

Factors Behind Construction Companies' Purchasing Decisions of Wood Products and Insight into how Local (In-State) Wood Product Suppliers can have a Bigger Market Impact

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Companies in the construction industry have a wide range of choices of suppliers for the company's needs in building materials. Local (in-state) suppliers within key southern states have issues gaining market share within the construction sectors. Construction companies often outsource their purchase of wood products from a different state or country, which adversely affects the local economy due to not purchasing from in-state or local wood product suppliers. Construction companies are often not aware of local suppliers due to lack of resources or general lack of knowledge. The primary research question of this thesis is: can construction company procurement decisions and supplier selection methods help local wood product suppliers gain more market share within the construction industry? Companies within the states of Georgia, Texas, Oklahoma, South Carolina, Florida, and Virginia were interviewed over the phone and in person to determine how the companies choose the wood product suppliers and what factors impact the purchasing decisions. Key factors included: cost, quality, delivery, flexibility, location, relationship, and payment options. A survey of construction companies was created and conducted after the interviews were concluded. Important factors highlighted by the survey responses included: cost, quality, relationship, and lead time in choosing a supplier. Suppliers were asked to differentiate their products using information the construction companies highlighted as factors they emphasized. Construction companies offered insight into how they purchase wood products, the factors they desire in their suppliers, and how often they purchase in-state. In-state wood product suppliers have an opportunity to gain market share within the construction industry using the factors those construction companies favored in interviews and survey results.

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Dedication

I dedicate this thesis to both of my parents for their unconditional and continuous support of me in this endeavor. Thank you for believing in me when I said I would go to graduate school. I also dedicate this thesis to my fraternity brothers Rob Vrablik and Brandt Reilly who were taken from us way too soon, we all miss you.

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1. Introduction

1.1 Overview

Construction is defined as the erection, maintenance, and repair of immobile structures, the demolition of existing structures, and land development (Eccles 1981). The U.S. construction industry is among the world's largest markets, reaching over \$1,293 billion. There are typically three defined sectors (or types of projects) within the construction industry: commercial construction, public construction, and residential construction. These are contained within the "private" or "public" construction sectors; private construction projects generally contain residential and commercial projects, while public construction projects usually involve governments buildings. According to 40 USCS § 3301 (5) [TITLE 40. Public Buildings, Property, and Works; Subtitle II. Public Buildings and Works; Part A. General; Chapter 33. Acquisition, Construction, and Alteration], the term "public building" "(A) means a building, whether for single or multitenant occupancy, and its grounds, approaches, and appurtenances, which is generally suitable for use as office or storage space or both by one or more federal agencies or mixed-ownership government corporations."

Commercial projects involve a number of different regulations which set them apart from residential construction projects. All projects have to follow state and local building codes, fire, safety, etc. Examples of commercial projects include: shopping malls, restaurants, and structures designed for commercial use. Residential projects typically include apartment buildings, houses, and occasionally multi-story high rise buildings. Primarily, commercial projects use materials such as steel and concrete, while residential homes use wood frames on a foundation of concrete.

Finally, public construction projects are local, state, or federal infrastructure projects, usually financed by government institutions for various public purposes. These projects can include residential and commercial elements; an example would be a government funding a project for low income assisted living. Additional examples of public construction projects include: parks and recreational facilities, and government structures such as post offices, jails, public education facilities, roads, and power facilities.

After the 2008 recession, construction projects that had initially stalled have drastically increased and progress accelerated. This increase was due to positive trends in the residential market rebounding from the recession (Wang 2019).

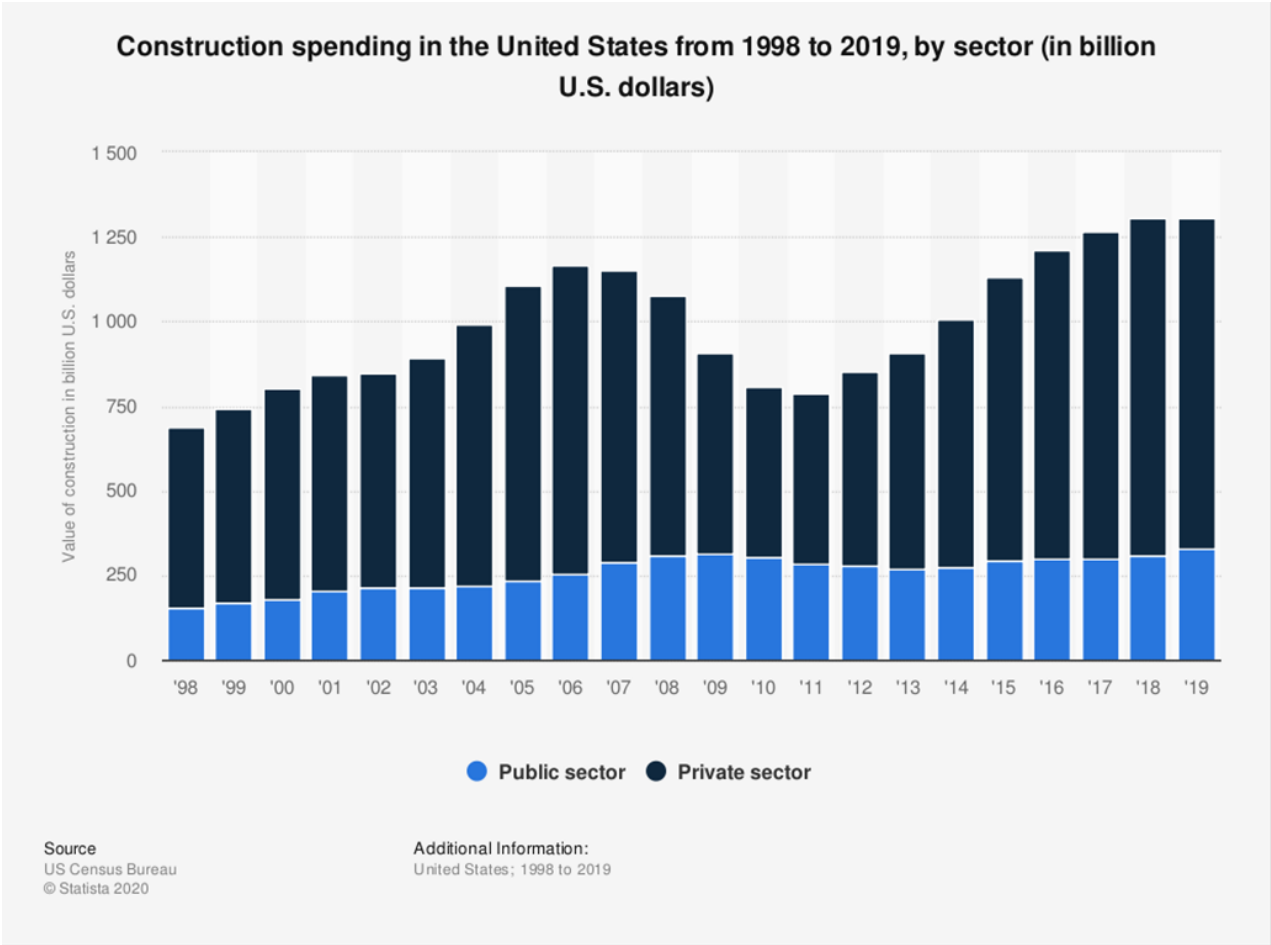


Figure 1. Spending in the United States Construction Industry by Sector (Wang, 2019)

Market opportunities for U.S. forest products expanded, not only for traditional building and emerging products, but traditional forest products have seen more growth than alternatives such as concrete and steel (Goergen, Harding, Owen, Rey, & Scarlett 2013). The construction industry has been moving towards more sustainable options such as wood in their numerous projects. Sustainability in building materials is the concept of using more biodegradable materials for construction projects. Sustainable development is described as enhancing quality of life and allowing people to live in a healthy environment and improve conditions for present and future generations (Ortiz, Castells, and Sonnemann 2009). In 2009, Ortiz, Castells, and Sonnemann wrote “The improving social, economic and environmental indicators of sustainable development are drawing attention to the construction industry, which is a globally emerging sector, and a highly active industry in both developed and developing countries.” To illustrate these concepts, the life cycle assessment helps evaluate the environmental load of products and processes. In 2009, Ortiz, Castells, and Sonnemann also wrote

“The life cycle inventory (LCI) involves collecting data for each unit process regarding all relevant inputs and outputs of energy and mass flow, as well as data on emissions to air, water and land. This phase includes calculating both the material and the energy input and output of a building system.”

Essentially, these analyses help determine the life cycles of certain building materials and how these materials can impact the environment during their useful life and after they have used for their purpose. The life cycle inventory impact assessment also evaluated potential environmental impacts of certain materials used within the building. The idea is to promote the use of more sustainable building materials such as wood, and engineered wood products as opposed to

products such as steel and titanium. Wood materials tend to be more environmentally friendly, and help to reduce energy consumption compared to the traditional building products such as steel and concrete. Carbon emissions are important to consider when deciding the sustainability of building materials, as well as the life cycle of certain materials.

Falk, 2009, wrote “Wood has many positive characteristics, including low embodied energy, low carbon impact, and sustainability. These characteristics are important because in the United States, slightly more than half of the wood harvested in the forest is used in construction.” There is a difference in energy consumption when mining for materials needed to make products such as steel and other metals. Wood is easier to harvest and uses less energy to construct projects. The construction of a steel-framed house in Minneapolis used approximately 17 percent more energy than a wood-framed house (Lippke et al. 2004). Table 1 discusses the designs of houses in Atlanta and Minneapolis and the difference in energy consumption between steel-framed and wooden-framed structures.

