative planning and forecasting</td>
<td>Actors work closely together to develop plans and forecast future orders and market changes (DeGroote &amp; Marx, 2013).</td>
<td>Improve ability to quickly sense market changes and develop response plans (DeGroote &amp; Marx, 2013).</td>
</tr>
<tr>
<td>Information system integration</td>
<td>Information system integration</td>
<td>Shared IT system where actors share information regarding supply chain operations, sales, orders, forecasts etc. (Yu, Jacobs, Salisbury &amp; Enns, 2013).</td>
<td>Actors are constantly updated on supply chain activities (Yu, Jacobs, Salisbury &amp; Enns, 2013), and can quickly receive orders and customer requirements (Gunasekaran et al., 2008).</td>
</tr>
<tr>
<td>Supplier development</td>
<td>Supplier development</td>
<td>Actors share resources and information with suppliers to improve their performance (Rosenzweig, Roth, &amp; Dean, 2003).</td>
<td>Increased supplier awareness of the supply chain, optimizing production to achieve economies of scale, reduction of net cost etc. (Rosenzweig, Roth, &amp; Dean, 2003).</td>
</tr>
<tr>
<td>Performance evaluation and continuous improvement</td>
<td>Performance evaluation and continuous improvement</td>
<td>Monitoring of customer and supplier performance to provide feedback (Gousins &amp; Menguc, 2006).</td>
<td>Actors strengthen relationships, and improve performance and customer service (Gousins &amp; Menguc, 2006)</td>
</tr>
<tr>
<td><strong>Operational</strong></td>
<td>Optimization of resources</td>
<td>Actors ensure resources are used optimally to achieve common goals (Sezen, 2008).</td>
<td>Increased business performance, decreased waste of resources, decrease in cost and time required to satisfy customer demands (Sezen, 2008).</td>
</tr>
<tr>
<td>Electronic data interchange (EDI)</td>
<td>Electronic data interchange (EDI)</td>
<td>Digital transmission of business data in a common format (Hill &amp; Scudder, 2002).</td>
<td>EDI easily adapts to different technology platforms, enables constant reception of information, and simplifies communication (Hill &amp; Scudder, 2002).</td>
</tr>
<tr>
<td>Synchronized physical flow</td>
<td>Synchronized physical flow</td>
<td>An integrated system where actors know the movement and all activities related to physical goods (Stank, Keller &amp; Closs, 2001).</td>
<td>Improved logistics performance (Schoenherr &amp; Swink, 2012), reduced excess material and holding times (Silvestro &amp; Lustrato, 2014), smooth product movement (Gunasekaran et al., 2008), reduced safety stock (Eltantawy, Paulraj, Giunipero, Nashlund &amp; Thute, 2015).</td>
</tr>
</tbody>
</table>

Table 2 Summary of Supply Chain Integration practices
The cost of integration can thus be prohibitive, making it an inappropriate strategy to apply across the board, rather than managing products and the corresponding relationships separately, cost often being a strategic imperative (Gelderman & Van Weele, 2003; Gangurde & Chavan, 2016). The sourcing process has long since been formalised, Kraljic (1983) having developed a matrix, sorting products into categories according to their impact on profit, and the risk to product availability and the ability for substitution. The emphasis here is that for products that are low in impact on profit, abundant in supply and where suppliers are easily substituted, it is most appropriate for a company to leverage buying power to minimize cost rather than invest in relationships. Conversely, if the opposite is true for a product, integration is crucial.

Richey, Roath, Whipple and Fawcett (2010), identified three factors acting as barriers to integration, the first being the unidirectional flow of process and planning. Unwilling to share vital information, companies take a one-way approach to information flow to limit exposure (Fawcett et al., 2008; Alfalla-Luque et al., 2015; Yuen & Thai, 2017; Ragatz, Handfield, & Scannell, 2003; Dunant, Drewniok, Sansom, Corbey, Allwood, & Cullen, 2017). This limits the ability to establish meaningful relationships, and opportunities for collaborative learning and value creation (Patnayakuni, Rai, & Seth, 2006; Richey et al., 2010). Incongruent business behaviours are those conducted without consultation or regard for partners, keeping partners at arms-length and utilizing inconsistent goals and disconnected performance measures, with different internal departments striving to achieve their targets with no attention to, or a resistance to, external actors (Richey et al., 2010; Richey, Chen, Upreti, Fawcett, & Adams, 2009; Ragatz, Handfield, & Scannell, 2003). A company can also internalize values, attitudes and regulations, such that employees lose sight of external conditions and customers, decreasing the ability to manage customer requirements, and the likelihood of seeing the importance of Supply Chain Management.

While a company might employ an IT system tailored for their operations, the difference in technology use can cause problems when interacting with other organizations, necessitating compatible systems (Subramani, 2004). The integration of IT should not be seen as a complete solution, as yet again there is a risk of overlooking the human relationship aspects, thereby foregoing the full benefits of an integrated system (Prajogo & Olhager, 2012). There is also the aspect of power to consider, with larger companies tending towards more advanced and costly systems, and in turn forcing its adoption upon partners, rather than finding mutually agreeable solutions, leading to long implementation periods and decreased performance (Patterson, Grimm & Corsi, 2003; Kelle & Akbulut, 2005).

2.2.2 Drivers for integration

The motivations for a company to integrate can be split into two categories, with external drivers denoting environmental conditions, and internal drivers referring to motivations for change coming from the company itself (Richey et al., 2009; Yunus & Tadisina, 2016). In this sense, uncertainty acts as a critical external driver, with companies more inclined to integrate the more uncertain the environment. Uncertainty of supply, i.e. the risk that a supply stream might be interrupted or lost, thus pushes companies to integrate with suppliers to ensure steady and reliable access to supplies (Paulraj & Chen, 2007). Technological uncertainty, the lack of design convergence of a certain product in an industry, gives an emerging industry more uncertainty than one with well-defined products (Auster, 1992). The lack of information surrounding the involved technology therefore prompts companies to cooperate to pool knowledge (Paulraj & Chen, 2007; Auster, 1992). Uncertainty of demand has been named as
another driver, pushing companies to integrate to better create and manage demand, though this seems to be less significant (Paulraj & Chen, 2007). Since demand uncertainty is omnipresent, companies could already be aware and conditioned of it, and consequently do not consider it a key determinant for integration (ibid.).

A desire to improve performance is a critical internal driver for integration (Richey et al., 2009; Gatignon & Xuereb, 1997). This entails a willingness to abandon old habits in favour of changing business culture and operations, seeking new opportunities beyond current capabilities that may lose competitiveness in the future (Seo, Dinwoodie, & Kwak, 2014). As a result, the flexibility of the organization is improved, helping in the adaptation of suitable strategies for performance improvement, such as SCI (ibid.; Richey et al., 2009). The ability to adapt is crucial, as SCI entails the ability to collaborate regardless of the general business strategies of the involved parties (Richey et al., 2009). The acquisition and sharing of knowledge is important, with awareness of best practice, for instance through benchmarking, being a predictor of the adoption of innovations, and therefore another critical driver (Daugherty, Ellinger & Rogers, 1995). As is the expectation of performance benefits, and increased market share, from the sharing of knowledge and capabilities with supply chain partners (Lummu & Vokurka, 1999, Frohlich & Westbrook, 2002). Further, a formal understanding of the concept and meaning of Supply Chain Management increases the likelihood of a company adopting an integration strategy (Fawcett & Magnan, 2002; Mentzer et al., 2001). Finally, customer orientation, the desire to satisfy an end customer, drives a company to further collaborate internally and working closer with supply chain partners (Yunus & Tadisina, 2016). Thus, we can create an integrated model of factors influencing SCI, illustrated in Figure 3.

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Barriers</th>
<th>Level of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply uncertainty</td>
<td>Cost</td>
<td></td>
</tr>
<tr>
<td>Demand uncertainty</td>
<td>Low supply risk</td>
<td></td>
</tr>
<tr>
<td>Technological uncertainty</td>
<td>Incompatible personalities</td>
<td></td>
</tr>
<tr>
<td>Desire to improve</td>
<td>Vulnerability to abuse</td>
<td></td>
</tr>
<tr>
<td>Knowledge acquisition and sharing</td>
<td>Unidirectional flow of processes and planning</td>
<td></td>
</tr>
<tr>
<td>Customer orientation</td>
<td>Incongruent business behaviours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internalized values</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incompatible IT</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3 Influencing factors for Supply Chain Integration.

2.3 THE CONSTRUCTION INDUSTRY

Although construction rates have increased dramatically in recent years, the road ahead is not without challenges. The explosive growth of construction is being bottlenecked by a labour shortage (Brege et al., 2017), and restrictive residential zoning (SOU, 2015). Another is the perceived high cost of construction, which has for over a decade consistently increased at a rate well in excess of Consumer Price Index (SOU, 2015; SCB, 2017). The Swedish construction industry in general has often been condemned for its high costs and a lacking propensity for improvement (Stehn & Brege, 2007; Lind, 2006). Infamously criticized in the governmental report Skärpning gubbar (SOU, 2002:115), it was described as one of high degrees of vertical
integration and cartelization, leading to low degrees of competition, productivity and quality. A follow-up report confirmed earlier findings and found that no improvements had been made (SOU, 2009:6). The assumption that low levels of competition is to blame has been challenged by a later study, however, which also asserted that the increase in cost is comparable to neighbouring countries, and commensurate with developments in construction quality (SOU, 2015).

Solutions for low productivity and high costs in construction generally revolve around the standardization of processes, either on the construction site itself, or by partially moving activities upstream through the pre-fabrication of house components in a manufacturing environment (c.f. Ballard, 2000; Brege et al., 2017). Thus, lean principles are applied in trying to level production flows and find avenues for continuous improvements (Shang & Sui Pheng, 2012). The project-based nature of construction is, however, not a good fit for process standardizations (Salem, Solomon, Genaidy, & Minkarah, 2006), with indications that quality assurance systems such as ISO-9000 is not effective in the Swedish construction industry (SOU, 2002:115). Rather, it is the shifting of processes into the sphere of manufacturing, a much more appropriate arena for standardized processes, that is mainly hailed as the harbinger of efficiency (Stehn & Brege, 2007; Björnfot & Sardén, 2014; Brege et al., 2017).

![Diagram of prefabrication techniques](image)

Figure 4 Comparison of prefabrication techniques. Jonsson & Rudberg (2013).

The utilization of well-defined products shifts resources from the design phase to the remaining value chain, enabling continuous improvements for the elimination of waste (Björnfot & Sardén, 2014). However, coordination of the supply chain to ensure reliability and efficiency, and to avoid miscommunication, is a key prerequisite for pre-fabrication (Goodier & Gibb, 2007; Nadim & Goulding, 2011). Thus, the integration of processes would enable responsive relationships to reduce delays (Lessing, Stehn, & Ekholm, 2005), while increasing efficiency with the removal of a continuous contracting process (Barlow et al., 2003). However, in classifying construction strategies according to degree of prefabrication, and the product variety and volume per product type [Figure 4], Jonsson and Rudberg (2013) found that no strategy would inherently outcompete another in all circumstances. Rather, the framework represents the trade-off between efficiency and customization, and strategy must therefore be
chosen accordingly, taking the intended customer segment into consideration (ibid.). Figure 5 shows examples of degrees of prefabrication in construction, categorized by Gibb and Isack (2003) as the following:

- **Component manufacture and subassembly**: Raw materials and components are used for construction on site. Little or no prefabrication.
- **Non-volumetric pre-assembly**: Two-dimensional elements, i.e. floors and walls, are pre-fabricated off site and assembled on site.
- **Volumetric pre-assembly**: An independent frame is constructed on site, in which volumes of specific house parts prefabricated off site are assembled.
- **Modular building**: Modules are pre-fabricated off site to a high degree of completion, requiring only final assembly and finishing operations on site.

![Figure 5 Degrees of prefabrication. Upper left: Component manufacture and subassembly (stick-built/lösvirke). Upper right: Non-volumetric pre-assembly (planelement). Lower left: Volumetric subassembly (volymelement). Lower right: Modular building (volymelement/modulhus).](image)

Construction is mostly characterized as engineer-to-order, products being of high value, with customers highly involved in conception and design, and work organized as projects (Gosling & Naim, 2009). Vrijhoef and Koskela (2000) found construction in normal situations to have large amounts of waste and problems, most caused in another stage of the supply chain than

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4 These are not necessarily the same definitions as those used by the industry, who tend to use the designations *stick-built* (lösvirkeshus) where construction is entirely on-site, non-volumetric pre-assembly (*planelement*), and letting volumetric pre-assembly (*volymelement*) denote any volumetric pre-fabrication regardless of the degree of completion (Melander et al., 2017). Volumetric pre-assembly thus often becomes synonymous with modular building, where kitchens and bathrooms etc. are completed in the factory, possibly as the term *modular* has connotations of building barracks (ibid.).
that in which it was detected. Further, they found that the root causes of these was the short-sighted and departmentalized control of the supply chain. Thus, it was suggested the interface between on-site activities and the supply chain be improved and integrated, along with improvements to product definition in the supply chain, and that activities be moved off-site (ibid.).