Table 1. Environmental Performance Indices for Above-Grade Wall Designs in Residential Construction (Lippke et al. 2004)

	Wood frame	Steel frame	Difference	Change (%) ^b
Minneapolis Design				
Embodied design (GJ)	250	296	46	+18
Global warming potential (CO ₂ kg)	13,009	17,262	4,253	+33
Air emission index (index scale)	3,820	4,222	402	+11
Water emission index (index scale)	3	29	26	+867
Solid waste (total kg)	3,496	3,181	-315	-0.9
Atlanta Design				
Embodied design (GJ)	168	231	63	+38
Global warming potential (CO ₂ kg)	8,345	14,982	6,637	+80
Air emission index (index scale)	2,313	3,373	1,060	+46
Water emission index (index scale)	2	2	0	0
Solid waste (total kg)	2,325	6,152	3,827	+164

^b % change = [(Steel frame – Wood frame)/(Wood frame)] X 100

Carbon plays an important role in the earth’s ecosystem and in climate change. It is viewed as having a negative impact on ecosystem sustainability. Forests play a major role in balancing the Earth’s carbon cycle. Essentially, forests and other vegetation remove carbon in the atmosphere through the carbon cycle. This process converts carbon dioxide and water into sugars for needed for tree growth as well as releasing oxygen into the atmosphere. Approximately 26 billion metric tons of carbon is sequestered within standing trees, forest litter, and other woody debris in domestic forests and another 28.7 billion tons in forest soils (Birdsey and Lewis 2002). Different materials have different carbon emissions, table 2 shows carbon emissions of common building materials and materials used in construction.

Table 2. Net Carbon Emissions in Producing a Ton of Various Materials (Falk 2009)

Material	Net carbon emissions (kg C/t) ^{a,b}	Near-term net carbon emissions including carbon storage within material (kg C/t) ^{c,d}
Framing material	33	-457
Medium-density fiberboard (virgin fiber)	60	-382
Brick	88	88
Glass	154	154
Recycled steel (100% from scrap)	220	330
Concrete	265	265
Concrete ^e	291	291
Recycled aluminum (100% recycled content)	309	309
Steel (virgin)	694	694
Plastic	2,502	2,502
Aluminum (virgin)	4,532	4,532

^a Values are based on life-cycle assessment and include gathering and processing of raw materials, primary and secondary processing, and transportation. ^b Source: EPA 2006. ^c From Bowyer et al. 2008; a carbon content of 49% is assumed for wood. ^d The carbon stored within wood will eventually be emitted back to the atmosphere at the end of the useful life of the wood product. ^e Derived based on EPA value for concrete and consideration of additional steps involved in making blocks.

Table 2 shows how carbon emissions from traditional building materials such as concrete, steel, and aluminum are greater than wooden framing material and medium-density fiberboard. Wood materials also have a negative value in near-term carbon emissions, meaning the materials are more beneficial to the environment in terms of carbon emissions. Wood products have a low level of embodied energy, compared to other building products, and because wood is one-half

carbon by weight, wood products can be carbon negative (Bowyer et al. 2008). Wood materials help with issues such as “green-building” and being more sustainable because these materials have lower carbon emissions and in turn can potentially help reduce the energy consumption of a building. It is important for the wood products and forestry industries to properly manage the forests to use sustainable harvesting methods for materials needed in the construction industry.

This thesis focused on identifying the procurement process of construction companies, their supplier selection in regards to wood products suppliers, and using responses by construction companies to help produce recommendations for suppliers to follow to help increase their demand. The three objectives in this study were as follows:

1. Identify companies and stakeholders in the construction sector within the stated region.
2. Identify key determinants in the purchasing decisions of construction companies.
3. Produce recommendations for sellers and buyers to follow for selling and purchasing wood products.

2. Literature Review

2.1 Supply Chain Management

The supply chain was defined by Chopra, 2019, as follows:

“A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves...the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service.”

More specifically, supply chain management as defined by the Council of Supply Chain Management Professionals in 2017, states that supply chain management: “encompasses the planning and management of all activities involved in sourced and procurement, conversion, and all logistics management activities. More important, it also includes coordination and collaboration with channel partners.” A supply chain can also be defined as a set of three or more entities involved in the upstream and downstream flows of products, services, information, etc. to a customer (Mentzer et al 2001). Reasons for forming supply chains include: reducing inventory investment in the chain, helping increase customer service, and helping to build a competitive advantage for the channel (Cooper & Ellam 1993). Some issues arise when attempting to reduce inventory and reducing costs. What happens often in supply chain management is that an organization will try to reduce inventory to reduce costs, however this might hurt service. Pressure is put on the suppliers to improve their respective performances

(Davis 1993). When all channels of a supply chain work together effectively, each company can reduce their costs and have an effective process. Thomas and Griffin in 1996 stated:

“The supply chain generally begins with the procurement of raw materials. It is not uncommon for the raw material purchase to account for 50% or more of the cost of sales. Many traditional inventory models have focused on determining optimal order quantities for the purchaser.”

While traditional models focused on optimal order quantities, they neglect other opportunities with reducing cost. Reducing cost may be possible without changing the order policy within a company. This would be achieved by investment in data exchange technology or material handling equipment. Another method for reducing costs would involve finding order quantities that is optimal for both the buyer and the vendor. However, the two sides would have to negotiate how to divide the savings. While working together can be difficult, reducing costs for all involved is ideal.

There are different strategies used for effective supply chain management. Chopra in 2019 provided efficient and responsive supply chains use different goals and other strategies to move products.

Table 3. Comparison of Efficient and Responsive Supply Chains (Chopra, 2019)

	Efficient Supply Chains	Responsive Supply Chains
Primary goal	Supply demand at the lowest cost	Respond quickly to demand
Product design strategy	Maximize performance at minimum product cost	Create modularity to allow postponement of product differentiation
Pricing strategy	Lower margins because price is a prime customer driver	Higher margins because price is not a prime customer driver
Manufacturing strategy	Lower costs through high utilization	Maintain capacity flexibility to buffer against demand/supply uncertainty
Inventory strategy	Minimize inventory to lower cost	Maintain buffer inventory to deal with demand/supply uncertainty
Lead-time strategy	Reduce, but not at the expense of costs	Reduce aggressively, even if the costs are significant
Supplier strategy	Select based on cost and quality	Select based on speed, flexibility, reliability, and quality

Supply chain responsiveness measures the ability to respond quickly to a wide range of demand while supply chain efficiency measures the ability to deliver the product to the customer at a low physical cost. Effective supply chain characteristics help influence a supply chain’s competitive strategy.

Table 4. Competitive Strategy Elements and Corresponding Enhancing Supply Chain Characteristics (Lapide, 2015)

Supply Chain Influenced Competitive Strategy Element	Supply Chain Characteristics Aligned to Enhance the Element
Lowest Prices	<ul style="list-style-type: none"> • Lowest Operating Costs
Highest Margin Products	<ul style="list-style-type: none"> • Highest Availability at Point-of-Sale • Lowest Operating Costs
Highest Quality	<ul style="list-style-type: none"> • Highest Quality of Suppliers • Strongest Process Quality Controls
Fastest Customer Response	<ul style="list-style-type: none"> • Shortest Order-to-Delivery Cycle • Fastest Request-to-Promise Date
Most Innovative	<ul style="list-style-type: none"> • Most Efficient/Effective New Product Launch
Highest Return-on-Assets	<ul style="list-style-type: none"> • Highest Plant/DC Utilization • Lowest Inventories
Broadest Product Line	<ul style="list-style-type: none"> • Most Efficient/Effective Inventory Management • Shortest Manufacturing Changeover and Setups
Highest Customer Service Ratings	<ul style="list-style-type: none"> • Most Effective Customer Service Segmentation • Highest Availability at Point of Sale
Most Effective Post-Sales Support	<ul style="list-style-type: none"> • Highest Availability of Service Parts
Most Environmentally Responsible	<ul style="list-style-type: none"> • Lowest Waste and Highest Recycling

Lapide, in 2015 defined the supply chain characteristics which align with the type of strategy element used in a supply chain influenced environment. There are ways for companies to gain a competitive advantage through using the supply chain as a strategic asset. For example: if a company would want to have the lowest prices, they would push for having the lowest operating costs. If a company preferred to have a faster customer response, they would have a very short

order-to-delivery cycle and fast request-to-promise date. The supply chain strategy of a company would influence the characteristics used to enhance that strategy.

Table 5. Using the Supply Chain as a Strategic Asset (Cohen & Roussell, 2013)

Primary basis of competition	Product and service attributes	Key supply chain contribution
Innovation	Cutting-edge, must-have	Time to market and time to volume
Customer experience	Tailored to meet customers' specific needs	Supply chain interactions designed from the customer's perspective
Quality	Reliable performance	Procurement and production excellence and quality control
Cost	Lowest priced	Efficient, low-cost configuration and processes

Cohen and Roussell in 2013 provided insight for how a supply chain could be a strategic asset. A company could use any of these strategies to remain competitive and contribute to the supply chain. There are also different operating strategies that a company could use in different situations.

Table 6. Types of Operating Models (Cohen & Roussell, 2013)

Operating model	When to choose this model	Benefits
Make to stock	<ul style="list-style-type: none"> Standardized offerings selling in high volume 	<ul style="list-style-type: none"> Low production costs Meeting customer demands quickly
Make to order	<ul style="list-style-type: none"> Customized offerings Offerings with infrequent demand 	<ul style="list-style-type: none"> Low inventory levels Wide range of product options Simplified planning
Configure to order	<ul style="list-style-type: none"> Offerings requiring many variations 	<ul style="list-style-type: none"> Customization Reduced inventory Shorter delivery times
Engineer to order	<ul style="list-style-type: none"> Complex offerings that meet unique customer needs 	<ul style="list-style-type: none"> Responding to specific customer requirements

If a company would want to focus on innovation within their products, the attribute of the products would be cutting-edge and the supply chain contribution would be how fast it would

arrive to the market. A different company could focus on the cost of the products, so the products would be the lowest priced while the supply chain contribution would be efficient, low-cost processes. These separate bases of competition differentiate how a company would operate in a given supply chain.

Cohen and Roussell in 2013 also produced different types of operating models seen in Table 6. A company would have to decide what type of product they want to sell then look at the operating model they want to use in order to efficiently get their product across a supply chain. For example: a company would choose the model of make to order when the main customer base would want more customized products and the benefits would be low inventory levels, a wide range of products, and simplified planning schedules. It would be important to consider the main customer base and the benefits of each operating model that would best fit the company vision.