The purchasing function serves a large role in the efficiency of engineer-to-order companies, often making up a substantial part of product costs (Jahnukainen & Lahti, 1999). To ensure efficient purchasing, just-in-time (JIT)\(^5\) and supplier development initiatives, such reducing the number of suppliers while deepening the relationships with those left, should be employed (ibid.; Hicks, McGovern, & Earl, 2000). However, the nature of engineer-to-order business is not necessarily congenial to such measures, with low volume and infrequent demand making relationships unjustified, and historically adversarial relationship hampering trust (Hicks et al., 2000). Briscoe and Dainty (2005) added that the large number of supply chain partners and the level of fragmentation in the construction industry limit the levels of integration that is achievable. The project nature of construction and the power structures it leads to create an environment resistant to integration measures, necessitating high levels of buyer dominance or interdependence, and regular volumes (Ireland, 2004).

2.3.1 The Swedish wooden house industry

Wooden houses represent around 90% of newly constructed single-family housing in Sweden (IVA, 2014), with around 80% of all new houses being pre-fabricated wooden houses (TMF, 2018b). The advantages of this are two-fold: both in the utilization of pre-fabrication techniques, and the environmental benefits inherent in the material itself. Wood, as opposed to concrete, is a renewable material and readily available in Sweden, where forests have been actively managed for over a century, during which time annual forest growth has surpassed harvest rates (Lundmark et al., 2014). Brege et al., (2017) calculated that substituting prefabricated wood for concrete in Swedish multi-family house construction would reduce emissions by 40%, or an equivalent of 0.3-0.4 million tons of CO\(_2\) if the market share of prefabricated wood increases to 50% by 2030 from 10% in 2015. This would account for 1% of the Swedish commercial CO\(_2\) reduction target, and increases to a reduction of 0.6-0.9 million tons if the carbon storing capabilities of wood is included in the calculation.

<table>
<thead>
<tr>
<th>Contract type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-Build contract <em>Totalentreprenad</em></td>
<td>The manufacturer is responsible for the entire project.</td>
</tr>
<tr>
<td>General contractor <em>Generalentreprenad</em></td>
<td>The manufacturer will supply the house materials, but a main contractor is responsible for construction, and will subcontract as necessary.</td>
</tr>
<tr>
<td>Trades contract <em>Delad entreprenad</em></td>
<td>The manufacturer will supply the house, and the client is responsible for project management and contracting.</td>
</tr>
</tbody>
</table>

\(^5\) Just-in-time is the application of a *pull* strategy in moving goods through the supply chain, striving to match produced quantities with demand, and trying to ensure that products and components reach the correct process or customer as close to the time of consumption as possible. In doing so, waste is reduced as there is no over- or underproduction, and inventory costs are minimized (Esparrago, 1988).
Single-family houses are unique products partly in that they are very expensive and generally only purchased once in a lifetime, and partly because the combination of house design, lot, foundation and other local factors makes every house unique (Melander et al., 2017). The target end customers range from those with a lower budget, such as young families and older couples whose children have moved out, to those willing to splurge on houses they regard as more than mere dwellings (ibid.). The industry thus differentiates their products through cost, customization, and the degree to which they offer a complete solution rather than just providing design and materials, determined by the types of construction contracts on offer [Table 3]. The Swedish wooden house industry in 2017 consisted of 527 companies with a total of 6062 employed, of which 111 companies had more than 5 employees, 32 of which contribute to TMF statistics and account for 75% of the market share of assembly-ready houses (TMF, 2018b; TMF, 2018c).

To understand how companies in the wooden house industry operate, the study of business models is a valuable tool. Although there is little consensus on the definition of the concept of business models, Zott, Amit, and Masa (2011) found four common themes among the disparate previous usage of the word. Firstly, the business model appears to be a unit of analysis spanning or bridging traditional ones, such as the firm and the network. Secondly, the business model adapts a holistic perspective of looking not only at what an organization does, but how it is accomplished, involving both content and process, focusing on the systemic rather than the particular. Thirdly, the concept of activities, as conducted by the focal firm or another with which it has relations, is central to the concept of the business model. Finally, the business model promotes a dual purpose of value creation and value capture, with the focus being on the former. In summary, then, a common definition of the business model can be a firm-centric but boundary spanning activity system, whose purpose is that of value creation and capture. The concept might therefore be used to explain how a company operates and acts as an architecture for products and services with a description of various actors involved, and can provide a coherent framework to describe how inputs are acquired and delivered as economic outputs (George & Bock, 2011).

While most wooden houses are built utilizing prefabrication, there is a large degree of fragmentation in terms of business strategies in the industry, with Melander et al. (2017) identifying four general types of business models present in the Swedish wooden house industry for single family houses, named after well-known trademarks. The Willa Nordic model addresses the segment of the market that are after unique houses that also act as status symbols, with the budget to match. The customer expects a high service level, leaving the company with the challenge of achieving a quality experience while staying on budget. The Älvsbyhus model, on the other hand, addresses those with a limited budget who are more inclined towards an easy transaction in which the product is well-defined. In other words, there is a limited number of pre-defined models to choose from, which have a high degree of prefabrication, and are sold as part of a contract in which the manufacturer takes on most responsibility (i.e. a design-build contract). The Myresjöhus model is characterized by flexibility, in that non-volumetric pre-assembly is used to combine pre-fabrication with on-site construction and enable some degree of customization. This model is thus positioned between

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6 There is a lack of consensus on what should be included in a design-build contract, with companies offering various degrees of responsibility for activities outside the house itself, such as the foundation (Melander et al., 2017).
the formerly mentioned ones, and compete with both, but itself addresses a wide segment of customers. The common aspects are the utilization of pre-fabrication, selling through their own channels, and offering houses across the national market regardless of geographical distance. Finally, the Fiskarhedenvillan model is somewhat of a unique case in that they (along with Varbergshus) sell a complete set of materials and components with no pre-fabrication shipped from their logistics centre in central Sweden, which is then fully assembled on-site. While they use terms such as house models, they also stress that all houses are uniquely designed. This puts them in competition with a substantial part of the market, with their smart purchasing and logistics solution giving them a cost advantage over other stick-built manufacturers and letting them compete against pre-fabrication models.

2.4 SUMMARY

Supply Chain Integration increases business performance by linking and optimizing the flow of material and information throughout the supply chain, beyond that of a single company. To achieve Supply Chain Integration, a company should first integrate its internal processes, before moving to integrate with supply chain partners. The strategies of external integration can be split into categories ranging from inward-facing, with no or little integration, to outward-facing, where a company is deeply integrated both with suppliers and customers. Companies tend to follow one of two routes when developing their integration strategy, and industry conditions have been shown to influence the degree to which companies tend to integrate. The integration strategies in turn consist of a variety of practices, that require collaboration between organizations. This leads to the first research question of this thesis:

RQ1: How does the Swedish wooden house industry approach Supply Chain Integration?

While companies may to some extent be aware of the benefits of Supply Chain Integration, the low degree to which companies have generally integrated has been criticized, prompting the question of identifying the factors influencing the ability and desire to integrate. The total propensity to integrate can be seen as the sum of its barriers, decreasing propensity, and its drivers, increasing propensity. As such, the barriers are the costs and risks involved in integrating, and the personal characteristics of those involved, which leads companies to act defensively. The drivers in turn are various environmental uncertainties that can be overcome by integration, and the internal characteristics of the company that leads the company to innovate in search for better performance. Placing this into the context of the chosen industry, the second research question is as follows:

RQ2: What factors influence Supply Chain Integration in the Swedish wooden house industry?

The Swedish construction industry has long been criticized for being slow to increase productivity, though one major solution has been to move processes from the construction site to the factory floor through pre-fabrication, which now accounts for 80% of single-house construction. The utilization of pre-fabrication enables processes to be standardized and reduces waste but requires some degree of integration with suppliers, a lack of which often being the root cause of problems. While pre-fabrication in general thus decreases cost, higher degrees of pre-fabrication comes at the expense of customization. The wooden house industry, just as the construction industry in general, is fragmented with a multitude of actors and business models, an industry structure that might provide resistance to integration measures.
3  METHODOLOGY

This chapter details and motivates the methods used to construct this thesis, starting with the underlying assumptions, from which the specific methodology of literature review, sampling, data collection, and finally analysis follow. The chapter will conclude with a discussion on research ethics and quality.

3.1  RESEARCH PHILOSOPHY

The basis for all research is its research philosophy, the assumptions on which it is built, which informs the later decisions on the design of the study implicitly, if not explicitly. The research onion, as presented by Saunders, Lewis, and Thornhill (2009) in Figure 6, provides a rough overview of possible design choices, that form the foundation of this thesis.

Since the phenomenon being studied is of a social nature, an interpretivist stance has been taken, emphasizing the fact that interpretations play a significant role in meanings given to social actors, roles, and phenomena (Saunders et al., 2009). To conduct research in the same manner as with inanimate object would therefore be inappropriate, as the nature of these are not affected by the subjective nature of human interaction. In other words, since what is being studied in this thesis is the interaction of organizations and individuals, it follows that the research philosophy must be suited for the study of these interactions, and not just easily replicable physical phenomenon.
The interpretivist ontological position maintains that social reality is socially constructed, affected by subjective interpretations, a product of language and shared meanings (Saunders et al., 2009). The epistemological base for knowledge thus becomes the subjective meanings and social phenomena observed in people. Finally, interpretivism makes the axiological statement that as social actors themselves, researchers cannot be separated from what is being researched, and whose values will invariably influence interpretations.

3.2 **Research Design**

To most appropriately conduct this study, the logic adopted was decided to be abduction. This type of reasoning differs from deduction and induction, which are usually associated with theory testing and creation. Deductive reasoning applies a rule R to a precondition A to reach a result B and is therefore used for theory testing (Menzies, 1996). Inductive reasoning finds the rule R by observing numerous examples of A and B, thereby creating theory. Abduction, on the other hand, is used to find the precondition A by applying the rule R to the result B. In other words, rather than creating or testing theory, abduction is used to relate new knowledge to previous knowledge gained through a review of previous literature (Svennevig, 2001).

As the precise nature of the problem is not clear from previous research, having introduced conditions from a specialized industry, an exploratory study is appropriate (Saunders et al., 2009). This type of study implies a degree of flexibility and adaptability, in that researchers are open to changing the direction of the study as new insight is gained.

A multiple case study was selected as the most appropriate method for collecting empirical data, using multiple sources to study phenomena within their context from a variety of perspectives (Robson, 2002). This method is qualitative in nature, consisting of data in a non-numeric form, created by processes that are interactive and interpretative (Saunders et al., 2009). Multiple case studies are commonly used to investigate the *how* and *why* aspects of phenomena and is as such an appropriate method for this study, the purpose being to investigate *how* the wooden house industry approaches Supply Chain Integration and *why* they do so. A review of available literature has already made it apparent which (the *what* question) frameworks are applicable to the situation, and the selection of the Swedish wooden house industry makes it self-evident *where* actions take place. *Who* specifically is conducting certain activities is not being mapped by this study. The answer to such questions are better acquired through alternative methods, such as experiments or surveys. Since the topic for the study is the industry, rather than an individual company, the method is not limited to a single case study.

The aspect of time can generally be approached in two ways, conducting the study as either longitudinal or cross-sectional. As the former implies investigating a phenomenon over time, a cross-sectional study was deemed appropriate, since the objective is not to track progress conducted in the field, but rather to learn of the current status of integration.

In summary, this study was designed as a qualitative, exploratory, cross-sectional multiple case study of Supply Chain Integration in the Swedish wooden house industry, interviewing industry practitioners on the current state of Supply Chain Integration and the reasons for integration strategy selection.
3.3 DATA COLLECTION

Any research requires data, whether secondary data collected from previous work, or primary data collected oneself. This thesis uses secondary data to build an understanding of the theoretical background to build a purpose and to form the basis for analysis, and primary data collected through interviews in order to find the specific answers to our stated purpose.

3.3.1 Reviewing the literature

The literature review provided the foundation for this thesis, giving a theoretical background to construct our purpose and to conduct an analysis. The material was gathered primarily using searches on Web of Science, a search engine for academic articles. In this endeavour, a focus has been to use well-cited sources, or alternatively if the articles were less than 5 years old, well-cited journals. In assessing the reliability of journals, the impact factor was considered, which with a few exceptions tends to be above a score of 2. The search terms used are detailed in Table 4. For background information pertaining to the industry investigated, sources were also provided by Anders Melander, an expert in the field. For the industry background specifically, using purely academic articles has not been appropriate, wherefore those sections contain numerous references to government reports and statistics, and research reports other than academic articles. The reason for this is that the information needed is too specific to have been sufficiently covered by academic articles, while the alternative sources referenced in this situation can be deemed sufficiently reliable. In reading articles, it has also been possible to retrieve more material from any relevant source literature, in essence using a snowballing strategy.