Lee in 2004 produced another model that summarizes supply chain strategy is called the triple-A supply chain. It utilizes: agility, adaptability, and alignment to support a supply chain's strategy. This supply chain model focused on how a company should respond regarding the certain objectives of a supply chain. Agility is important because it would help with collaboration of suppliers and designing for possible postponement of products. Adaptability would help with the flexibility of product design and monitor economies all over the world. Alignment helps gather separate companies together with sharing costs and risks to exchange information freely between one another.

Table 7. Building the Triple-A Supply Chain (Lee, 2004)

Agility	Adaptability	Alignment
<p>Objectives: Respond to short-term changes in demand or supply quickly; handle external disruptions smoothly</p>	<p>Objectives: Adjust supply chain’s design to meet structural shifts in markets; modify supply network to strategies, products, and technologies</p>	<p>Objective: Create incentives for better performance</p>
<p>Methods:</p> <ul style="list-style-type: none"> • Promote flow of information with suppliers and customers • Develop collaborative relationships with suppliers • Design for postponement • Build inventory buffers by maintaining a stockpile of inexpensive but key components • Have a dependable logistics system or partner • Draw up contingency plans and develop crisis management teams 	<p>Methods:</p> <ul style="list-style-type: none"> • Monitor economies all over the world to spot new supply bases and markets • Use intermediaries to develop fresh suppliers and logistics infrastructure • Evaluate needs of ultimate consumers- not just immediate customers • Create flexible product designs • Determine where companies’ products stand in terms of technology cycles and product life cycles 	<p>Methods:</p> <ul style="list-style-type: none"> • Exchange information and knowledge freely with vendors and customers • Lay down roles, tasks, and responsibilities clearly for suppliers and customers • Equitably share risks, costs, and gains of improvement initiatives

The triple-A supply chain strategy helps outline the basics of what companies do to help their type of supply chain.

Another model for mapping out a supply chain is called the Supply Chain Operations Reference (SCOR ®) model. The SCOR Model is the world’s leading supply chain framework, “linking business processes, performance metrics, practices and people skills into a unified structure.” (SCOR – professional training, 2017). The SCOR model gives a certain standard for defining

and measuring supply chain performance, using measurements and benchmarks to help improve overall performance.

The SCOR Model was developed to model business activities associated with all the phases of trying to satisfy a customer’s demand. The model evaluates the following within the supply chain: plan, make, source, deliver, and return. Planning is balancing resources against demand establishing and communicating strategies within the entire supply chain, not just one part. Making is the scheduling of production, and transformation of raw materials into the finished products. Sourcing is working with suppliers (internal or external) to receive incoming materials, including: procurement, delivery, repair, receipt, and inspection. Delivery involves delivering orders to customers, management of customer database, accounts receivable, and delivery schedules. Return is managing returns in two separate areas: raw materials to suppliers and finished goods received from the customers. The SCOR attributes can be defined further.

Table 8. The SCOR Attributes (SCOR Metrics, 2017)

Performance Attribute	Definition
Reliability	The ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the reliability attribute include: On-time, the right quantity, the right quality.
Responsiveness	The speed at which tasks are performed. The speed at which a supply chain provides products to the customer. Examples include cycle-time metrics.
Agility	The ability to respond to external influences, the ability to respond to marketplace changes to gain or maintain competitive advantage. SCOR Agility metrics include Flexibility and Adaptability
Costs	The cost of operating the supply chain processes. This includes labor costs, material costs, management, and transportation costs. A typical cost metric is Cost of Goods sold
Asset Management Efficiency (Assets)	The ability to efficiently utilize assets. Asset management strategies in a supply chain include inventory reduction and insourcing vs. outsourcing. Metrics include: Inventory days of supply and capacity utilization.

The SCOR metrics are categorized in terms of how they perform with respect to the different performance attributes.

Table 9. The SCOR Level-1 Metrics (SCOR Metrics, 2017)

Performance Attribute	Level-1 Strategic Metric
Reliability	Perfect order fulfillment (RL 1.1)
Responsiveness	Order fulfillment cycle time (RS 1.1)
Agility	Upside supply chain flexibility (AG 1.1) Upside supply chain adaptability (AG 1.2) Downside supply chain adaptability (AG 1.3) Overall value at risk (AG 1.4)
Costs	Total cost to serve (CO 1.001)
Asset Management Efficiency (Assets)	Cash-to-Cash cycle time (AM 1.1) Return on supply chain fixed assets (AM 1.2) Return on working capital (AM 1.3)

2.2 Factors in Supplier Selection

According to Cengize et al, 2017, different factors affect a construction company’s decision of which supplier they want to proceed with. These factors include: cost, quality, location, the relationship, and flexibility of the suppliers. Cost is frequently the most influential factor when selecting a supplier. Cost also happens to be one of the easiest factors for companies to measure and report on as it is both quantitative and recorded (Ting & Cho 2008). Quality in products is also highly regarded in supplier selection. Quality is defined as the characteristics attributed to a product or service which meets or exceeds the customer’s expectations and creates customer satisfaction (Sahney, et al., 2004). On-time delivery from suppliers is another important factor in selecting a supplier for a company. The ability of potential suppliers to meet quality standards and delivery schedules stand out as two critical factors in supplier selection (Dickson 1966). Results from a survey conducted by Verma and Pullman, 1998, show that managers perceive “quality” to be the most important supplier attribute, followed by “on time delivery”. Supplier

selection and evaluation is important because it plays a key role in reducing the cost and time to market whilst improving the quality of the products (Aksoy & Öztürk 2011). Table 10 discusses strategic and organizational factors that play a role in supplier selection.

Table 10. Summary of Factors and Components of the Strategic Performance Metrics and Organizational Factors Clusters (Sarkis & Talluri, 2002)

Strategic Performance Metrics	Organizational Factors
Cost (Barbarosoglu & Yazgac 1997)	Culture (Ellram 1990)
Low initial price (LIP)	Feeling of trust (FOT)
Compliance with cost system (CCA)	Management attitude/outlook for the future (ATT)
Cost reduction activities (CRA)	Strategic fit (SF)
Compliance with sectoral price behavior (CSP)	Top management compatibility (TMC)
Quality (Choi 1996)	Compatibility among levels and functions (CALF)
Conformance quality (CQ)	Supplier's organizational structure and personnel (SOSP)
Consistent delivery (CD)	Technology (Ellram 1990; Barbarosoglu & Yazgac 1997)
Quality philosophy (QP)	Technological compatibility (TCOMP)
Prompt response (PR)	Assessment of future manufacturing capabilities (FMC)
Time (Choi 1996)	Supplier's speed in development (SSD)
Delivery Speed (DS)	Supplier's design capability (SDC)
Product development time (PDT)	Technical capability (TCAP)
Partnership formation time (PFT)	Current manufacturing facilities/capabilities (CFC)
Flexibility (Choi 1996)	Relationship (Choi 1996)
Product volume changes (PVC)	Long-term relationship (LTR)
Short setup time (SST)	Relationship closeness (RC)
Conflict resolution (CR)	Communication openness (CO)
Service capability (SCAP)	Reputation for integrity (RFI)

The strategic performance metrics (cost, quality, time, and flexibility) are metrics that organizations can use to manage their processes regarding how the company wants to approach supplier selection. Sarkis and Talluri, 2002, stated "Within each of these metrics, there are tangible and intangible factors that may be used in their evaluation. Each of these major strategic

performance metrics can be further evaluated through their components or subfactors.” These metrics are broken down further into subfactors in order to make educated decisions within the company. For comparing these subfactors, a pair-wise comparison within the primary metrics is done. An example would be: does a company value a short setup time for products over the service capability under the flexibility metric? As for organizational factors, there are three sets of factors (culture, technology, and relationship) which focus less on the competitive factors seen with the operational measures and more on the abilities and characteristics of the organizations that the company will form a strategic partnership with. Much like the performance subfactors, a company can do a pair-wise comparison such as: does this company value a long-term business relationship compared to the closeness of the relationship to the supplier? Supplier selection would be determined based on the factors described and compared to one another. An example would be: does supplier one have a much faster delivery time with its products to the company when compared to supplier two? Although this is a comparison between two suppliers, the decision-making process could be generalized between any number of suppliers.

Successful companies recognize and act on the increasing impact which service performance is coming to have on customer satisfaction by introducing innovative services (Davidow & Uttal, 1989). Müller, 1991, stated:

“Service innovations can be strategically managed in two different ways. A single-stage service innovation strategy aims at building a service-supported competitive advantage in one single phase of the purchase decision-making process... a multi-stage service innovation strategy is concerned with securing competitive advantages.”

The multi-stage service innovation has several phases which focus on the customer driven decision-making process. Gaining competitive advantage in markets help differentiate and put suppliers above one another.

2.3 Vertical Integration

According to Racher, 2010, Vertical integration is the degree to which a firm owns its upstream suppliers and its downstream buyers. There are three variations: backward (upstream) vertical integration, forward (downstream) vertical integration, and balanced (both upstream and downstream) vertical integration (Racher 2010). The supply chain is viewed as lying between fully vertically integrated systems and between other systems where each channel member operates independently (Cooper and Ellram 1993). Vertical integration within a company can help improve its processes by having all of the steps involved in manufacturing a product under the control of that company. The concept of vertical integration carries the concern of monopolizing the market since all of the process would be under one parent company. However, Richard Mpoyi, 2003, suggests “So to support the competitive strength of their companies, managers that intend to change the levels of vertical integration may look at their competitors' levels, but more importantly they should base their decisions on relevant organizational characteristics.” While certain companies may do better with a vertical integration process, not all companies need to implement it; it is dependent on their own structure and company goals. Richard Mpoyi's, 2003, analysis showed that 50 percent of companies did not change their levels of vertical integration from 1980- 1997. This result suggests that once certain levels of vertical integration have been achieved, these companies did not see that changing them would improve their ability to compete. Essentially, once a certain level of competitiveness is reached, it is not

worth the time, money, and effort to keep introducing new technologies to try to maintain vertical integration.