<table>
<thead>
<tr>
<th>Search stem</th>
<th>Boolean term</th>
<th>Combination term</th>
<th>Nr. Search results</th>
</tr>
</thead>
<tbody>
<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>benefit</td>
<td>6282</td>
</tr>
<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>information</td>
<td>2423</td>
</tr>
<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>physical</td>
<td>153</td>
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<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>sustainability</td>
<td>441</td>
</tr>
<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>barrier</td>
<td>199</td>
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<td>“supply chain integration”</td>
<td>AND</td>
<td>driver</td>
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<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>construction</td>
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<tr>
<td>“supply chain integration”</td>
<td>AND</td>
<td>“wooden house”</td>
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</tr>
<tr>
<td>“arcs of integration”</td>
<td></td>
<td></td>
<td>1783</td>
</tr>
</tbody>
</table>

Table 4 Summary of key search terms

The first idea of studying Supply Chain Integration in particular came from a short discussion with Johan Larsson, a lecturer on business administration at Jönköping International Business School (JIBS). This was combined with the already made decision to study the Swedish wooden house industry with mentoring from Anders Melander, associate professor of business administration at JIBS, and researcher in the Smart Housing Småland project. As one of the authors of this thesis had already written a thesis on this particular industry (Ruus & Odehammar, 2016), it felt natural to continue the collaboration. The bachelor thesis having provided an initial background, the first order of business was therefore to find basic information on SCI and current information on the industry, so that a purpose might be constructed. The literature review then grew to include the main aspects of SCI, the arcs of integration model, and issues in implementing integration. While initially placed first in the literature review, it was decided to place the industry information last, properly following the
funnel approach in structuring. Throughout the process of reviewing the literature, and through discussions with Anders, the purpose went through several iterations to ensure that a research gap was being covered, and that the thesis would produce something of value. As empirical material was analysed, more literature was procured for use in the analysis section. At its core, the methodology is based on Saunders et al. (2009), and is supplemented by academic articles when more detail needs to be provided.

### 3.3.2 Empirical data collection

In line with the exploratory nature of this study, several semi-structured interviews were conducted to gather data (Stake, 1995; Saunders et al., 2009). Semi-structured interviews are built upon themes for discussion and pre-determined general questions that researchers need uncovered (DiCicco-Blom & Crabtree, 2006). The intent is to motivate participants into free discussion and contemplation, so that the investigated themes can be expanded and elaborated upon without narrowly focusing on specific questions. Thus, the interview is conducted using a topic guide, in which the questions are covered but treated more as a discussion, giving space to cover topics more in depth as they come up. The topic guide used is attached as Appendix A, and is constructed as a composite of survey questions used by Frohlich and Westbrook (2001) and Schoenherr and Swink (2012). As these questions were used to classify companies into SCI strategies, they were appropriate as a baseline for our own topic guide, and were supplemented to include the reason for each answer. Finally, interviewees were asked how they perceive future development in integration for their company. Using semi-structured interviews enabled new insight to be gained throughout the session, leading to improvised questions that gave a thorough understanding of each individual case. As it would turn out, the original topic guide questions did not always make perfect sense in the context of the direction the study would finally take, but the open-ended nature of the interview approach would serve to give valuable and appropriate data regardless. Further, the topic guide was not used in its entirety for all interviews, as asking for instance suppliers about their level of internal or supplier integration was not relevant to this study. The questions were therefore selected and adapted to work in the context of each interview, serving as a guide for conversation and not necessarily being read literally.

In setting up the interviews, meeting face-to-face was the preferred method, as in doing so, participants are more likely to open up to the conversation at hand, promoting a creative discussion which improves the quality of data (Saunders et al., 2009). The exception was two interviews conducted over phone, being more convenient at that stage of the study. One of the authors of this study not being proficient in Swedish, some of the interviews had to be conducted in English. Potential participants were asked ahead of time if they were willing to conduct the interview in English, in which case both authors could participate. In those cases, one author would head the conversation while the other took notes and observed the interviewee. Where the participant was unwilling to conduct the interview in English, only one of the authors would participate, the interview instead being conducted in Swedish. The collected data was subsequently translated to English to enable processing and presentation.

### 3.3.3 Sampling method and access

For the data collection it was decided to mainly follow a purposive sampling method. In doing so, suitable interviewees and cases were found in order to meet the objectives and to further answer the research questions (Saunders et al., 2009). As such, house fabricators were selected with a special focus on trying to get representatives from each business model as identified by
Melander et al. (2017). Elements of a convenience method were also utilized, in that locations close to Jönköping were preferred, which heavily influenced the selection of sales agents and contractors. The addition of agents, contractors, and supplier was a later idea, the intention being to get multiple perspectives throughout the supply chain in addition to the focal firms themselves. Table 5 summarises the sample of all conducted interviews. Industry experience here refers to experience in working with or within the wooden house industry, a question that was asked in most interviews.

<table>
<thead>
<tr>
<th>Company</th>
<th>Name</th>
<th>Position</th>
<th>Industry experience</th>
<th>Interview type</th>
<th>Date</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
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<td>COO</td>
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<td>Face-to-face</td>
<td>08/03/2018</td>
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<td>Vimmerbyhus</td>
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<td></td>
<td>Mikael Eriksson</td>
<td>CLO</td>
<td>22 years</td>
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<td></td>
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<td>Götenehus</td>
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<td>Pontus Eklind</td>
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<td>BMI Group</td>
<td>Kristian Stenfelt</td>
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<td>23/01/2018</td>
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<td>Klas Fridsäll</td>
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<td>Fredrik Gustavsson</td>
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<td></td>
<td>Face-to-face</td>
<td>25/04/2018</td>
<td>16m</td>
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Table 5 Conducted interviews

Potential participants were contacted by phone, through which a time for the interview could be agreed, if the candidate was willing. On occasion, this planning took place in a follow-up mail conversation. Further, two of the interviews were conducted entirely by phone for reasons of convenience. Of the 14 house fabricators contacted, 4 explicitly declined, 4 failed to reply after having accepted and having been sent a mail, and 6 were successfully interviewed. All 3
suppliers contacted were successfully interviewed, with an additional 4 that were found at the Nordbygg construction industry convention in Stockholm. Of 5 contacted sales agents, 4 were successfully interviewed. Interviewing contractors proved more difficult, as only 1 out of a contacted number of 6 was successfully interviewed.

3.4 ANALYSING THE EMPIRICAL DATA

The interviews conducted were recorded and transcribed, which yielded almost 60,000 words of data. To systematize the data into something manageable and appropriate for analysis, the method of content analysis was used, described by Cavanagh (1997) as a technique which distills textual content that share meanings and purpose into categories to facilitate analysis. These categories can come from previous theories, the research questions, or from the data being analysed (Easterby-Smith, Thorpe, & Jackson, 2015). The specific method for achieving this was using a process of coding, whereby quotes were given tags and sorted into categories. The first step was to do an initial sorting of all data into general categories to facilitate the coding process, created by applying a general understanding of the topic gained from previous literature, colouring text as appropriate that would then be moved into separate documents. Within these categories, quotes were given codes to signify specific meanings. Next, a table was created where codes were presented within their respective general categories. In doing so, the codes could be further sorted into subcategories, and moved around to reform the general categories to better fit with the collected data. Quotes were then able to be moved and sorted according to the sorting conducted in the table and refined to become the results chapter of this thesis. Thus, the headings found in chapter four is a direct result of this coding process, which is illustrated in Figure 7. Having compiled the results of the study, the analysis section could thereafter be written, building upon the result and the findings of previous literature. Finally, a conclusion was written to summarize the findings of the thesis and provide insight for future research.

3.5 RESEARCH ETHICS

The choice of whether or not to keep the identities of participants anonymous varies depending on the purpose and goal of the research (Vainio, 2013). Social research is very context dependent, with anonymity being appropriate in some circumstances to protect the participants. Vainio (2013) notes that the granting of anonymity can empower participants to speak openly about the investigated phenomenon without fear of reprisals or other negative consequences. The disclosure of identity does not necessarily contribute to the result of the study, and might in fact have a negative effect. The personal gravitas of individual participants could serve to influence the perception of the study by the reader in an unwanted way, legitimizing anonymity as a way to ensure focus on the actual results rather than the individuals that have contributed.
Further, there is a possibility that the disclosing of identities will lead researchers to take a less critical approach in analysis as a way of protecting participants.

On the other hand, Vainio (2013) argued that it is difficult to identify what the actual harm would be in revealing the identities of participants. In some cases, in fact, doing so will increase the visibility of the study, using the personal notoriety of participants to elicit public interest (Wiles, Crow, Heath & Charles, 2008). Further, some participants can be practically impossible to keep anonymous, due to the specific nature of the study and their identity. Regardless, researchers are advised to discuss the issue of anonymity with participants, as it should ultimately be their choice.

For this study, participants have for the most part been identified in Table 5, as a way of ensuring research trustworthiness, as discussed below. However, the identities have only been disclosed in the presentation of results and discussion if it served the purpose of furthering the purpose of the study, as to constantly refer to the identity of participants would be superfluous and might cause harm. Participants were asked whether or not they wanted anonymity, to which most declined.

3.6 Research Trustworthiness

Research trustworthiness is the concept applied to address the quality of the chosen methods in a given study, suggested by Lincoln and Guba (1984) as necessary to ensure research solidity, and consists of four elements.

The first element is that of credibility, ensuring that the constructed realities of researchers and study participants are aligned, participants recognizing presented data as conforming to the context in which they operate (Lincoln & Guba, 1984; Sinkovics, Penz, & Ghauri 2008; Sandelowski, 1986). Credibility is argued as being established through the use of triangulation, i.e. the use of multiple sources to gain deeper understanding of the phenomena, and a clear presentation of methodology (Lincoln & Guba, 1984; Cope, 2013). Credibility in this study is therefore established through the use of a multiple case study method, in which a multitude of sources were consulted, and a detailed methodological chapter.

The second element is transferability, which refers to providing adequate detail in the description of a phenomenon, ensuring that findings can be applied to other contexts than that specifically described in the study (Lincoln & Guba, 1984). It is hoped that the detail provided in this study will enable the reader to gauge whether findings can be applied to their respective context.

The third element is dependability, relating to the consistency and repeatability of findings, ensuring no obvious data errors by conducting the study in a trustworthy way (Lincoln & Guba, 1984; Jacobsen, 2009). Given a similar context, the study should consequently be able to be conducted again with similar results (Richards & Morse, 2007; Koch, 2006). The use of semi-structured interviews does little to ensure repeatability of results, in that the personal characteristics of interviewers and interviewees, along with environmental factors, influence the progression of interviews beyond the topic guide, and thereby the outcome. Providing said topic guide, and a description of conducted interviews, helps alleviate this, in that repeat studies can approach similar conditions.

Confirmability, the final element, concerns the degree of neutrality of results, ensuring findings are formed by participants rather than the biases of the researchers (Lincoln & Guba, 1984).
Hence, interviews were conducted in such a way as to avoid the steering of interviewees into preconceived conclusions, and quotes were provided to present participant responses without analysis by the researchers, as recommended by Cope (2013).

Another aspect to consider is that of authenticity, described by Polit and Beck (2012) and Cope (2013) as accurately presenting the sentiments and feelings of interviewees. In effort to do this, quotes were translated and paraphrased in such a way as to as closely as possible represent what participants expressed in the interviews.
4 EMPIRICAL FINDINGS

In this chapter the empirical material collected through interviews will be presented. The material is presented according to the categories found in the coding process, described in the methodology chapter, and is displayed as a combination of summarizing text and quotes.

4.1 INDUSTRY CHARACTERISTICS

4.1.1 Supply chain structure

If not already apparent, the process of buying a house is far from straightforward. If one were to consider all components constituting a finished house, even without furniture, most of the value is in components procured by the house manufacturer and assembled along with the house structure. The material actually being manufactured and supplied by the house factories themselves, according to one manufacturer, constitutes only about 20-25 percent of the final material value, the rest being added on to the product at various stages of construction. In this sense, the use of volumetric prefabrication moves this assembly from the construction site to the factory floor and eliminates many activities that would otherwise be conducted by specialized subcontractors, such as electricians. According to TMF, volumetric prefabrication also tends to be synonymous with Design-Build contracts. However, one interview revealed some confusion as to the meaning of the concept of Design-Build. That is, whether to call it Design-Build if the foundation is not included, or to call it a general contract, despite the complete house being provided within a single contract with the house manufacturer itself. For the purposes of this thesis, Design-Build will be defined as the house manufacturer providing a complete house within one single contract, regardless of whether or not the foundation and peripherals are included.

The supply chain for any given company will thus be contingent on a multitude of factors, in that the mode of prefabrication and construction contract type will influence contracting with partners, and the routing of physical flow. It is interesting to note that some material suppliers are not always in the same chain as the house manufacturer, despite delivering to the same project, and thereby contributing to the final product. One such example is that of ceramic tiles, which will usually only be delivered to the house company if they are building volumetric, in which case they also have a contractual relationship. In other cases, the tiles are to be put up on site, and will therefore be delivered to the tiler, or directly to the construction site. This may or may not entail a contractual relationship with the house manufacturer, as tiles might be procured by other actors. With a Design-Build contract, the contract will likely be through the house manufacturer, as a finished product is delivered to the end customer, with the customer in the case of Konradssons going to the local tile outlet for product selection. Should the contract not be with the house manufacturer, it could instead be with the tiler, or a floor distributor. According to one house manufacturer, contractors will sometimes try to entice end customers to buy tiles through them by indirectly lowering the price of construction. Willa Nordic, who design and manufacture highly customizable houses, also revealed another quirk of the industry, in that they will often have customers bringing their own material to the project.

Having understood that there is a degree of complexity to how any given supply chain will be designed, one can start looking at the industry’s connections with upstream actors. Starting with second tier suppliers, interviewees described it as necessary by the house manufacturers.
in the cases of some products to be in contact with the original product manufacturer. Thus, in the procurement and selection of wood treatments, a house manufacturer might join their wood supplier in discussions with the treatment sub-supplier. Another example would be directly contacting the manufacturer for window and door handles, who will know more about their product than a distributor or supplier of doors.

The range of suppliers in the supply chain depends on the degree of customization, with house manufacturers with customers keen on customization often having to buy specific products with suppliers they have no other relationship with. To keep costs down, contracts are written with key suppliers to create a base model, with cheaper components due to the increased volumes. Some companies are vertically integrated with part of the supply chain that supplies base building materials, like A-hus/Derome through their ownership of saw mills, or Vimmerbyhus, who co-own a wood distributor. Much material is consolidated at the house manufacturer before delivery to the construction site. Like ceramic tiles, however, some materials are routed directly to the site, especially if volumetric prefabrication is not utilized. Such tends to be the case with roof tiles, which will have to be mounted on a finished construction. In the case of kitchens, the supplier will often handle most of the contact with the customer, delivering a complete kitchen to the construction site:

"In the add-on process the kitchen supplier is pretty much our best sales force. Partly because kitchens are the part you’d pick the most add-ons for, people don’t usually leave there without adding something."

Looking downstream, we can also see a degree of variability between manufacturers. Although some companies utilize an in-house sales force, sales are often brokered through independent sales agents. In these cases, customer contact is mostly with the agent rather than the company itself, which is not readily apparent to the customer, with agents acting as the face of the company. Further, if the contract is not Design-Build, the agent will also act as the point of contact between the company and the contractors. In Design-Build, the company will have their project managers taking over the contracting responsibility from the customer, and will serve as the direct contact between company, contractors, and the customer on question relating to the construction phase, assuming all responsibility. Some companies are vertically integrated with the contractor and will utilize its own personnel if the construction site is within geographical range. In a trades contract, the end customer themselves will have to manage the contractors but will have them recommended by the agent. For contracts not handled directly by the manufacturer through Design-Build, one house manufacturer described the contractor relationship as being managed through a dedicated department. The relation is created on the basis of a gentlemen’s agreement rather than a contract, wherein the manufacturer recommends the contractor to customers in return for the contractor living up to the manufacturer’s standards. The customer itself might be either an end customer or a developer, buying several houses for brokering or renting to end customers. Some companies have this function vertically integrated and assumes the role of land procurement and development. The relationship with the end customer was described as comparatively long, considering the length of the purchase and construction process, and that a finished house will have to be inspected quite some time after completion.
Figure 8 illustrates how the selection of prefabrication method and construction contract type influences the supply chain structure. Note that the examples simplify actual supply chain structures, and do not take into account for instance subcontractors or sales agents, who would add extra layers to the image.

![Diagram showing supply chain structure for volumetric prefabrication with Design Build contract and non-volumetric prefabrication with general contractor.]

**Figure 8 Examples of the effect of prefabrication and construction contract selection on supply chain structure**

### 4.1.2 Market power

Participants expressed a distinct lack of suppliers for many of the components required to deliver a finished house. While raw construction material, i.e. wood, is abundant and companies often have several concurrent suppliers, in other areas key suppliers are down to a selection between two or three major suppliers in the market. In the market for heat pumps, the manufacturer NIBE has a de facto monopoly, supplying virtually the entire wooden house industry. Often the lack of suppliers is caused not by the lack of actors per say, but the lack of capacity. Such is the case of stairs, which are easy to procure as a private customer, but not at the volumes required for mass production of houses. In this sense, even large suppliers might have problems filling orders. Given the lack of suppliers, house manufacturers tend to stick to suppliers for comparatively long periods of time, noting that switching will not guarantee improvements, as the competing suppliers often work in similar ways. The changing of suppliers is further complicated by the fact that new suppliers could be unable to deliver products to the same specifications as what has previously been marketed, which may for some products be a question of branding. The limited market also makes formal tools superfluous:

‘There’s a limited number of suppliers, and everyone knows everyone. If I need a supplier of ceiling panel, I’ll know the best three on the market with two calls, and I’ll know everything about them.’

The market for contractors, on the other hand, consists of a vast number of local actors, where at least one per city or village might be contracted to build houses. Despite this, the absolute supply of contractors is a bottleneck for house manufacturers, who can struggle to find the manpower to construct their houses.
The question of buying power was a recurring theme in discussing barriers to external integration, in that the house manufacturers do not feel they are large enough clients to have the influence required for closer integration. Likewise, large suppliers perceive their customer base to be too large to merit closer relationships. Thus, the fact that house factories tend to be an underdog in terms of market power hampers their ability to integrate. One company also expressed a fear of becoming too dependent on a supplier through integration, with a supplier also noting that house manufacturers may avoid investing in relationships if they feel they can save money by sourcing from multiple suppliers. In addition to the small relative size of a company hindering integration with larger actors, a small absolute size limits the resources available for improvements and integration. However, while sales volumes might grant preferential treatment, it does not automatically mean more time will be invested in the relationship by major suppliers, as one supplier noted:

“Time is an issue, because I have 60 or 70 customers, so I have to share the time between all of them, and it’s not like the biggest company takes up the most time - maybe it’s a smaller company because they don’t know what to do.”

4.1.3 Market volatility
The construction industry in general was presented as very sensitive to the business cycle, often leading to extreme changes in revenues in relation to other industries. One participant described how revenues would increase tenfold from bust to boom and then shrink again with the same magnitude. Further, one participant expressed an aspect of seasonality, with summers experiencing more construction activity. The volatility of the construction market has very noticeable consequences for the supply of contractors in the market, with house manufacturers losing control over their selection of contractors when the market booms, as contractors become unavailable. This has led house manufacturers to prioritize giving work during busts to those contractors who prove competent, to ensure they stick with the manufacturer when construction projects become abundant. While busts give manufacturers more control in selecting contractors, the lack of customers do force some to make concessions, unable to stick to core activities by refusing customers. The resulting changes in revenue brought on by the business cycle can be massive, limiting resources devoted to improvements, and changes the power dynamics vis a vis the contractors:

“Yes, we’d want to [ensure contractors are properly educated], but suddenly there’s a market boom and it’s hard to find builders. Then you’ll just have to take who you can get.”

4.1.4 Product characteristics
The product itself seems to have some characteristics hindering integration both internally and externally. Standardization is an issue, with products often being flexible and customizable, and even if not are subject to local conditions:

"But there are still different terrain conditions, so it might not be the same house, despite it being the same. After all, we don’t spit out things to put in a box."

Further, the complexity and nature of the product as a collection of ready-made components and furnishings limits the house manufacturers in the influence they have over individual components:
“A lot of what we put in the house are giant industries in and of themselves, who are good at developing what the customers want, and in a sense they’re just things we put in our house frame. So getting involved in everything a house consists of seems impossible, if you consider what’s actually included.’’

An agent noted that much of the brand is in the agent’s competence, which will have to be sold to the customer along with the product itself. Customers are often perceived as being unreasonable in their expectations, coming up with unrealistic designs, or expecting unrealistic results:

“If you’re building a house in wood, it’s going to made of wood. Wood is a living material. We had a lot of discussions with a customer about wooden panelling, which had twigs. Of course it does, it’s wood. If you want plastic panelling, get plastic. They can use a flashlight on a wall and say it’s not completely straight. It’s ridiculous.’’

The subject of brand was also brought up in the context of who the buyer perceives as the seller. In the case of a customer buying a property through a real estate agent, one interviewee noted that the customer might still feel they are buying from the house manufacturer. There is an aspect of responsibility here, with a contractor joking that when a house turns out well the contractor is responsible, but when something is wrong it is the fault of the manufacturer. The perception of customers that the house is still a product of the house manufacturer, regardless of who assembles it, was often mentioned as a driver of collaboration with contractors, to ensure a high standard of results and behaviour. Agents also noted the similarity of offers between companies, with some tendency of confusion among customers, and a propensity to overlook what is included when considering the final price. There is a possibility of obstacles, such as ground conditions preventing construction when the project has already begun.

4.1.5 Performance metrics

Most of the interviewed house manufacturers track customer satisfaction in some manner. Common methods in the industry for tracking customer satisfaction includes NKI (Nöjd Kund Index, or satisfied customer index) and a survey by the consultancy firm IMA, with the latter providing the ability to compare results against the industry standard. Other than customer satisfaction, there was a sense of difficulty in being able to accurately measure performance among some interviewees. Using metrics that make sense to employees and provide a good basis for analysis was an issue here, and one interviewee noted that the project-based nature of the industry makes measurements less than straightforward:

“It’s not a homogenous industry, we can sell a house in a town for three and a half million that would cost four and a half in a city just because of the property prices, but that doesn’t mean we get a certain margin on that extra million. But somewhere you’ve just asked if it feels ok and matched it against the market price. We used to have metrics for the material part of the cost, but we don’t anymore as it’s too hard to measure when we have contractors etc. and it’s just too hard to see what the price includes, it just gets too arbitrary. That just leads to errors. Obviously, we measure operating margin, but even that’s pretty rough.’’

4.1.6 Mindset

The mindset of the industry was often quoted as a barrier, most commonly being referred to as traditional, in the sense of companies being unwilling to try new things, claiming that it has already been tried, or sticking to old behaviours for no apparent reason. Some mentioned a
willingness to move towards more integration, but that the current organization of the company was very traditional. One interviewee also noted that many companies in the industry, particularly contractors, tend to not be that professional, and required extra care in ensuring that potential partners are capable and economically fit. Another aspect of a faulty mindset is a failure to see the big picture of the company. There seems to be a tendency for industry members to have stayed within the industry for relatively long periods, thus limiting exposure to other industries. One supplier felt disappointed in the industry’s ability to plan:

‘‘It’s an industry that is bad at planning, they really have no sense of foresight, and when they call to ask for delivery and you ask them when, they want it yesterday.’’

There are no formal tools used for purchasing decisions, one interviewee describing his initial surprise at the lack of theoretical models in use in the construction industry. While interviewees were more or less familiar with the term Supply Chain Management, it is not a widely used concept in the industry and often lacks a proper definition. The concept of SCM is new to the wooden house industry, some noted, with the interviewee adding that different industries use different concepts. Further, common strategic plans at the supply chain level was not something the interviewees seemed familiar with. However, most interviewees recognized that closer integration would have various benefits, often in terms in direct performance improvements, with increases in quality and efficiency. As one interviewee noted:

‘‘We’ve pushed our saw mill a lot on the aspect of quality, which is outstanding today compared to what it was like earlier, when we’d have to throw away 10-15% of all wood. By the time you’ve realized a piece of wood is defective, you might’ve even gotten as far as to cut it, and then you’ve lost half an hour of work. Now we only waste maybe 2-3%, which translates to enormous savings.’’

4.2 INFORMATION FLOW

4.2.1 Access
Granting access to internal IT-systems, or implementing EDI, seemed to be the exception rather than the rule among participants, most sharing systems neither downstream or upstream. In the cases where this is allowed, access means the ability for outside actors to see forecasts and information related to on-going projects, such as blueprints. An aspect that seemed to be commonly considered is the digital communication of project status to the end customer, letting them see at what stage of production their house is. It was argued that allowing customers access to IT-systems in this way would improve communication, and decrease time spent on manually tracking project status upon the request of the customers. The access of the house companies to the systems of others was also very much a rarity. Given the formal status of agents as external actors, the question of agent access is an interesting aspect, with some companies allowing agents full access and some none. One agent explained the drawbacks of the lack of access:

‘‘We get a weekly newsletter with terrible information. How many deals have been made, if someone’s on maternity leave, pretty much. What is the budget, what is the result, how’s the company doing? Because I don’t know. But if the customer asks I have to tell them something, I can’t tell them I don’t know.’’
Two quotes were found to illustrate different perspectives on the question of secrecy in regard to access. On the one hand, one company claimed too many doors had to be shut for it to be effective. One the other, another company gave different levels of access depending on the type of partnership, but noted that most information is not of a sensitive nature, considering the type of product that is sold:

“I don’t see what’s so dangerous about it. Most customers only buy a house once, it’s not like a competitor can call our customers and offer them a better deal if they know who we’re delivering to. It doesn’t work that way. You could conceivably lose some product development, but nothing is really revolutionary in this industry. If I want to know how a competitor builds their houses, I’ll go and look at one. It’s not hard to figure out.”