2.4 Wood Products Industry Vertical Integration

The importance of vertical integration is prevalent in raw-material based industries such as forest products (D'Aveni and Ilinitch 1992). An example of balanced vertical integration is as follows: a wood products company using vertical integration would have control of harvesting the raw material from the forest, converting the logs using technologies such as debarkers, saws, presses, sanders, etc. to manufacture their product, storing their product, and eventually marketing/retailing it. If the company only had access to the harvesting and those inputs that would be backward (upstream) vertical integration, while if it only had control of retail and distribution centers that would be considered forward (downstream) vertical integration. The main issue that arises with attempting to vertically integrate wood products companies is that land in the U.S. is either public or private. When establishing an integrated wood products industry, consideration must be given to not only the quantity and quality of the wood supply, but also to the reliability of the supply over time. The best way to reduce the risk to investments associated with feedstock supply is to have a variety of land ownerships. For example, only having federal lands as a wood supply is very risky because that supply would be subject to the politics and bureaucracy associated with federal agencies (Racher 2010). Large private land parcels can lead to either investments in wood products industries not being made or those industries having the wood supply compromised by pricing (Racher 2010). Since, in the U.S., land ownership is split between public and private, wood products companies have issues with achieving a balanced vertically integrated process. This leads to most companies either having an upstream or downstream process, so they need to outsource either their supply or their product.

Under these circumstances, construction companies have to contact multiple suppliers to search for the products they need. An example of a low-scale wood products industry is represented in Figure 2.

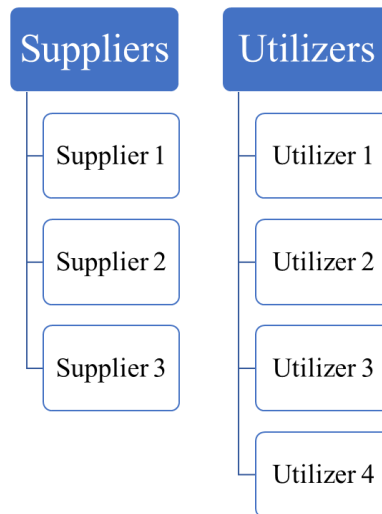


Figure 2. Example of Low-Scale Wood Products Industry (Racher, 2010)

Figure 2 is representative of low-tech wood product industries such as firewood production and post-production. In figure 3, the size of the box represents the size of the supplier and utilizer. As shown, the supplier and the utilizer side are separated, thus not using a vertically integrated system. However, since concern of the monopolization of the market is present, having a diversity of suppliers who provide the raw material needed for the construction industry is ideally the most sustainable system. Figure 3 represents the idea of a balanced supplier and utilizer relationship.

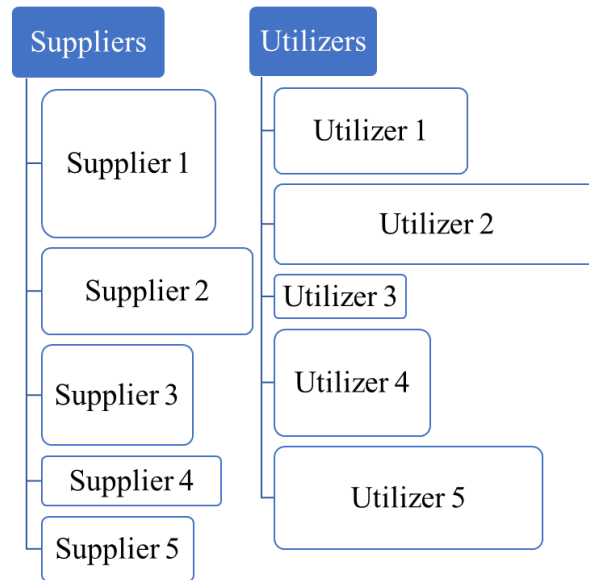


Figure 3. Example of Balanced Supplier and Utilizer Relationship (Racher, 2010)

As previously mentioned by Brett Racher, 2010, monopolization in the wood products industry is a concern, and vertical integration could be seen as an enabler of monopolization. Due to the privatization of land, integrating wood products through balanced vertical integration is quite difficult. Companies either use upstream or downstream vertical integration. The issues that construction companies face are similar; the fact that they don't have vertical integration means that they don't have their own equipment and land to get the raw material needed to build their projects. They count on suppliers of wood products to provide the material they need. Typically, the process of determining a supplier is through bidding.

Vertical integration is of key importance to wood products and construction companies.

Construction companies know what they are looking for in terms of product, and selecting a supplier through an extensive bidding process is a burden. Most construction companies have downstream vertical integration with warehouses and distribution centers full of the material needed for their projects. Through vertical integration, a firm encompasses a market nexus (Adelman 1955). Vertical integration would allow these companies to easily procure to the raw

material needed in more quickly. Most wood product companies have market share in the harvesting and production department, which provides upstream vertical integration and control over the production of the products needed for construction companies. Where the wood products industry falls short, is not owning distribution centers or retail sites, thus they would act as a middle man for the construction industry, which decreases their profits. Both of these industries coincide; the wood products industry making products for the construction industry to use. If these industries can work to vertically integrate their processes, it would simplify product production, harvesting the material they need, and selling their product.

2.5 Forest Products Marketing

Mater et al, 1991, state,

“Wood readily qualifies as the ideal raw material for many needs. Smaller companies can turn out attractive, useful items with a relatively small investment. Manufacturers of wood items can often find a market niche. Wood has character, connotes quality, is a renewable resource, and has been a preferred material throughout history.”

Wood can be used to fabricate numerous products examples include: lumber, oriented strand board, fiber board, furniture-based products, etc. This makes forest products marketable to various sectors. Differentiating products is quite important. Price is a differential advantage commonly used in marketing industrial and construction products (Mater et al, 1991). There are non-price product differentials which include: adding new or innovative features not available from other products, demonstrating how the product helps save the customer production time or costs, helping the customer comply with regulations, showing how the product meets health, safety and environmental concerns, highlighting the manufacturer’s credibility, meeting new

style trends, offering superior service, offering favorable credit terms, providing technical support, providing follow up after installation, with the ability to provide an immediate quotation, deliver products on time, establishing a reputation for reliability, availability of flexible specialization, offering large discount spreads, and using a well-known distributors (Mater et al, 1991).

Hansen and Juslin, 2005, stated

“Production-oriented companies concentrate on producing large volumes of commodities at low costs and rely on sales to move the product away from the production facility. A production-oriented company feels that a marketing department is only a cost creator between the mill and the market.”

The technology and raw materials would dominate the market thinking of production-oriented companies. While this approach would work well in earlier times when the demand was high and customer needs were simple with limited competition, it would not be as effective in the future. Production reliant thinking was dominant in earlier times, however more innovative solutions were needed. Hansen and Juslin, 2005, stated

“Product strategy can be divided into an emphasis on three alternatives: commodity, special, or custom-made products. ...Core competencies are what allow the firm to be truly differentiated from the competition. A well-recognised brand can be a core competency. Trus Joist® has been successful in establishing its name as a recognised brand.”

Strategy of producing specialized products has grown more in the wood products industry. The specialized products have a more marketable approach. Differentiating a product to the point

where it is recognized as its own brand can be crucial to wood products manufacturers and suppliers. A brand is more marketable than a generic product. Trus Joist® is more recognizable than a generic lumber product.

The ability of forest certification to promote sustainable forest management may depend in part on the extent to which managers of forest products companies perceive a market-based incentive to supply certified products (Stevens et al., 1998). The forest certification program helped produce better marketing opportunities for some companies.

Through effective differentiation of products, and inherent differences within the wood/forest products themselves, a supplier can market their products. Suppliers can promote what their product does well, how it is different from competitors, and how their products look in order to market their company and products.

2.6 Construction Industry Trends

In 2000, Arditi and Mochtar undertook a comprehensive study with surveys conducted in 1979, 1983, and 1993 regarding general productivity of the construction industry. Arditi and Mochtar, 2000, stated “Out of the 400 questionnaires mailed to the top 400 US contractors, 139 (or 35%) were returned in the 1993 survey, compared with 15% in the 1983 survey and 20% in the 1979 survey.” Table 11 describes the company characteristics of the responding survey participants.

Table 11. Company Characteristics of Responding Contractors (Arditi & Mochtar, 2000)

Company Characteristics	Percent of Respondents		
	1979 Survey	1983 Survey	1993 Survey
Type of Project			
Three types	15	15	12
Two types	20	18	20
One type	62	65	68
Other construction	3	2	0
Annual Sales (\$ Million)			
10-50	30	20	12
50-100	40	36	37
100-500	20	38	40
>500	10	6	11
Number of Permanent Employees			
<100	15	22	21
100-500	55	62	58
500-5000	17	13	18
>5000	3	3	2
Number of Temporary Employees			
<100	18	20	33
100-500	33	47	37
500-1000	26	18	17
1000-5000	13	8	5
>5000	10	7	3
Dollar Value of Construction Equipment (\$ Million)			
<5	52	52	48
5-25	28	28	26
25-50	15	8	10
50-200	3	10	9
>200	3	2	7
% of Construction Equipment Leased or Rented			
0	11	16	15
<25	44	44	44
25-50	22	12	17
50-75	8	13	7
75-100	15	15	16
% of Work Subcontracted on Average Job			
<25	31	28	18
25-50	27	31	22
50-75	31	23	25
75-100	11	18	36
Geographic Location of Projects			
Northeastern states	36	28	44
Mid-Atlantic states	15	30	46
Southern states	11	51	46
Southwestern states	10	44	40
Central states	5	34	32
Western and northwestern states	4	51	39
Outside continental USA	15	15	7

Arditi and Mochtar, 2000, stated

“It indicates that: 1. over 60% of the responding contractors performed one type of construction; 2. over 60% had annual sales ranging from \$50 million to \$500 million; 3. over 55% employed 100±500 permanent employees and over 50% hired fewer than 500 temporary employees...6. all the companies performed projects almost exclusively in the continental USA.”

The study conducted showed positive trends throughout the construction industry from the late 1970's to the early 1990's. Heavy equipment was not leased nor rented often and companies did not tend to subcontract. An important take away is that the construction industry in the U.S. performed most of its projects within the continental U.S.; companies didn't tend to outsource. This means that the construction industry needed supplies such as wood products within the U.S. to minimize transportation costs and delivery time to project sites. According to Hümmels, 2007, in general, transportation costs: are relative to the value of goods being moved, are relative to other barriers such as tariffs, and the extent to which transportation costs alter relative prices. Suppliers within the U.S. would help minimize these costs.

2.7 Construction Industry Supply Chain

Bayazit et al, 2006, defined priorities of logistical performance in table 12. There are different factors for a construction company to consider when selecting a supplier. Logistical performance, commercial structure, and production highlight the needs of the construction company.

Table 12. Priorities of Logistical Performance Criteria (Bayazit et. Al 2006)

Major Criteria	Logistical Performance 0.364					
Sub-Criteria	Delivery Performance 0.159			Cost Analysis 0.841		
Secondary Sub-Criteria	Quantity 0.233	Lead-Time 0.767		Price 0.766	Terms of Payments 0.165	Cost-reduction assistance 0.069

According to Bayazit, et al, 2006, price was the highest factor under the cost analysis branch and lead-time was the highest factor for delivery performance for construction companies. Bayazit, et al, 2006, stated

“...production is the most important factor of selecting the best supplier with a priority of 0.555. For the sub criteria of Logistical Performance, cost analysis received the highest priority, 0.841. Under cost analysis, not surprisingly, price received the highest priority, 0.766). And under the delivery performance sub criterion, lead-time turned out to be the most important one, 0.767. When we evaluated the commercial structure branch, technical capability turned out to be the most important one with the priority of 0.345 and the second highest priority, for organizational culture, is 0.156.”

There are prominent roles of supply chain management in construction. More specifically, four roles were defined by Vrijhoef and Koskela, 2000.

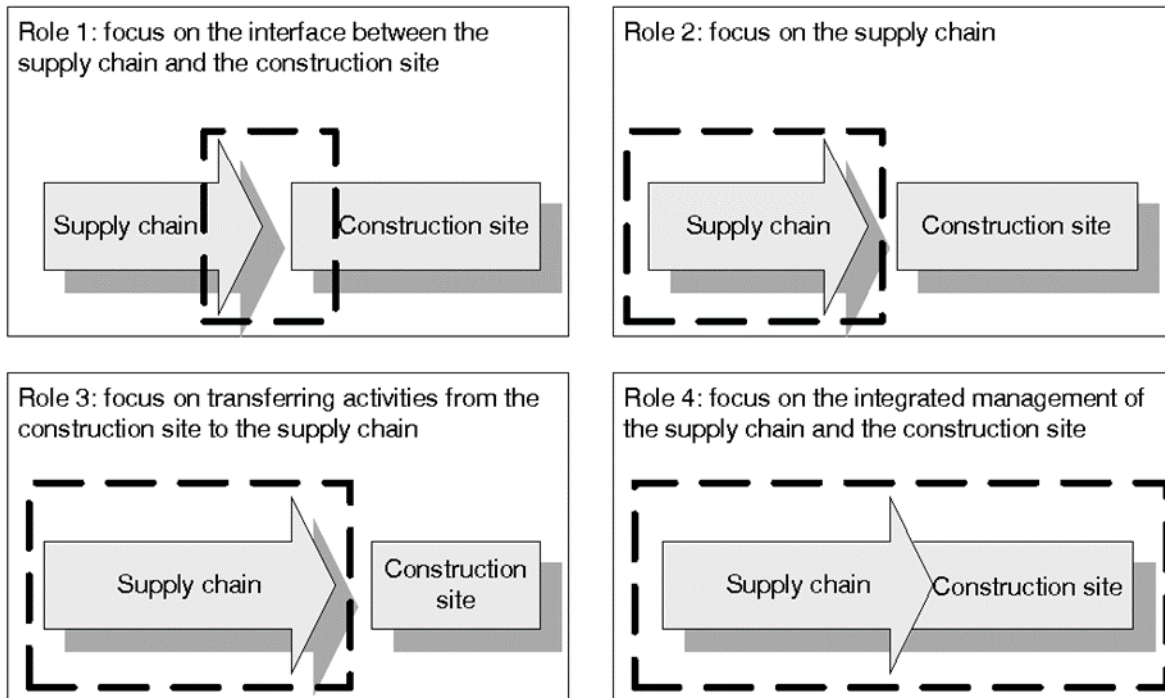


Figure 4. The Four Roles of Supply Chain Management in Construction (Vrijhoef & Koskela 2000)

Vrijhoef and Koskela, 2000, stated

“Firstly, the focus may be on the impacts of the supply chain on site activities. The goal is to reduce costs and duration of site activities. In this case, the primary consideration is to ensure dependable material and labor flows to the site to avoid disruption to the workflow. This may be achieved by simply focusing on the relationship between the site and direct suppliers. The contractor, whose main interest is in site activities, is in the best position to adopt this focus.”

The overall goal of the supply chain is to reduce costs relating to logistics, lead-time, and inventory. Suppliers to the construction industry may adopt this focus as well. Transferring activities from the site to the earlier stages of the supply chain help avoid inferior conditions found on the site. It also helps achieve coexistence between activities. Focus on integrated

management and improvement of the supply chain and site production integrates clients, suppliers, or contractors.

Xue et al, 2005, defined another model of the construction industry supply chain in figure 5.

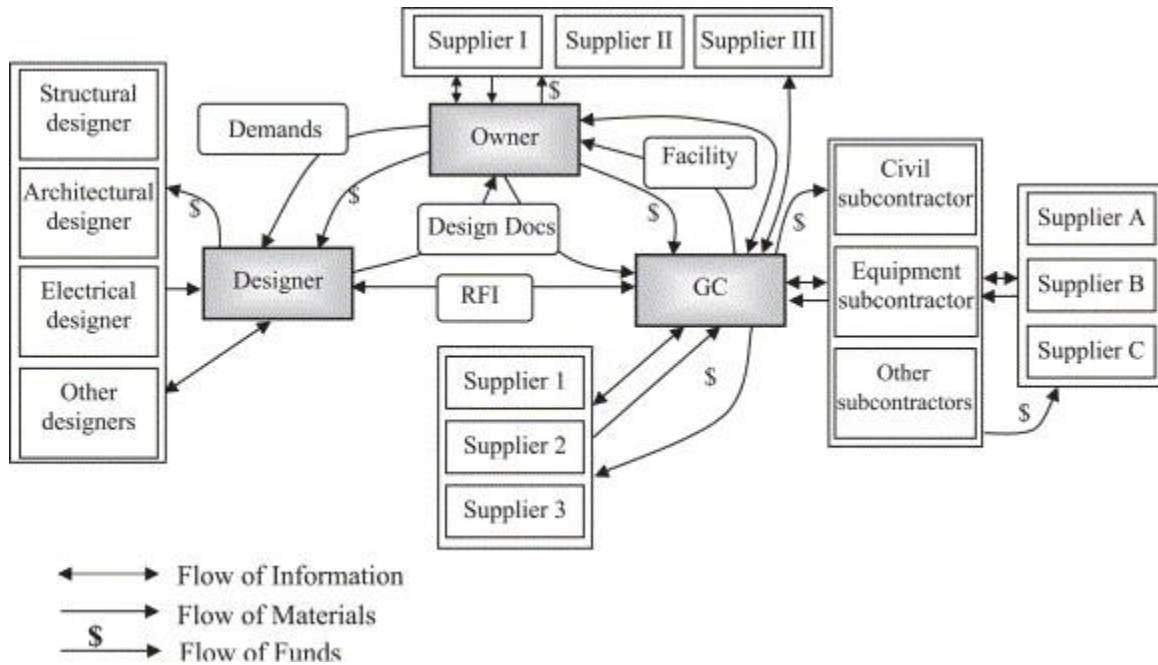


Figure 5. Model of Construction Supply Chain (Xue et. Al 2005)

This model shows what is involved in all parts of the construction industry supply chain. An owner interacts with various suppliers to acquire materials. The owner produces funds to answer demands of a designer for the project. The designer uses the funds on the various designers to produce sketches of the project. The owner and general contractor (GC) interact with each other when the designer relays the sketches back. The general contractor has suppliers as well as subcontractors which have their own suppliers to produce materials needed for the project.

2.8 Survey Methodology

Loosveldt, 2008, stated

“The essential characteristics of a face-to-face interview are the direct personal contact between interviewer and respondent, the specific division of tasks between them (asking and responding questions) and the use of a questionnaire in which the wording and the order of the questions are fixed. Face-to-face interviews are therefore more suitable for longer interviews with more complex tasks.”

With the presence of an interviewer, it gives more opportunity but also more risks. There are biases involved with face-to-face interviews which include leading the interviewee to an answer. However, more complex questions and answers are answered with face-to-face interviews. An in-person interview offers greater opportunity and more insight than a phone interview may give. Loosveldt, 2008, also stated “A question-answer sequence in an interview can be considered as a simple stimulus response model.” Standardized question and answer sequencing prevent bias from taking over and prevents the interviewer from steering the respondent to an answer.

Steeh, 2008, stated “Public willingness to be interviewed, always less over the telephone than in face-to-face surveys, has declined dramatically over the last twenty years.” Telephone interviews had issues with willingness to participate; people would rather have in person (face-to-face) conversations.

de Leeuw and Hox, 2008, stated

“Postal or paper mail surveys and Internet surveys are the two best known forms of self-administered questionnaires, especially in social sciences and in polling. In these surveys, there is no personal contact with the respondent, and all information (for example, instructions, explanations, the questionnaire itself) has to be transmitted through paper or via a computer interface.”

Respondents do not have to interact with anyone when filling out a paper or online survey, making less room for bias. de Leeuw and Hox, 2008, also stated “Because a mailed questionnaire can easily be lost, or thrown away, or lie for days unnoticed and forgotten on a desk or kitchen table, a carefully planned system of reminders and follow-up mailings is necessary.” de Leeuw and Hox suggest that having reminders and follow-ups to an original survey are necessary for good response rates.