Internally, most companies had systems set up with the requisite information for production accessible to those using it. It was noted, however, that the access given by A-hus to other Derome Group members has its disadvantages, as in-group suppliers would sometimes base their delivery decisions on a faulty understanding of the available information. In another case, a company was still in the process of implementing an internal IT system, though in the meanwhile information on individual projects was collected in a physical binder, accessible only at the head office, or by calling the responsible manager:

“The only way to access it is to talk to the manager or someone in production. Most information is in the binder, in the computer there’s not that much. … We search for the binder a lot.”

The compatibility of IT is an issue, in that the use of disparate systems creates barriers to information sharing, or as one supplier put it:

“Everyone uses different systems, it’s an enormous challenge. If everyone would use the same system it would probably be easier, but then we have to tailor the system to the product, so I guess that’s the real challenge.”

4.2.2 Method of communication

Information regarding projects are communicated internally through both formal and informal channels, often described as an even mix, with the choice of method said to be contingent on physical distance, or the size of the company. One respondent highlighted the importance of correct choice:

“I think we’re an industry in which mistakes often have large consequences, and we often make a lot of mistakes. A success factor is avoiding these disasters, because if we make a bad deal it can turn out really bad. When things go wrong it can be like a never-ending resource sink, fortunately it doesn’t happen that often. But when it happens it’s often because you’ve underestimated the importance of information, both the digital and the verbal. I think there’s much to be gained from spending some extra time there.”

Informal communication with outside actors is mainly through phone, being a convenient way to get quick responses. Weekly meetings are often held internally to discuss issues between management and various departments, while supplier meetings are held with varying frequency to evaluate performance. Barring access to IT-systems, email can be used to transfer more formal information:
"Yes, some information is good for the suppliers to know, I believe we give them access to our delivery plan, we do that today, but in a manual way by sending them an excel file to look over. This is to see what is upcoming for the next six months for the kitchen supplier, stairs and for those suppliers that have problems in planning production and delivery weeks."

Various IT systems are in use by the companies, often using different systems for different purposes. In the case where companies used an integrated IT solution, it was presented as a convenience as different functions can have full visibility over the projects they are working on, with one company striving to eliminate the use of paper so as to centralize information. The issue of cost was raised by one interviewee, in that expensive systems cannot be invested in without the requisite resources. It was mentioned that the increasing rate of digitalization in terms of communication methods was a driver for integration between actors. This was also mentioned in the terms of market transparency, as increased customer awareness of market offers due to the advent of the internet was a driving force of integration to increase competitive advantage in the face of increased competition.

4.2.3 Internal collaboration
Participants presented a degree of compartmentalization, with functional areas not working as cross functional teams, but rather sequentially, with various degrees of smoothness in transitions. While this was mostly expressed as working well, some difficulties were perceived to arise from the fact that functional areas did not always have a holistic view of projects, despite having access to project information, thus potentially leading to costly mistakes. Therefore, some argued that the prevention of a loss of information because of poor communication between divisions was a reason for wanting to increase internal integration. Spatial distance was perceived by some to be a contributing factor, limiting ease of communication and disrupting the sense of team. One interviewee described a lack of maturity and internal integration as a limiting factor in integrating with other actors, expressing a need for process improvement before deeper collaboration with partners could be achieved. Another issue that was brought up was the fact that agents, as formally independent actors, might have a conflict of interest, but that this was usually rare and very much dependent on the person. One company expressed some interest in employing cross functional teams:

"I think in the beginning we’d want to work across functions, to design the house so it’s adapted more to all involved teams. That way it’s adapted already at the point of conception, so that it’s easier to deliver, because we’ve planned properly from the outset."

4.3 Physical flow

4.3.1 Procurement process
While different methods for purchasing were detailed, companies most commonly have inventories of basic construction materials with which to fabricate their building blocks, a notable exception being that of Fiskarhedenvillan, who simply package incoming materials rather than manufacturing building blocks. In general, inventories were described as being comparatively small, with short turnover cycles. The responsibility for stocking this inventory differed from company to company, with some having it be managed by a purchasing department, others by the factory or other departments. With building blocks produced from bulk inventory, specific items for each house are often purchased on a per project basis. Thus,
one company described their procurement process as being partly based on stock levels in their IT-system, and partly on purchase orders for project-specific items.

One interviewee noted that buying products by bulk has the benefit of being able to control transport, which is a risky stage and can lead to considerable delays considering the lead times, but that buying bulk requires a great deal of standardization. A base package was mentioned as a way of using standardized items, even though the customer might have to option to pick unique items. Standard items can then be stocked, or procured for a lower price using negotiated rebates, while unique selections will be more expensive. However, it was also mentioned that despite having a standardized house and procurement list, suppliers would still make mistakes in delivery at a rate far greater than mistakes made on the production line.

Willa Nordic mentioned how they will often procure unique items from suppliers they have no relationship with, while Fiskarahedenvillan noted how all of their purchases were essentially customer unique, with supplier contracts worded in very general terms, avoiding mentions of quantities or even specific products. A house manufacturer may also procure some items and materials from the contractor. In the case of ceramic tiles, house manufacturers might decide a standard selection based on sales numbers from the tile supplier from which the customer can decide on by visiting a local tile outlet, or order non-standard and pay the difference. Similarly, the kitchen is often ordered through direct contact between the customer and the supplier, with relatively little involvement by the house manufacturer.

Purchases are planned after the known delivery lead times of the supplier, with orders made to minimize the time spent at the warehouse before consolidation and delivery to site. House manufacturers tend to get delivery guarantees from key suppliers, defining the length of delivery times, as delays will have large consequences for the production line and may end up halting production entirely. Purchase orders are also contingent on the customer being finished with selections, as lead times tend to be long. It is, however, not unusual for customers to change their minds and request design changes after selections have been made, the accommodation of which entails disrupting the planned workflow. Such occurrences are one influencing factor in companies deciding the completion level of their building blocks, as one interviewee pointed out:

‘Something that is often discussed is that when our walls arrive, the builder will have to add components to it, that our competitor has already pre-assembled in the factory. Obviously, that takes time, so the builder would prefer it to be pre-assembled. But then the customer suddenly decides they want to move their TV, so you’d have to tear down the wall to move the power outlet. So, should you let the customer discuss it with the electrician before they start drawing wires, or should you try and do it on a blueprint, which is a lot harder?’

Before purchases can be made, blueprints and plans will also have to be submitted to the government for approval. One house manufacturer did note that since they had several suppliers for each item, they did not feel like they had to take their capabilities that much into account when planning. Conversely, another manufacturer criticized the inability of some suppliers to manage purchase orders:

‘It’s normal in this industry, which really frustrates me, that if I send a purchase order well in advance, maybe months before it’s even needed, the supplier will wait until the last minute
The approach to forecast sharing differed across the industry, with suppliers asking for different time frames to be shared. While one house manufacturer claimed forecasted sales were shared upon request, another mentioned that only very rough estimates were given in connection with price negotiations, and that they were not perceived as very meaningful. A supplier noted that the long process required to build a house from conception to finish enables the house manufacturers to share forecasts for current projects well in advance. A house manufacturer explained that some suppliers need detailed information on each project, and that this was given along with delivery forecasts to key suppliers.

The process for evaluating supplier performance and selecting partners differed slightly across the interviewed companies, but house manufacturers generally described contract negotiation meetings on at least an annual basis, in addition to changing those suppliers who in obvious ways do not fulfil their obligations.

4.3.2 Delivery process

There is a great deal of importance in that the construction site is prepared to receive items and materials upon delivery. Materials such as indoor or roof tiles are extremely heavy in bulk and is moved only with great effort. Items that are meant for indoor use risk damage if delivered before the house is safe from the elements and will only be in the way if preparatory work needed for installation is not complete. Appliances and heat pumps are highly valuable and will be delivered as close to installation and final inspections as possible, or risk being stolen. Conversely, late delivery of products to the construction site may entail large expenses in wages and equipment rental as construction crews are left to wait. For some construction material, like roof tiles, time required for consolidation of shipments for delivery is hard to estimate due to the size of shipments. The fact that some customers want to undertake some of the construction personally further complicates planning, as it adds an aspect of unpredictability in time estimation. While JIT was often mentioned as an ideal to strive for, it was not discussed in terms of having been achieved. One interviewee contrasted the relative inability of the construction industry to plan deliveries with other industries:

“In other industries things like delivery precision might often be more important than quality. In the construction industry you often ask which day a delivery will arrive, whereas in the pharmaceutical industry it will arrive on Wednesday at 2 o’clock. And if it doesn’t arrive at 2 o’clock the supplier’s in big trouble.”

Packaging methods was mentioned as an area of potential collaboration and improvement, as current methods are sometimes seen as an inefficient use of time and resources. One house manufacturer lamented the unwillingness of a supplier to collaborate on this issue, causing them unnecessary expense and risk:

“I don’t know what the future is going to be like, but they’re not willing to change. They can’t handle transportation directly to the construction site, but if they did we wouldn’t have to unload, repack, reload, and transport with all the risk of damage it entails. We just want to avoid having to flip things over and damaging them by having better packaging in the first place.”
The use of third-party logistics companies varied between house manufacturers, although external transport services were commonly used for direct supplier deliveries to the construction site. For deliveries of house building blocks, some manufacturers have their own vehicles, although one interviewee noted that it was almost certainly unprofitable. While many use the services of major logistics companies, an issue was brought up concerning the relative inability of these to follow routines, causing damage to the transported products. As far as transport optimization, only one interviewee remarked that their logistics flow had been optimized by their transport provider. Conversely, a supplier mentioned that synching transports with the house manufacturer might be difficult considering deliveries cannot be made simultaneously, as if to do so would cause problems at the construction site. Therefore, the supplier and its customers would not share logistics providers.

4.4 **PRODUCT DEVELOPMENT**

The wooden house industry has been described as being far from innovative in terms of product development. It was mentioned that the market mechanism plays a large part in developing products, in that development is simply based on what is being purchased. TMF noted a surprising lack of collaboration on development between house manufacturers and suppliers. One interviewee contrasted the industry to the automobile industry, where the manufacturers are more active in driving development of components. Rather, developments in the industry tend to be incremental in nature, limited to small improvements in the manufacture of building blocks, or changes in the design of items. To this end, one house manufacturer mentioned how they work with lean activities in production, holding worker meetings to discuss possible improvements. While expanding this line of thinking to collaborations with supply chain partners was not being done, however, another interviewee made the point that despite them not working with lean principles per se, they collaborated on incremental improvements with suppliers.

A key reason for collaboration on development is to make assembly easier. Elitfönster, for instance, have been asked to adapt products to optimize assembly in house factories, but noted that their products are currently designed to fit a wider range of customers and project types. Further, the interviewee noted that closer collaboration with the customers could yield results in better adapting products to the houses, but that large builders that have tried it had historically had poor results. One example was given of a supplier investing in machines to cut wood to the exact specifications of the house company, although this type of investment seems uncommon for the industry in general.

Complex assembly requires of contractors a great deal of competence, and frequently leads to errors and failed inspections, which drives contractors to collaborate on matters of assembly with house manufacturers. Utilizing in-house builders or Design-Build contracts, where builders are managed directly by the house manufacturer, was said to increase the rate at which contractor experience can be absorbed into building block design to optimize assembly. One interviewee noted, however, that optimizations will have to be balanced between the factory and the construction site, noting that reductions in time at one stage might lead to increases at the other. For the same purpose, house manufacturers also sometimes offer education and assistance on-site, so that contractors may familiarize themselves with the building block systems. Beyond optimization of assembly, however, there seems to be little collaboration between house manufacturers and contractors on product development.
Energy regulations was often mentioned as a driver of product development, putting ever stricter demands on components, and driving costs higher. For instance, NIBE collaborates with the biggest house manufacturers to improve performance and compatibility of heat pumps and houses. The products manufacturers participate most in designing are those related to the building blocks rather than later components. Thus, a key area where the house manufacturers are involved in improving energy efficiency are the walls themselves, requiring the involvement of isolation and wood supplier, although wood itself has very few developments.

In terms of item and component design, there is some collaboration between house manufacturers and suppliers. Manufacturers for door and window handles, for instance, often get requests from house manufacturers to make changes to colouring, or to adapt foreign products to Swedish locking mechanisms. Consultants and architects feature heavily in designing and developing some products, architect-designed sinks for instance possibly becoming standard equipment after discussions with the purchasing department. However, for many products, like appliances, suppliers seem less than interested in designing bespoke products to fit the wooden house industry.

For house design, the customers and their architects are a driving force in design and development, with customer expectations and demands pushing the boundaries for what is possible. However, these demands create issues when they do not easily fit the rest of the design, or when products turn out problematic, with the house manufacturer still being held responsible for the end result. One interviewee explained that customer demands for unique designs was causing the company millions in losses when the designs turn out to cause problems. An agent also commented on how expectations are often excessive in designing houses:

‘‘We have a dilemma there, because no matter your profession you think you’re able to design a house. It’s strange, why do everyone think they know exactly how to design a house, that they know exactly what they want? Even if you’re 25 years old. We have to accept that, but it’s kind of funny. We have architects who are highly educated and experienced, and in comes a 20-year-old and tells them how he wants his house, that he knows best and if he doesn’t get it he’ll go somewhere else.’’

4.5 Summary
The results of the empirical study can be summarised by its key findings. It is interesting to note that the contribution of the house factories to the final product value only amount to around 25 percent, as quoted by one manufacturer. While this number is sure to vary between companies, it does illustrate that most of the value is contributed by external actors. Further, it was found that the mode of prefabrication and the construction contract type are deciding factors in the layout of the supply chain, that will usually vary between projects. This entails both the routing of supplies, which will for instance be concentrated through the house factories for volumetric prefab, and the contractual connections between actors, with some actors delivering directly to the construction site without any formal connection to the house manufacturer. Thus, while higher degrees of prefabrication will concentrate flows through the house manufacturer, the construction contract type will decide whether or not the house manufacturer and the contractors have formal agreements, and thereby the degree of information flow and control. The level of customization granted to customers of the house design and selection of components determine the degree of control of purchasing decisions.
the house manufacturer retains, with more customization often entailing procurement from suppliers with which there is little or no previous relationship. Even with no significant customization option available, the product must still be adapted to local conditions for each customer’s property. In addition, most sales are through independent sales agents, who are not formally part of the house manufacturer’s organization but represent the brand nonetheless.

There is a lack of suppliers for many of the components required by the house manufacturers, who often lack market power in relation to the suppliers. At the same time, while there are large amounts of contractors, they are small and operate at the local level, forcing house manufacturers to work with different contractors for each geographical area. The industry is also very susceptible to changes in the business cycle, that will switch the relative positions of power between contractors and house manufacturers, cycle booms for instance leading to contractor deficits, giving contractors more influence. Concurrently the business cycle radically changes the amount of capital available to house manufacturers as levels of revenue varies dramatically. The question of branding sometimes becomes ambiguous, as even if contractors are responsible for final assembly, customers still often perceive the house manufacturer as the responsible seller. Performance metrics are also ambiguous for this industry, with many metrics being of questionable value, with many instead relying heavily on customer satisfaction metrics.

The construction industry in general is often described as being traditional in mindset, with difficulties in seeing beyond one’s own processes to a more holistic perspective, including other functions and actors. Insufficient and lost information in handovers between functions was described to be problematic and potentially extremely costly for house manufacturers. Formal knowledge of Supply Chain Management was discovered to be low, and although there was some awareness of the concept, it is not formally applied. Access to IT systems, if they exist, are usually not granted to external actors. Further, companies tend to use different IT systems, both internally and in comparison to each other, a fact that was noted as problematic by suppliers. IT systems enabling a greater degree of projects and their related processes was described as valuable by house manufacturers, whose benefits could be extended to include external actors, for instance by facilitating procurement and planning by suppliers.

Inventories are comparatively small, and mostly consist of bulk materials required for the manufacturing of house building blocks. Base models and designs for houses are used in attempt to standardize, and are tied to procurement contracts to secure rebates with suppliers, but that the customer can override by selecting unique items. This is a common occurrence, with items bought specifically for each project, and not seldom from suppliers with which there is no relationship. Projects are planned after estimated supplier lead times, as these tend to be long and disruptions costly. Despite on-time delivery being critical, the industry tends not to focus on delivery precision, and forecasts of upcoming projects and purchases are not consistently shared. Further, transport services are seldom shared between house manufacturers and suppliers due to deliveries due at different stages of the project.

Finally, product development in the industry is incremental in nature, and collaboration mostly focused on design adjustments and increasing assembly efficiency, which mostly tends to be accomplished through contractor feedback in connection to assembly. There is also some collaboration between house manufacturers on improving energy efficiency in building blocks, driven by government regulations.
5 **ANALYSIS**

In this chapter the empirical material will be analysed and contrasted with previous research. The first section will cover the current state of Supply Chain Integration in the Swedish wooden house industry, analogous to the first research question. Here, two industry-specific barriers were also found. The second section will further discuss the drivers and barriers found in the literature review, and how they relate to the wooden house industry. This section, along with the two industry specific barriers that have been identified, are therefore analogous to the second research question.

5.1 **CURRENT STATE OF SUPPLY CHAIN INTEGRATION**

5.1.1 **Internal integration**

With internal integration significantly improving the effects of external integration (Schoenherr & Swink, 2012), determining the internal processes of the wooden house industry is important to gauge whether the industry is receiving the full benefits of integration with supply chain partners. The results show that the participating companies at least have some room for improvement in this regard. With the information loss experienced by some in the transitions between functional areas, knowledge gained from customer and supplier integration processes is less likely to be applied and fully realized to benefit company flexibility and delivery capability, as Schoenherr and Swink (2012) notes. While they also found that the effect of external integration on cost and quality is mostly independent of the degree of internal integration, the perceived immaturity due to limited internal integration was shown to affect the willingness to integrate with other actors in at least one case. There seems to be some development on this front, however, with companies stating that they have upcoming improvement projects, notably in the field of IT. Internal IT systems are already in use by some companies to ensure project visibility for all involved divisions, decreasing the loss if information during transitions. For some, such a system is in development or due for upgrading. Further, some expressed an interest in improving processes for improved information flow, noting that crossfunctional early involvement would benefit projects by leveraging company competencies in project design to avoid later issues, and ensuring that information and intentions are fully communicated throughout the process.

5.1.2 **Purchasing strategy**

From the interviews, it seems apparent that a company’s choice of business model is linked to the potential for integration, in that it influences the number of suppliers in the company’s network. Chiefly, it is the amount of customization offered that decides how limited the selection of suppliers can be, and consequently, the effort spent on collaboration with any given one. Ergo, companies of the Willa Nordic model will bring less of their buying power to bear on a single supplier, instead having to spread purchases out over a larger range of suppliers due to customer requests. Conversely, the Älvsbyhus model, represented in this study by Hjältevadshus, has a greater impetus for supplier integration, as working with standardized models and items will enable greater results from integrated activities, as noted by Lavigne, Agard, and Penz (2012). This does not, however, mean that companies are actively seeking out integration strategies at the rates appropriate for their business models, as mentioned above.
Hjältevadshus, for instance, did mention that several suppliers are utilized for any given item, and that their capabilities were not taken into account, alluding to the fact that these were not at the limit of their capacity, and that further utilization is possible. Figure 9 illustrates the progression of integration potential as a function of customization, with the Fiskarhedenvillan model being roughly equivalent to the Willa Nordic model in this regard.

Figure 9 Progression of integration potential as a function of product customizability.

As the core product of the house manufacturers, the building blocks or structural components, is less open for customization in terms of component selection, this part of the process has the greatest potential for integration. This fact does not change much across the business models, as customers are seemingly uninterested in the selection of for instance wood or isolation suppliers. Thus, around a third of the value of the product, according to the number given by one of the interviewees, would be equally appropriate for the application of integration strategies regardless of the selected business model.

The actual level of integration to be strived for in this segment is, however, contingent on the type of product procured, and whether or not a company has already vertically integrated some of the processes involved. The Kraljic (1983, Figure 10) matrix, notes that the effect of a product on profit, and the ease of procuring in terms of product and supplier availability, should be taken into consideration when selection procurement strategy. Wood, for instance, while making up a noticeable portion of the final product value, is readily available for the wooden house industry. Exploitation of buying power vis-à-vis the suppliers might therefore be an appropriate strategy, being that the product itself is not easily differentiated, or in the terms of an interviewee: ‘‘Wood is not a sexy product.’’. Hence, house manufacturers can relatively aggressively negotiate prices for this product. It is clear, however, that different methods are being used in the procurement of wood, with some choosing to utilize multiple suppliers, with another alternative being close collaboration and integration of processes. Two other aspects seem to play a role here, the first being the ability for the supplier to differentiate their offer by providing an additional function. One house manufacturer explained how their supplier of wood had invested in machines that would ensure all wood was delivered pre-cut to the house manufacturers specifications, while another interviewee mentioned that such a machine would be pointless as that function was already being performed in-house. The other aspect is whether there is something to be gained from having multiple suppliers. Again, two alternative
approaches were presented, with some sourcing from multiple suppliers, and others noting that any extra savings are usually not worth the increase in procurement complexity and supply risk. Dealing with a large number of suppliers entails low degrees of efficiency and high transaction costs, as noted by de Boer, Labro, and Morlacchi (2001), while limiting the number of suppliers facilitates economies of scale, but increases the risk to supply.

<table>
<thead>
<tr>
<th>Profit impact</th>
<th>Many suppliers</th>
<th>Few suppliers</th>
</tr>
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<tbody>
<tr>
<td>High</td>
<td>Leverage items</td>
<td>Strategic items</td>
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<td></td>
<td>Characteristics:</td>
<td>Characteristics:</td>
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<tr>
<td></td>
<td>• Adequate supply</td>
<td>• Strategically important</td>
</tr>
<tr>
<td></td>
<td>• Alternatives available</td>
<td>• Substitutes difficult to find</td>
</tr>
<tr>
<td></td>
<td>• Standard products and substitutes available</td>
<td>Procurement behaviour:</td>
</tr>
<tr>
<td></td>
<td>Procurement behaviour:</td>
<td>• Seek collaborative/long-term relationships</td>
</tr>
<tr>
<td></td>
<td>• Reduce costs by exploiting purchasing power through competitive bidding etc.</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Routine items</td>
<td>Bottleneck items</td>
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<tr>
<td></td>
<td>Characteristics:</td>
<td>Characteristics:</td>
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<tr>
<td></td>
<td>• Adequate supply</td>
<td>• Substitution difficult</td>
</tr>
<tr>
<td></td>
<td>• Standard products and substitutes available</td>
<td>• Possible monopoly on supply</td>
</tr>
<tr>
<td></td>
<td>Procurement behaviour:</td>
<td>• High barriers to entry to market</td>
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<tr>
<td></td>
<td>• Reduce transaction costs through efficient order processing</td>
<td>Procurement behaviour:</td>
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<td></td>
<td></td>
<td>• Ensure volume</td>
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<td></td>
<td>• Safety stocks</td>
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Continuing with the Kraljic (1983) matrix, it can also be noted that for many products, close collaboration and involvement is appropriate, considering the apparent lack of suppliers for many products in the market. Considering for instance the lack of suppliers for isolation, windows, and kitchens, as mentioned by interviewees, it might reasonably be expected these to be more closely integrated with house manufacturers than wood suppliers. Indeed, we find that these relationships at the very least tend to be exclusive, with kitchen suppliers even taking an active role in the sales process. It should be noted that despite some apparent correlation with the matrix’s suggestions and actual behaviour in the wooden industry, none of the interviewed manufacturers claimed to be actually using the framework to find appropriate strategies for any given product. The lack of suppliers in general was often given as a reason, with interviewees seemingly thinking it to be a non-issue, noting the lack of complexity in the supplier market. A further observation is that supplier selection for highly customized houses is largely out of the hands of the manufacturer, being selected instead by the customer, making structured supplier selection a moot point.

### 5.1.3 Integration practices
In regard to the actual integration practises in use by the wooden house industry, one might compare the industry with Table 2 in the literature review. On the strategic level, it can be
observed that for the most part, companies are unlikely to think of their upstream suppliers in terms of extended organizations or integrated supply chains, or in other words, that companies would compete as supply chains rather than individual companies. That is, the results of this study did not find significant mission alignment as a common feature of companies in the industry, although examples did exist, notably in the cases of vertical integration of supply chain function, such as A-hus/Derome with its concept of “From tree to finished house”. Downstream, sales agents and contractors have a greater degree of mission alignment, with agents in particular working with the house manufacturers in much the same way an employee would. Contractors, on the other hand, have a vested interest in the success of any house project in which they participate, as they are effectively sharing the brand name of the manufacturer. Joint decision making was observed in some cases, for instance the joint selection of subcomponents along with a supplier, but it was made clear this was not a common occurrence.

Knowledge sharing was noted, with manufacturers offering education and walkthroughs for contractors. Further, collaboration on house and kitchen design with external architects and kitchen suppliers, respectively, could be considered knowledge sharing in the strategic sense, when in the case of the former knowledge leads to improvements beyond the project level. Joint research and development was observed to some degree, though such collaboration was more in the form of the sharing of input for incremental improvements rather than active development of products. Such examples are contractor input for assembly, requests for product modifications, and collaboration for energy efficiency. More comprehensive R&D collaboration would, however, involve closer alliances in which scientists and engineers from different companies consult each other to solve operational and technological problems, and jointly developing new products and services (Hagedoorn, van Kranenberg, & Osborn, 2003). Joint investments were very rare judging from the interviews conducted, with only one example given, where a supplier would invest in a machine to cut wood to customer specifications ahead of delivery to the house manufacturer, in return for future business. In general, then, integration initiatives on the strategic level were few and far between, with examples given being at relatively low degrees of intensity.