Survey delivery methods (in terms of timing) were based loosely around the following figure.

	Postal survey	Mixed-mode survey
Week 0	Letter and postal questionnaire (n = 400)	Letter with request to fill out an Internet questionnaire (n = 400)
Week 1	Thank you card as reminder	Thank you card as reminder
Week 4	Nonrespondents received another postal questionnaire	Nonrespondents received reminder for the Internet questionnaire and a paper version of the questionnaire
Week 6	Nonrespondents : reminder to fill out previously received postal questionnaire	Nonrespondents : reminder to fill out Internet questionnaire or previously received paper questionnaire

Figure 6. Survey Time Dates (Zuidgeest et. Al 2011)

Figure 6 shows that the survey was sent out via paper and had an online version as well. Week zero is the week the survey is sent out, a reminder is sent out for week four, and the second wave is sent out ideally in week eight.

The literature review has provided evidence of the supply chain issues regarding the wood products industry and construction industry in general. The review has offered insights into how certain industries conduct supplier selection, how the construction industry itself conducts

supplier selection, and the issues presented in the logistics as well as acknowledgment of possible cost and logistic efficiency issues within the industry. There is an issue regarding the general knowledge about wood products suppliers within the construction industry. The lack of knowledge of suppliers being closer (i.e. possibly being within the construction company's own state) may cause construction companies to pay more in transportation costs, more for a similar product, as well as possibly paying more for an inferior quality product. This lack of knowledge about wood products suppliers is detrimental to cutting costs for construction companies, as well as for the local wood products suppliers losing sales.

3. Goals and Objectives

The primary goal of this project is: *to identify construction company procurement decisions and supplier selection factors to produce recommendations for wood products suppliers to follow for increasing demand in the construction industry.* The implementation of a knowledge database of locations of wood products suppliers in the states within this study would be ideal for supplementing the lack of this knowledge within the construction industry. Additionally, guidelines based on construction industry supplier selection information gathered through a survey questionnaire sent to construction companies in the states included in this study will help provide insight into how local wood product suppliers can gain more market share.

The main research question for this thesis is: can construction company procurement decisions and supplier selection methods help produce recommendations for local wood product suppliers to follow in hopes of gaining more market share within the construction industry? The main hypothesis tested was company size is equal to communication with suppliers, bigger companies have better communication than smaller companies. Communication with suppliers was shown to be a major supplier selection factor. This research aims to provide guidelines that will help wood product suppliers assess their current business model and make minor changes to improve factors to make them more aligned with construction company needs. The three objectives in this study were as follows:

1. Identify companies and stakeholders in the construction sector within the stated region.
2. Identify key determinants in the purchasing decisions of construction companies.
3. Produce recommendations for sellers and buyers to follow for selling and purchasing wood products.

The objectives explored how to solve issues involving both the construction industry logistics and cost issues, as well as local wood product suppliers demand issues.

4. Methodology

This research involved interviews with construction companies in the U.S. southern states of Virginia, South Carolina, Georgia, Florida, Oklahoma, and Texas. Calls to construction companies within these states as well as in-person interviews were conducted to gain insight into their procurement decisions, purchasing factors, and supplier selection in general. Interviews with utilization marketing specialists in the given states were conducted as well to gain more of an understanding of the construction industry within the state. The information shared by these companies was used to draft a questionnaire that was sent out to additional construction companies within the states mentioned earlier. There were 500 construction companies generated randomly by a third-party Standard Industrial Classification (SIC) Code database website for each state in the study for a total of 3,000 companies. The first objective used interviews with the utilization marketing specialists as well as database searches, to help identify companies within the construction sector. For the second objective, interviews with companies in the construction field were conducted, over the phone as well as in person. Two to three companies in each state were interviewed over the phone as well as in-person totaling at least four interviews per state. A questionnaire based on their responses and the literature review was drafted and sent out to identify key factors in their purchasing decisions. The third objective drew from the responses of the survey to produce a model based on key factors in wood products supplier selection.

4.1 Objective 1

Objective 1: Identify companies and stakeholders in the construction sector within the stated region.

4.1.1 Task 1: To Determine the State of the Construction Industry in the Key States.

4.1.1.1 Description of Activities and Methods:

As a general overview of the construction industry in the U.S. private construction spending reached approximately \$992 billion in 2018. By 2022, new construction projects are forecasted to reach over \$1.53 trillion. The U.S. gross domestic product totaled \$19.5 trillion in 2017, and construction contributed \$781 billion to that total (Simonson 2019). Nonresidential spending in the U.S. totaled \$748 billion in 2018, with \$435 billion in private construction and \$295 billion in public construction (Simonson 2019). Looking at the states involved in this study, Virginia, South Carolina, Georgia, Florida, Oklahoma, and Texas, construction plays a vital role in their economies. In Virginia, construction projects contributed \$20.2 billion of the state's gross domestic product of \$510.6 billion. (Simonson 2019). Private nonresidential spending in Virginia totaled \$6.9 billion in 2017, and state and local spending totaled \$5.9 billion (Simonson 2019). In South Carolina, construction projects contributed \$11.5 billion of the state's gross domestic product of \$221.7 billion (Simonson 2019). Private nonresidential spending in South Carolina totaled \$5.4 billion in 2017, and state and local spending totaled \$5.6 billion. For Georgia, construction projects contributed \$22.4 billion of the state's gross domestic product of \$563.6 billion (Simonson 2019). Private nonresidential spending in Georgia totaled \$9.1 billion in 2017, and state and local spending totaled \$6.2 billion. Florida's construction contributed \$49.7 billion of the state's gross domestic product of \$976.4 billion (Simonson 2019). Private nonresidential spending in Florida totaled \$16.5 billion in 2017, and state and local spending totaled \$12.7 billion (Simonson 2019). Oklahoma's construction contributed \$6.9 billion of the state's gross domestic product of \$188.6 billion (Simonson 2019). Private nonresidential spending in Oklahoma totaled \$3.7 billion in 2017, and state and local spending totaled \$3.9 billion (Simonson 2019). Finally, Texas' construction contributed \$87.5 billion of the state's gross

domestic product of \$1.7 trillion (Simonson 2019). Private nonresidential spending in Texas totaled \$44.7 billion in 2017, and state and local spending totaled \$30.8 billion (Simonson 2019).

More specifically, questions were asked in an interview with each state’s utilization market specialist regarding the state of the construction industry and how the construction industry is linked to wood products as a whole. Table 13 indicates the questions asked in interviews with the state utilization marketing representatives.

Table 13. Questions for Interviews with State Utilization Marketing Representatives

Question	Type of Question Asked
What could you tell me in general terms about the construction industry in your state?	Industry information
Do you have any information on main stakeholders of the construction industry in your state?	Industry information
Based on your knowledge, what characteristics are contractors looking for when searching for suppliers?	Supplier selection
Is there a database with a list of construction companies for your state?	Company information
What construction companies would you suggest visiting for an onsite tour and interview?	Company information

4.1.2 Task 2: To Determine Construction Companies Within the Key States

4.1.2.1 Description of Activities and Methods:

For determination of preliminary phone interviews with construction companies, suggestions from the state marketing representatives were taken into account. Primarily, they were looking at the various state home builder associations to see if any other databases existed. Table 6 describes the comments for each state involved in the study regarding finding construction companies.

Table 14. Discovering Companies for Each State

State	Comments	Helpful Websites/ Contacts
VA	<ul style="list-style-type: none"> ● Looked on AGC (Associated General Contractors) VA member index, researched companies found ● Went to ABC (Associated Builders and Contractors), only for members ● Viewed list of 2018 executive club members 	<ul style="list-style-type: none"> ● www.nxtbook.com/naylor/VGCD/VGCD0018/index.php#/42. ● https://www.abcva.org/Membership/Membership-Directory.
FL	<ul style="list-style-type: none"> ● Florida Building Association and other suggested websites, no access to company names. ● Found link to Associated General Contractors of America website, was able to find and use a huge list of members 	<ul style="list-style-type: none"> ● http://fhba.com/membership/local-hba/ ● https://directory.agc.org/
SC	<ul style="list-style-type: none"> ● Called Building Industry Association of SC, was told to go to website member page ● Was able to view company profiles 	<ul style="list-style-type: none"> ● http://www.biaofcentralsc.com/
OK	<ul style="list-style-type: none"> ● Found many companies on OK directory and Certified Builders Website and also on Associated General Contractors of America website 	<ul style="list-style-type: none"> ● https://www.oshba.org/current-certified-builders. ● https://www.webuildoklahoma.com/pages/membership-search.asp. ● https://directory.agc.org/
TX	<ul style="list-style-type: none"> ● Found many companies on Texas Builders Website and also on Associated General Contractors of America website 	<ul style="list-style-type: none"> ● https://directory.agc.org/ ● http://www.texasbuilders.org/membership/member-directory.html#bf_dirFrame_2831.
GA	<ul style="list-style-type: none"> ● Associated General Contractors of Georgia (AGCGA) website was not as helpful as the Construction Association website (AGC) 	<ul style="list-style-type: none"> ● https://www.agcga.org/web/Copy_of_Find_Members/web/eCommerce/Directories/Public_Organization_Search.aspx?hkey=f738821c-2137-49d3-b1f9-66f5076ef240 ● https://directory.agc.org/

Using the various methods in Table 14, a list of ten to twelve companies for each state was generated to be contacted about phone interviews regarding their supplier selection process. This original list was also used for in-person interviews that were conducted after the phone interviews. The goal was to receive least two to three interviews per state, including phone and in person interviews.

For generating companies for the survey, a third-party website was used to compile a randomly generated list of 500 companies under specific categories per state for a total of 3,000 companies involved in the study. The companies were under the categories of: general contractors, home builders, construction companies, building contractors, and home improvements. General contractors, home builders, building contractors, and home improvement companies all use wood products as do construction companies, so it was important to know if they purchased from local wood products suppliers, to gain a broad perspective of supplier selection and purchasing. Sometimes, these companies were under the umbrella of a construction company as well.

4.2 Objective 2

Objective 2: Identify key determinants in purchasing decisions of construction companies

4.2.1 Task 1: To Identify Factors of Supplier Selection

4.2.1.1 Description of Activities and Methods:

A comprehensive literature review was conducted regarding important factors in supplier selection. Table 15 describes a summary of the factors found in literature from various sources.

Table 15. Analysis of Peer Reviewed Articles

Factors in Supplier Selection	Definition	Number of Times Mentioned	Authors
Cost	Price contractor must pay supplier for product	12	(Cengiza et al 2017) (Schramm & Morais 2012) (Dickson 1966) (Lu & Geyao 2010) (Kannan 2018) (Ordoobadi 2009) (Ting & Cho 2008) (Verma & Pullman 1998) (Alayeta et al 2018) (Saf et al 2014) (Galankashi et al. 2015) (Navarro 2018)
Quality	Percentage of product that meets specified requirements	11	(Dickson 1966) (Ordoobadi 2009) (Schramm & Morais 2012) (Alayeta et al 2018) (Ting & Cho 2008) (Kannan 2018) (Cengiza et al 2017) (El Mokadem 2017) (Percin 2006) (Galankashi et al. 2015) (Navarro 2018)
Delivery	Agreed upon time it will take for supplier to deliver whole order to contractor and type of method of transportation that delivers product to agreed location	8	(Cengiza et al 2017) (Ting & Cho 2008) (Ordoobadi 2009) (Dickson 1966) (Verma & Pullman 1998) (Saf et al 2014) (Galankashi et al. 2015) (Navarro 2018)
Flexibility	Ability of supplier to maintain resilience after orders need to be adjusted or a problem occurs	5	(Kannan 2018) (Ting & Cho 2008) (El Mokadem 2017) (Percin 2006) (Navarro 2018)
Location	Distance between contractor and supplier	3	(Percin 2006) (Galankashi et al. 2015) (Navarro 2018)
Relationship	How easy it is to communicate, coordinate, and cooperate with a contractor at the tactical and operations levels. Supplier performs in accordance with agreements.	3	(El Mokadem 2017) (Percin 2006) (Navarro 2018)
Payment Options	Flexible payment options and scheduling	1	(Cengiza et al 2017)

The interview questions for construction companies were based on the factors listed in table 15, along with asking open ended questions to the companies to gain insights into how their purchasing process worked. The literature review along with the construction company interviews helped influence the types of questions asked on the survey questionnaire as well. Production variables of suppliers were also considered when drafting questions for interviews and the survey. The variables included: production capacity and flexibility, technical capabilities and support, information and communication systems, financial status, innovation, and research and development (Taherdoost & Brard, 2019). Some companies and marketing representatives mentioned that the production capacity and factors of a wood products supplier could influence the decision of selecting a supplier.

4.2.2 Task 2: To Interview Construction Companies Within the Key States

4.2.2.1 Description of Activities and Methods:

Ten to twelve construction companies from each state were contacted about the possibility of conducting an interview over the phone regarding their purchasing decisions and supplier selection. Two to three companies per state were willing to do a telephone interview. Table 16 shows the questions asked during the phone interview, as well as the type of question asked. It was important to distinguish the type of question that was asked in order to produce the questionnaire.

Table 16. Questions Asked to Construction Companies in a Phone Interview

Question	Type of Question Asked
What are the most important aspects in selection of wood products suppliers?	Supplier selection
What is your purchasing process? Describe.	Purchasing
Who are your key suppliers home centers, distributors, direct sales from manufacturers?	Supplier information
What is important in the relationship with your suppliers?	Supplier relationship
How many wood products suppliers do you have?	Supplier information
Do you require bids/multiple quotations?	Purchasing
Do you have a preference for purchasing from local suppliers?	Supplier selection
What wood products do you use that are purchased within your state?	Purchasing
What is the size of your company?	Company information

These questions provided insight into a construction company’s purchasing decisions as well as brief information about their company. Primarily, the questions focused on how companies buy wood products, their preference for buying from local suppliers, and other important factors when considering suppliers.

Along with the phone interviews, in-person interviews with construction companies were conducted in the targeted states to gain further understanding about their practices. The questions were more in depth because the in-person setting allowed for more complete answers, as well as a better discussion regarding company practices. The questions asked are shown in table 17, as well as a short description of the type of question. The bolded questions indicate questions asked previously in phone interviews as an umbrella to the questions underneath it.

Table 17. Questions Asked to Construction Companies in In-person Interviews

Question	Type of Question Asked
What are the most important aspects in selection of wood products suppliers?	Supplier selection
Why does your company focus on factor X (cost, quality, etc.)?	Supplier selection
For these factors, how do you think your suppliers can improve?	Supplier selection/improvement on process
What is your purchasing process? Describe.	Purchasing
Is there any place in this process where your company can give feedback to the supplier?	Purchasing/feedback
What is the hardest part of the purchasing process and why?	Purchasing
Is there any way to improve the process on both ends?	Purchasing/improvement on process
What is the structure of the procurement process?	Purchasing
How does your company purchase wood products?	Purchasing
Who are your key suppliers?	Purchasing/supplier information
Can new suppliers enter the market and would you be interested in what they have to offer?	Purchasing/supplier selection
What do the key suppliers do well to maintain your company's business?	Supplier relationship
What is important in the relationship with your suppliers?	Supplier relationship
How can the relationship be improved?	Supplier relationship/improvement on process
What do these suppliers do well to maintain relationship?	Supplier relationship
Do you have any advice for smaller, local suppliers to try to get their product considered by companies such as yours?	Advice/supplier selection
Is there supplier training involved in the buying process?	Purchasing
How many wood suppliers do you have?	Supplier information
Does the number of lumber/OSB/etc. suppliers change seasonally?	Purchasing/supplier information
Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when your demand increases/decreases?	Purchasing/supplier information
Do you require bids/multiple quotations?	Purchasing
Is there any way for one supplier to raise itself above another?	Supplier selection
Do you have a preference for suppliers who have better business relationships?	Supplier relationship
Do you have preference for purchasing from local suppliers?	Supplier selection
What is the rough percentage of local to not local suppliers?	Company information
Why do you have no preference for local suppliers/have more preference for local suppliers?	Supplier selection
What could local suppliers do to get more of their product purchased by the company?	Supplier selection/advice
What wood products do you use that are purchased within your state?	Company information/wood product information
Have you looked into other wood products and their uses?	Wood product information
What would you say is the best product you purchase and why?	Wood product information
What is the size of your company?	Company information
Does the size change seasonally, i.e. are there temporary employees?	Company information
Do you think the size of your company affects the relationship between you and smaller, more local suppliers?	Supplier relationship
Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?	Company information/supplier relationship

Again, ideally two to three companies per state were to be interviewed in-person. However, there were obstacles. Only one interview in Florida was obtained due to time constraints.

Unfortunately, interviews in the state of Oklahoma were not conducted, due to construction companies' unwillingness to meet and discuss their information. Despite these circumstances, the interviews conducted gave valuable detailed information about company purchasing processes and supplier selection. The in-person interviews and phone interviews revealed similar information found in the literature. Both methods provided deep insight into company purchasing processes, basic company information, supplier selection at the industry level, business relationships, number of suppliers, and wood product usage. The interviews, as well as the literature, helped formulate the questionnaire.

4.2.3 Task 3: To Send Out Survey Questionnaire

4.2.3.1 Description of Activities and Methods:

The first wave of the questionnaire was sent out the week of March 2nd, 2020. The reminder to complete the questionnaire was sent out the week of March 30th, 2020. The second wave of the questionnaire was going to be sent out the week of April 13th, 2020 and the questionnaire was going to be closed the week of May 11th, 2020. However, due to COVID-19 a different schedule was followed.

For generating companies for the questionnaire, a third-party website was used to compile a randomly generated list of companies under specific SIC (Standard Industrial Classification) codes. The companies were under the categories of: general contractors, home builders, construction companies, building contractors, and home improvement. Information gleaned from literature and company interviews was used to form the survey questions. See Appendix A for a

copy of the questionnaire. The introduction of the questionnaire was designed to discuss the purpose of the survey and why the research was being conducted. The first section described as “Business Information” helped gather basic information about the company being surveyed such as the status of the company, sales made, title of person filling out the survey, etc. This section provided data of how big a company was and where they operated. The next section “Wood Materials used in your Company” asked questions about the types of materials the company used in their projects, where they got their materials from, and if they were aware if the materials they purchased came from in-state suppliers. The “Wood Products Supplier Selection” section of the questionnaire asked detailed questions about how the company chose their suppliers, whether they focused on factors such as: cost, quality, relationship, lead times, etc., as well as, how they searched for their suppliers. The final section “Wood Products Supplier Evaluation” evaluated how well their current suppliers performed and asked for general advice for local suppliers. An online version of the questionnaire was provided as well.

4.3 Objective 3

Objective 3: Produce recommendations for sellers and buyers to follow for selling and purchasing wood products.

4.3.1 Task 1: To Analyze Survey Results

4.3.1.1 Description of Activities and Methods:

The combined survey results and phone call data was put into a statistical software called JMP, from SAS an analytical software company. The results were categorized by wave one, wave two, and if the result was from the paper/online survey or from the phone calls. For the survey, the following questions were not combined with the phone call questions: job title within company,

company sales volume, year firm was established, if the company wanted to be included in an industry directory for wood products, if the company wanted a copy of the report, if the company was under contract for purchasing wood products, if the specific wood product purchased by the company was purchased by a distributor or manufacturer, as well as if it was purchased in-state, out of state, out of country, or did not know where the product was purchased, if the company required a bidding process within the purchasing process, percentage of in-state wood products purchased for the company, various purchasing decision questions within a categorial scale table, various purchasing factors questions within a categorial scale table, and various communication with suppliers questions within a categorial scale table.

4.3.2 Task 2: To Compare the Results to the Literature and Company Interviews

4.3.2.1 Description of Activities and Methods:

The combined results as well as the survey questions that were not combined with the phone call data were analyzed using JMP. The results of both methods were compared to what was seen in the literature, as well as the phone call interviews and in-person interviews that were conducted. This was done to see if the data collection results corresponded to what was seen in the literature regarding supplier selection and purchasing. The interviews and literature also aided in drafting the survey. The survey was used to gain a broad understanding of construction company purchasing practices and supplier selection. The combined data of the surveys and the phone interviews, as well as the survey questions that were not combined provided insight into construction company decision making within the south-eastern United States.