On the tactical level, the degree of integration seen was more significant. Shared problem solving did occur, especially in collaboration between house manufacturers and contractors, who will pre-emptively discuss potential issues for specific projects before construction. Contact with suppliers and sub-suppliers for problem solving was also mentioned as something of a relatively frequent occurrence. As each house is a project, various actors are also involved in the planning process, notably customers, external architects, and sales agents in the design phase. It is also necessary for suppliers to know ahead of time the expected dates for delivery requests, as lead times for many items and components tend to be long, and form the basis for the project timeline. The sharing of forecasts was noted as a valuable tool, though not by all interviewees, as it enables the suppliers to have foresight and plan for future orders, reducing the risk for stock outs and project delays. Similarly, IT integration was mentioned as giving an advantage, both in that the increased transparency facilitates planning by suppliers, but also that access to plans decreased the need for personal communication. This in turn saves valuable time in communicating information, with the lack of such a system being described by one house manufacturer as their biggest waste.

Performance evaluations was described as being conducted with a frequency of one to a few times per year, with metrics being an area of some difficulty, in that the project-based nature
introduces a great deal of ambiguity. Continuous improvement of processes as such was not particularly discussed beyond discussions on assembly with contractors, and the occasional problem solving, with one interviewee noting how improvements are made by calling and scolding suppliers who have made errors: ‘‘Well, indirectly that’s a form of improvement process, but essentially you’re booking a meeting and discussing what’s gone wrong and how to fix it.’’. Structured continuous improvement, however, would entail standardization of processes, and continuous experimentation for their incremental improvement, following frameworks such as the Plan-Do-Check-Act cycle, as described by Berger (1997). Cousins & Menguc (2006) assist in highlighting the importance of this, finding that providing feedback to suppliers is an effective tool to improve overall business performance and product quality. Supplier development was shown to be conducted in the form of the aforementioned education and walkthroughs for contractors, in which the house manufacturers ensures contractors are capable at assembling their building blocks, and that they can create a high-quality product. Increasing the capabilities of the contractor thus serves to increase performance for the house manufacturer. A similar process for or by suppliers to the house manufacturers was not discussed, however.

On the operational level, the degree of integration was again found to be higher than the aforementioned levels. Processes were in many places found to be closely aligned between actors in the industry, with the project-based nature of the product necessitating collaboration in some areas. Responsibility for sales was in many cases shared throughout actors, with kitchen and ceramic tile suppliers taking over the sales process for their respective products. Further, deliveries are planned to reduce complexity at the building site, with the overall project timeline planned after the lead times of the involved suppliers. Depending on the volume and nature of the products to be delivered, items and materials are therefore either consolidated or sent directly to the construction site at the appropriate project phase. The discussions of delivery timing revealed an interesting paradox in that both suppliers and contractors often were criticized for an inability to plan deliveries, while many stressed the importance for components to be delivered on time, or risk causing significant delays and costs. There seemed to be some difference of opinion on this topic as some seemed satisfied with the performance of contractors in this regard, and others noting the comparative inaccuracy of deliveries in the industry. Bergdahl, Örtendahl, and Fjeld (2003) found that a high degree of delivery precision was associated with reductions in time and cost, limiting delay times and increasing the amount of shipments deliverable in a given time frame, one interviewee noting that this concept was lost on the industry.

Interviewees gave several indications that time compression was not being fully utilized, revealing that silo-thinking had led to dysfunctional behaviour. A notable example was defective materials that had been shipped from a house manufacturer’s warehouse to the construction site, presumably after workers had noticed the rather obvious damage to the materials. The tendency for employees to not think beyond their own area of responsibility thus represents a significant area for potential improvement, as a wider organization or supply chain perspective would enable savings in total time and resources spent if functions would facilitate the processes of others. An example of such facilitation would be the inclusion of information during transitions between organizational functions in the process of a project, that would prevent future information queries and errors. This would represent an investment of time for the earlier function, but a total reduction of time spent across all functions, with Sherman,
Souder, and Jenssen (2000) finding that actors reduce time spent by combining resources rather than operating in isolation. This ties in to the optimization of resource use in general, with interviewees often admitting to some degree of waste in both time and other resources. What is interesting to note is that inventories are already fairly optimized for the house manufacturers, with stocks essentially only being kept for bulk material used in all products, and other items purchased specifically for each project, enabling comparatively small inventories. This system of pull, described by for instance Esparrago (1988), is often propagated further upstream, with suppliers producing and ordering specifically for the ordered components, reducing inventories in these tiers as well. It was observed that while components and materials was mostly done with third party logistics providers, the actual building blocks were often delivered with a company owned vehicle, described by one interviewee as being unprofitable, as it is effectively empty for half its running time. Interviews did, however, also reveal that current service offers, including by major logistics providers, are often considered unsatisfactory, with service providers unable to follow routines. The risk of delays and damage could therefore be considered a reason for sub-optimized transport in these cases.

5.1.4 Integration arcs
To analyse the progress of the wooden house industry in terms of integration strategy, Frohlich and Westbrook’s (2001) arcs of integration model might be used. While no quantitative study has been made to categorize the involved companies, the framework presents an appropriate way of illustrating integration progress. From the answers given in the interviews, it is possible to give an indication on where the participating house manufacturers would rate in the model. Thus, the first observation is that none of the participating companies could be considered as outward-facing, as this would require levels of integration with both customers and suppliers not exhibited in this study. While some integrative practises were found in companies, it is unlikely given the small selection of practises in use by a given company that a score high enough to reach the upper quartiles could be reached, should a study be conducted in accordance with Frohlich and Westbrook (2001). It is worthwhile to ponder whether such a level of integration is even possible, given that the market for contractors consists of such a large number of small actors, with it being impractical or impossible to consolidate these relationships. Considering the geographical size of Sweden, it would also be difficult for a house manufacturer to provide this function in-house, as to have enough range to cover the market would require immense resources. Further, it is clear that some parts of the supply chain, namely the incoming flow of materials for the house building blocks, are more appropriate for integration practises, while the remaining areas (comprising the majority of the final product value) are often outside the control of the house manufacturer. That is, for components and services selected by the customer, there is a high degree of uncertainty in supplier selection, hampering efforts to consolidate and improve relationships.

It should be noted that all of the three studies in Table 1, in which a distribution of arcs strategies were given, found the prevalence of outward-facing strategies to be low. It is not surprising, therefore, to not find this strategy in this study, especially considering the comparative complexity of the industry. Assuming no companies would reach the upper quartiles in either direction, all interviewed house manufacturers would fail to reach beyond the periphery-facing phase of integration. While it is possible that there are house manufacturers outside this study that would score higher, the interviewed suppliers did not give any significant indication that such was the case. The low prevalence of integration gives extra
credence to the arguments of Brege et al., (2017) and others pushing for higher degrees of prefabrication, which in addition to benefits of efficiency, would enable higher degrees of Supply Chain Integration. It should of course be noted that this can become a trade-off, as a loss of customization might entail a loss of differentiation.

The development patterns of the wooden house industry are less than straightforward in comparison to other industries, in that there is a question of definitions regarding contractors. Though downstream in terms of physical flow, the different forms of construction contract forms mean they could formally be either supplier or customer. However, even if classifying contractors as customers, there seems to be some bias toward integration efforts with key suppliers. This would indeed support the findings of Childerhouse and Towill (2011) regarding the likely paths towards integration, in that companies tend to first integrate with suppliers before turning significant attention downstream. It also reinforces the point that the market for contractors, being fragmented, inhibits progress in integration.

5.2 FACTORS INFLUENCING INTEGRATION

It is clear at this point that the findings of Wong, et al. (2017) concerning the differing degrees of integration in different industries apply to a very large extent to the Swedish wooden house industry. It is also clear that there are industry-specific conditions that affect a company’s ability to integrate. Namely, the level of product customization and contractor fragmentation, as previously elaborated upon, have been identified as barriers specific to the wooden house industry that may not affect other industries to the same degree. These factors are both aspects of the general market fragmentation of the construction industry, having been discussed before by for instance Briscoe and Dainty (2005), who found fragmentation to be a barrier for SCI in the construction industry. While the fragmentation of contractors is largely an external factor, however, the level of product customization that will determine the supplier fragmentation for each project is within the control of the house manufacturer.

Further, barriers and drivers have been found that are in line with previous research. The model summarizing influencing factors for SCI in the literature review can therefore be amended according to the findings of this study, with the industry-specific factors in bold. Note that, upon review, customer orientation turned out to be both a driver and a barrier for the wooden house industry, as it contributes to the level of product customization.

Drivers
- Supply uncertainty
- Demand uncertainty
- Technological uncertainty
- Desire to improve
- Knowledge acquisition and sharing
- Customer orientation*

Barriers
- Product customization
- Contractor fragmentation
- Cost
- Low supply risk
- Incompatible personalities
- Vulnerability to abuse
- Unidirectional flow of processes and planning
- Incongruent business behaviours
- Internalized values
- Incompatible IT

Level of integration

[Figure 11 Influencing factors for SCI in the Swedish wooden house industry.]
5.2.1 Barriers
In addition to the industry specific factors found by analysing the current state of integration in the industry, barriers already identified by previous literature can be compared to the results of this study. In doing so, it was found that some barriers are more relevant than others for the wooden house industry.

5.2.1.1 Cost
The cost associated with realigning the business culture, structure and implementing an IT system to become more integrated both internally and externally is generally perceived to be relatively high (Gelderman & Van Weele, 2003; Gangurde & Chavan, 2015). While not featuring heavily as an explicit barrier in the study, it was mentioned with specific regard to the volatility of the market. That is, the heavy fluctuations in revenue brought about by the market’s sensitivity to the business cycle tend to hamper investments in business systems, specifically expensive IT, meaning companies might be far less inclined to integrate during economic busts if integration requires expensive investments. Lack of financial capital is, Carpenter, Fazzari, Petersen, Kashyap, and Friedman (1994) point out, a major barrier for investments, and is influenced by environmental factors such as the business cycle. On the other hand, the low frequency at which cost was mentioned could indicate that it is not a major issue for the wooden house industry, or in any case less important than other factors.

5.2.1.2 Low supply risk
An abundance of suppliers on the market would constitute a low supply risk, as illustrated by the Kraljic matrix in Figure 11. For the wooden house industry, it was found that for many key suppliers, the situation was the opposite, with few suppliers available to the house manufacturer. It seems as the only market discussed as having an abundance of suppliers was that of the wood itself, with contractors on the other hand, while many in absolute number at the national level, having considerable power in their local markets. While customization, as discussed earlier, alluded to a large number of suppliers being used, it should be noted that this refers to specific projects, and does not imply an abundance of suppliers with the capacity to cover a house manufacturer’s full production. It would therefore seem like low supply risk is not a major consideration in the wooden house industry, with results tending instead to point to the opposite.

5.2.1.3 Incompatible personalities
Interpersonal issues, as noted as a barrier by for instance Ragatz et al. (2003), was covered only to a limited degree by participants. In this context, it was mentioned that some supply chain actors were unwilling to listen to criticism and improve accordingly, and in another case that some company employees might in a sense be considered outsiders. It would seem that this indeed exists as a barrier, but that it may not be as apparent as others.

5.2.1.4 Vulnerability to abuse
That Supply Chain Integration would open companies up to abuse, a barrier identified by for instance Harland et al. (2007), was not a fear shared among participants in this study. Such a fear was only expressed once, with the interviewee not wanting to become dependent on the suppliers, but it would seem that given the lack of choice in the market, the house manufacturers are already in a position of relative dependency. There is, however, some merit to this argument, with Cox (2001) recommending companies to consider integration with actors they are either in a dominant position over, or where there is interdependence.
5.2.1.5 *Unidirectional flow of processes and planning*

An unwillingness to share information was frequently observed in interviews, although to different extents, with companies often choosing to limit exposure to external actors, exemplifying one of the barriers described by Richey et al. (2010). Different participants had different views on how appropriate the sharing of information is, one view being that data protection is necessary, and another that the nature of the industry is such that there is very little risk involved even if rivals would be granted access. Interestingly, as one example would show, it would seem that the risk is not necessarily in malicious actions taken by rivals, but rather that supply chain partners can make poor choices based on access to information they do not properly understand. This limits the ability to establish meaningful relationships, and opportunities for collaborative learning and value creation as pointed out by Patnayakuni et al. (2006) and Richey et al. (2010). It is reasonable to assume that issues such as those just described is not a feature of knowledge sharing as much as an obstacle that can be overcome, given an investment of effort, which could yield significant benefits.

5.2.1.6 *Incongruent business behaviours*

Actions taken without regards to other actors in the supply chain, as described by Richey et al. (2010) and others, was observed on multiple occasions throughout the study. Examples were given of such behaviour both internally and externally, when individuals or actors were not specifically interested in improving productivity beyond their own process. The propensity to prefer arms-length relationships rather than closer collaboration is another example of this kind of mindset. On the other hand, the utilization of customer satisfaction as a performance metric can be argued to serve to focus efforts toward an end results rather than having at least internal departments competing to fulfil internally incompatible metrics. There were also often clear indications of a willingness to improve on this point, and a realization that focused optimization in a specific process might have negative consequences elsewhere, necessitating collaboration between divisions and processes.

5.2.1.7 *Internalized values*

Another barrier identified by Richey et al. (2010), the internalization of values and attitudes, has for long been criticized as a known shortcoming of the Swedish construction industry (cf. SOU, 2002). On this point, the findings of this study were far from unpredictable, and serves to confirm earlier sentiments. That is, participants were somewhat eager to criticize actors in the construction industry in general as lacking an innovative mindset, while lacking awareness on concepts covered by this thesis. That is not to say that it would be expected for everyone to have an understanding of Supply Chain Management, which is a specialized field, and participants were to their credit interested in improving. By their own admission, however, there is certainly a gap in the application of theoretical knowledge and management principles in use in other industries. The traditional mindset that is so often criticized can likely be tied in part to the availability of contractors as discussed above, with control over processes being in the hands of smaller actors who are less theoretically inclined than house manufacturers or other major actors. Other studies have also noted that the lack of competition in general has inhibited improvement efforts in the construction industry (cf. SOU, 2002:115; SOU, 2015).

5.2.1.8 *Incompatible IT*

The aspect of IT compatibility was not discussed to a significant degree by the wooden house manufacturers themselves, discussions being more in terms of granting access to internal
systems rather than investing in common systems. The latter was mentioned, however, though in the context of either common systems with vertically integrated companies, or in another case early discussions on investments in Supply Chain Management software. In other words, it does not seem like the house manufacturers are at a stage where common, integrated IT systems are being considered. Suppliers did mention the perceived difficulty in systems integration, in that systems used by the house manufacturers were different from both the supplier and each other’s, making it difficult to integrate into a single system. Indeed, IT systems are seldom perfectly suited to a company’s requirements, even less so those of several businesses of different character, as noted by Subramini (2004). However, complete integration and common usage of IT is not the only option, as the emphasis is the sharing of information in itself, not on the specific method by which it is shared. As discussed by Prajogo and Olhager (2012), integration of IT by itself is not a complete solution. Granting access to the house manufacturer’s own systems, limited where necessary, was thus discussed in this study as having significant benefits, without having to invest in common systems.

5.2.2 Drivers
In analysing the results, it has become apparent that there seems to be a comparatively small effect of the drivers found in the literature review on the wooden house industry. It would seem that industry conditions are often as such that they negate the effect of the drivers, or ensure that they fail to materialise. The result is an industry that is less than committed to Supply Chain Integration.

5.2.2.1 Supply uncertainty
Supply uncertainty as a driver essentially mirrors low supply risk as a barrier. That is, in the cases where there is a lack of suppliers, the supply risk is high, in that a company’s potential access to supplies is less certain due to the control of supplies being in the hands of a few number of suppliers. To secure access, companies tend to improve relationships in these instances, so as not to be cut off by potential shortages etc. (c.f. Paulraj & Chen, 2007). Given the lack of supplier for many of the products procured by the wooden house industry, this driver could therefore be expected to have a significant effect. Indeed, it would seem that in general, house manufacturers do tend to have closer relationships with suppliers in markets with higher degrees of supply uncertainty/risk. This is not absolute, however, but it should be noted that the utilization of several suppliers is also a way of dispersing risk, and is a valid strategy as discussed by the Kraljic matrix in figure X. In other words, cases in which there is a high degree of supply uncertainty, where several suppliers are being utilized, can reasonably be explained by the fact that products might be low in strategic value, to which the appropriate strategy is to disperse risk.

5.2.2.2 Demand uncertainty
While Paulraj and Chen (2007) posited that uncertainty of demand does not seem to be a major driver of integration, it does seem to have some effect in the wooden house industry. That is, to better control end product quality, house manufacturers did at several occasions mention a desire to integrate contractors. While this was mostly presented as a desire to vertically integrate, the context was that an increase in quality and brand control would help in controlling and creating demand. Within the wider context of this thesis, however, demand uncertainty does indeed seem to be of limited importance.
5.2.2.3 Technological uncertainty
With products repeatedly quoted as being less than innovative, technological uncertainty does not appear to be a driver of any significance in the wooden house industry, as it would be in a developing industry according to Auster (1992). Companies are as informed as can be on the products that are offered, with product differentiation at the service level rather than the technological. With products already being very well defined, there is little reason to integrate to solve this particular problem. It should be noted here, however, that there may be slightly less apparent for the customer considering the confusion of terms inherent in the industry concerning product offers. That is, while the house manufacturers themselves are well aware of what is being offered, customers seem to have a harder time differentiating between offers.

5.2.2.4 Desire to improve
The study gave mixed results on the industry’s desire to improve. Seo et al. (2014) described how such a desire would entail a willingness to abandon old habits, which is certainly not the image that has been presented of the construction industry in general. The construction industry seems in many places to be set in its ways, making only incremental progress. On the other hand, interest shown by the participating house manufacturers does imply a desire to improve, and part of the lack of interest in integration per say could simply be a lack of exposure to this particular field of study. In other words, wooden house manufacturers may in a sense be the victims of their surroundings, not willing to integrate because of industry conditions rather than a lack of desire to improve in general. It might therefore be said that this driver is present at least in the participating companies.

5.2.2.5 Knowledge acquisition and sharing
The construction industry in general was described in the study as being one in which everyone knows each other, and there seems to be a perception that industry practitioners know what is going on. Benchmarking was mentioned as being used in the form of the IMA customer satisfaction, granting some transparency in industry performance in various fields. However, it would seem that since Supply Chain Integration is not perceived as best practise, awareness of such is not as potent a driver for integration in the wooden house industry as Daugherty et al. (1995) described. In fact, while there is an awareness of the existence of Supply Chain Management as a field, the understanding of it seems comparatively low, which would have otherwise motivated companies to apply the related concepts, as according to for instance Fawcett and Magnan (2002). With some exceptions, there also seems to be no higher expectations of performance benefits from the sharing of knowledge and capabilities, at least in terms of supplier/upstream integration. That is, for contractors there is still the expectation that builders will need to understand the system they are working with to ensure high quality, while for the most part there is no corresponding expectation for suppliers. Not seeing the benefits of integration, as noted by for instance Frohlich and Westbrook (2002), it is only natural that integration is not pursued.

5.2.2.6 Customer orientation
Considering the very high degree of involvement by the customer in the wooden house industry, customer orientation is quite present in the minds of house manufacturers. It is clear that this leads to close collaboration with at the very least the customers themselves and their architects when applicable, and a desire to improve those processes that are most visible to customers. Interestingly, however, while Yunus and Tadisina (2016) described customer orientation as a
driver, this study has shown that this is not always the case. With the quest to satisfy customer demand often leading to design customization, house manufacturers are inclined to use suppliers selected directly by their customers, rather than collaborating more closely with their existing partners. It would seem in this case that customer orientation is a double-edged sword, although this level of customer influence might beyond most discussion on the topic.
6 CONCLUSIONS

The concluding chapter of this thesis summarizes the findings, provides insight for managers, and gives suggestions for future research on the topic. Finally, the limitations of the study are discussed.

The purpose of this study was to explore how Supply Chain Integration is approached by house manufacturers in the Swedish wooden house industry, given that the concept has been shown to positively impact performance. Two research questions were created to further this purpose, answering the questions of how integration is approached and what the factors influencing Supply Chain Integration are in the Swedish wooden house industry. The study confirmed that Supply Chain Integration is very much affected by industry conditions, and found that the choice of business model within the wooden house industry will determine the degree to which integration is possible with suppliers.

The Swedish wooden house industry cannot be considered to be at the forefront of Supply Chain Integration efforts judging by the results of this study. An application of the Frohlich and Westbrook (2001) integration arcs model illustrated that the participating companies are far from a stage where they would be fully utilizing the concept of integration either downstream or upstream. It was also found that internal integration was generally not at a level where the benefits of external integration could be fully leveraged. The selection of integration practises that were found in the literature seems for the most part to be used sparingly and at low intensity, with the industry seemingly not at a stage where supply chains, rather than individual companies, are competing against each other. Participants in the study seem to echo previous sentiment that the construction industry in general is less than innovative, although the participating house manufacturers were at least interested in improvement and seem to be making some headway in terms of integration. However, formal Supply Chain Management knowledge seems sparse, limiting strategy and practises perceived to be available to the industry.

The market in which the wooden house industry operates was observed as less than a perfect fit for fully integrated supply chains. Specifically, the requirement for construction personnel to actually assemble products on site means contractors have to be hired locally, as house manufacturers only in few instances will have access to their own staff. Further, considering the geographical size of Sweden, it is impractical to centralize the on-site assembly and construction function, as personnel would severely lack the range to cover the entire market. This means house manufacturers necessarily have to deal with a large number of small independent actors to provide this function. In turn, this diminishes the ability to integrate, partly because efforts are spread across a vast array of actors, and partly because these actors in themselves lack the resources and inclination for integration efforts. Further, the susceptibility of the industry to the business cycle means the relative dependency of contractors and house manufacturers will shift depending on the demand for houses. The capital available for investment will also vary dramatically throughout the cycle, meaning house manufacturers might be far less inclined to invest in business infrastructure and innovations during busts, even relative to other industries.

Drivers and barriers identified by previous literature were found to be present in the wooden house industry to varying degrees, some more relevant than others. Interestingly, it would seem
that conditions in the industry are such that many drivers are effectively negated, leading actors
to fail to see the benefits of integration in many areas. Paradoxically, and in contrast to previous
research, it was found that customer orientation in the case of the wooden house industry might
be as much a barrier as a driver. That is, in an effort to satisfy customers, many house
manufacturers cede control of procurement decisions to customers, with customers being able
to customize and select items to be included in the final product, and consequently which
suppliers to work with. This means house manufacturers are not consolidating their purchases
and making efforts to integrate with select suppliers.

6.1 MANAGERIAL IMPLICATIONS
For management, certainly within the wooden house industry itself, this carries a few
implications for those wanting to improve performance through integration with other supply
chain actors. Firstly, with customization handing procurement decisions over to customers,
business models tending towards more standardization would have more reason and ability to
integrate processes with suppliers, not having to spread efforts on a wide range of ever-
changing suppliers. This supports proponents of high degrees of prefabrication, in that
performance benefits can be found outside the company itself, in addition to internal efficiency
improvements. While this does not necessarily imply an increase in profit, as the filling of
market niches is a source of revenue, it does mean that for any products that are standardized
in its selection, business performance can be increased. Regardless of the business model,
therefore, one segment of the final product offering remains available for a high degree of
structure in purchasing decisions, namely the house building blocks. Analysis of the relevant
components would yield an appropriate purchasing strategy, and where appropriate enable
companies to integrate and leverage supply chain capabilities.

6.2 FUTURE RESEARCH
Having found two barriers preventing integration, and the associated performance benefits, a
natural next step would be to find ways of overcoming them. To that end, research studying
the integration of a large number of small actors would be highly relevant, in that strategies
accomplishing such a feat might be applied to integrate contractors in the wooden house
industry. This may also be relevant to the integration of suppliers, in those cases where the
company has ceded control over purchasing decisions to the customer.

6.3 LIMITATIONS AND GENERALIZABILITY
It is important to recognize that this study has some limitations in its validity and applicability.
Firstly, given the selection of a cross-sectional timeframe, the study does not provide insight
into the development of the field further than the stated intentions of participants. The sample
size is also a limitation, in that a larger selection of participants could potentially provide
answers to further or counter the findings of the study. Additionally, while a background for
integration and its determining factors in the wooden house industry has been given, practical
solutions for overcoming the stated obstacles have not been studied.

As for applicability beyond the studied industry, it is not a far stretch to be able to apply the
findings to the construction industry in general, of which the wooden house industry is part of.
While the focus of this study has been that of small houses, apartment houses are not only part
of the same industry, but are often part of the product offering of the same wooden house manufacturers that have been studied, sharing many of the same processes. The determining characteristic in this study is not wood per se, so the results should be able to be generalized to other construction materials, thus including manufacturers of concrete houses, which are also able to be prefabricated. Finally, as a central theme is house construction being conducted as a project, findings could have relevance to other project-based industries.
7 References


8 APPENDICES

8.1 APPENDIX A: INTERVIEW GUIDE

Internal integration

- How aware are functional teams of each other’s responsibilities?
- To what extent is there a common prioritization of customers in case of resource allocation and supply shortages?
- To what extent is operational and tactical information exchanged between functional teams? How is this facilitated by an IT system?
- How much are purchasing decisions based on shared plans agreed upon by all functional teams?
- How much are common product roadmaps and other procedures in use to guide product launch?
- Describe your use of performance metrics as it relates to trade-offs between customer service and operational costs
- What are the drivers and barriers to internal integration?

Supplier Integration

- How far do supplier relationships go beyond operational transactions? Which tiers of suppliers do you have relationships with? e.g. common planning, goals, investments
- How are your activities synchronized with your suppliers? e.g. common equipment, TPL usage
- How do your plans address the capabilities of individual suppliers?
- How is operational information exchanged with key suppliers? e.g. production plans, inventory levels, common IT use
- How do you reevaluate and develop working relationships?
- What are the drivers and barriers to supplier integration?

Customer Integration

- How far do customer relationships and involvement go beyond sales transactions?
- How are your plans addressing the requirements of an individual customer (note: not end customer)?
- How are your activities synchronized with your key customers?
- How is operational information exchanged with key customers?
- How do you reevaluate and develop working relationships?
- What are the drivers and barriers to customer integration?

How do you see your development in the future in terms of integration?