4.3.3 Task 3: To Develop Guidelines Based on Supplier Selection Practices

4.3.3.1 Description of Activities and Methods:

Based on the combined results from the survey and the phone interviews, guidelines and recommendations were made for suppliers. The recommendations were based on responses and results from those companies involved in the construction industry under the categories of: general contractors, home builders, construction companies, building contractors, and home improvements. The recommendations were forwarded to the South Carolina Forestry Commission (the entity funding the project) as a part of a comprehensive report based on the project. The South Carolina Forestry Commission has planned to release the survey data as well as the report to help further the relationship between suppliers and construction companies. The suppliers will be able to use the recommendations to help gain market share and promote products.

4.4 Timeline

A brief timeline of the project to date is described in figure 7.

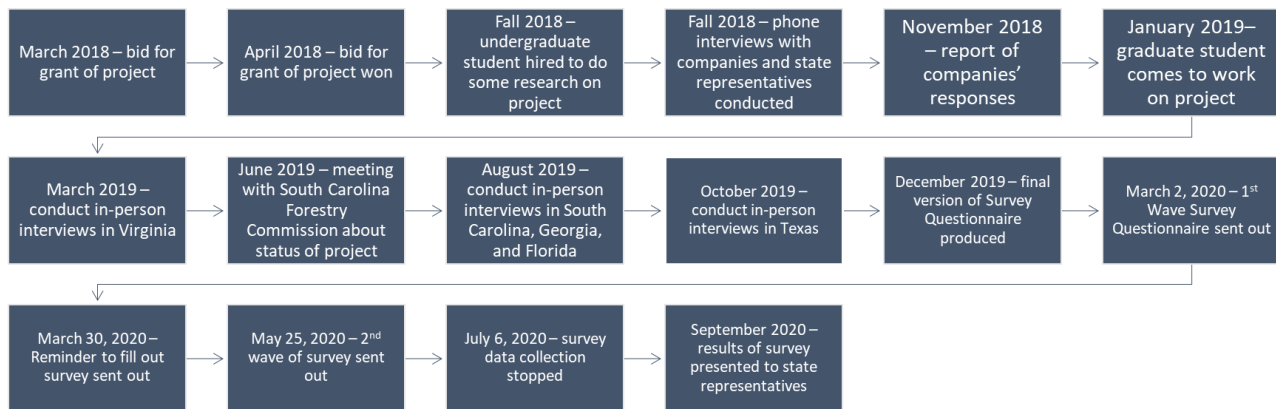


Figure 7. Timeline of Project

5. Results

The results are described below, using the earlier listed objectives.

5.1 Objective 1: Identify companies and stakeholders in the construction sector within the stated region.

The Virginia representative, during a telephone interview, said construction business depended on where in the state, as there seemed to be more construction near cities as opposed to rural areas. However, he did not have a lot of information, but he noticed a lot more timber, as opposed to metal construction in smaller buildings. There not much information about the stakeholders within the state, but the state directories might have more input. According to the Virginia representative who was interviewed, factors that contractors were looking for in their suppliers included: price/cost, reliability, delivery time, and making the job easier for the contractor. He was not aware if there was a database available for the construction companies within the state. He suggested: The Home Builder's Association, American Wood Council, and the Southern Forest Products Association. He had no suggestions for construction companies willing to host an onsite tour.

The South Carolina representative mentioned in a telephone interview, that the construction industry was a major driver of demand for the wood products industry. He said that some of the largest firms in America have offices outside of South Carolina, however he did not know the size of industry. There was not a lot on information available on the primary stakeholders, but more information was available on wood products associations. Clemson University, in South Carolina, has a department that focuses on working to increase wood use from the south-eastern region of the U.S. Cost was the major factor he emphasized regarding what contractors are looking for, but he implied that companies may not know about the sheer number of local wood

products suppliers willing to do business in the state. He was not aware if there was a database for construction companies within the state. He emailed information about one company willing to do an onsite tour.

The Georgia representative mentioned that the construction industry was doing well, perhaps due to the current administration, at the time this interview was conducted, that was the Trump administration. He saw a lot of houses, remodeling, smaller projects, etc. when he traveled. Commercial projects were also using a lot of wood products such as hotels and restaurants. He did not have data involving the construction industry and did not have any contacts within the industry. However, he mentioned Woodworks had a booth in Atlanta for education courses involving continuing education courses. Characteristics involved when searching for suppliers included the cost and supply of material. More specifically, cost would be the primary concern for contractors, although the supplier must also have a good supply of the product. He mentioned that the head of the national association of home builders was putting out false information regarding to importing timber from Canada. He said that the U.S. did not need to import as much as it does; it was a supply and demand issue. He also said that a lot of lumber mills were not running at capacity, while the prices for timber had gone up there had not been an increase in capacity. The contractors wanted a good supply of wood at a good price. It would not matter to those contractors where the wood came from; it was all about price. For a database, he mentioned there was not a public one, but one that could be purchased called Reference US. He said this publication narrowed down to the specifics of each industry. Many homes being built were in rural areas, and he said many large companies would not do business in rural areas, so local builders and local contractors were building in these areas. He mentioned a specific company that might be willing to do an onsite tour.

In Florida, business was also doing well according to the state representative during a telephone interview. He did not know where the wood was coming from, though he wanted to increase the consumption of local wood products. For the Florida Forestry Association, he established some contact, they were not directly involved with wood products, but with timber. He gave a contact for their information. There were a few associations that he mentioned as well. Again, the primary factor for contractors looking at suppliers was cost, then location of the supplier. He suggested familiarity of products and certain species was important. He was not aware of any database available involving construction companies, and was not aware of any construction company available for an onsite tour.

For Texas, again business was described as doing well and there were a lot of construction companies within the state. The state representative in a telephone interview, did not have any information regarding stakeholders and had no information regarding construction companies. Factors that the representative highlighted were first, location as this affects transportation costs, second was quality of the product, and the third factor mentioned was cost. This order was interesting in that cost was listed last as one of the factors, and the representative emphasized location over the other factors listed. The size of the supplier mattered, implying that the larger supplier might have a better reputation and could be trusted more than a smaller supplier. The representative emailed information for a website she was aware of for a database involving construction companies. The representative was not aware of any company available for an onsite tour.

The Oklahoma representative was contacted, however they never replied to share information about the state, so their input was not listed.

In general, the construction industry in each state seemed to be doing well and have a lot of business according to the representatives' answers. A lot of factors involving supplier selection that the representatives highlighted supported what was seen in literature. These factors included cost, location, supply, quality, reliability, and delivery time. A couple of factors that were interesting were the production capacity of a supplier and the species used for the wood products. There was not a much information available to stakeholders within the construction industry. An underlying problem found within all states was the lack of information available to construction companies for local wood products suppliers. This could lead to construction companies paying more in terms of transportation costs due to not being aware of local suppliers. Also, due to lack of knowledge, the construction companies did not have more options regarding supplier selection, so they could not negotiate deals or offers. There were not many databases in the states that contained construction company information. Basically, a lot of the issues construction companies experienced stem from lack of information regarding suppliers as well as too few databases available.

5.2 Objective 2: Identify key determinants in purchasing decisions of construction companies

Using the literature review, as well as the insights from the state marketing representatives, questions were drafted to ask construction companies during telephone and in-person interviews.

Table 18. Summary of Responses from Phone Interviews with Companies

State	Company	Important Factors	Key Suppliers	Relationship Importance	# of Wood Suppliers	Require Bids	Preference for Local Suppliers	Size of Company by Employees
FL	1	Cost, quality, reputation	Direct sale from manufacturers, distributors	Reputation, reliability	2	Yes	Yes	500
FL	2	Cost, distribution, chain of custody	Distributor, home center	Proximity, communication, availability	2	Yes	No	40
FL	3	Cost, efficiency	Distributors	Availability, ease	3	No	Yes	40
GA	1	Cost, availability	Distributors	Reliability	5	Yes	Yes	90
GA	2	Quality, cost	Distributors	Communication	40	Yes	No	55
GA	3	Cost, availability, reliability	Distributors	Communication	6	Yes	Yes	15
OK	1	Cost, availability, reliability	Distributors	Communication, information	2	Yes	Yes	16
OK	2	Service, cost, distribution	Distributors	Service	2	Yes	No	15
SC	1	Cost, represent company values, service	Home centers, distributors	Service	2	No	Yes	4
SC	2	Cost, service, availability, quality, lead time	Distributors	Trust, reliability, availability	6	Yes	Yes	10
TX	1	Cost, relationship	Distributors	Reliability, established credit	2	Yes	Yes	110
TX	2	Cost, reliability	Distributors	Trust, communication	45	Yes	Yes	33
VA	1	Cost, service, distribution	Direct sale from manufacturers	Reliability, service	4	No	No	5200
VA	2	Cost, distribution	Direct sale from manufacturers	Reliability	4	No	No	5000
VA	3	Cost	Home centers, distributors	Proximity, communication	3	No	No	90

Table 18 summarized responses from telephone interviews with construction companies. Two to three construction companies from each state responded to telephone interviews. Cost, service, and distribution were mentioned often as important factors for supplier selection. The companies often indicated that key suppliers were distributors. Communication, reliability, and service were emphasized regarding the relationship importance between the suppliers. The companies responded that they had few suppliers rather than a large number. Companies listed they had six or less suppliers. Most companies indicated that they required bids for their purchasing process, and had a preference for local suppliers. The size of the company by number of employees varied greatly.

Table 19. Summary of Responses from In-Person Interviews

State	Company	Important Factors	Purchasing Process	Key Suppliers	Relationship	# of Wood Suppliers	Local Suppliers Preference	Wood Product Information	Company Size
VA	1	Not going to take cheap route, will pay for quality, billing can be a struggle	Bidding if new supplier, constant communication, complicated process, data driven	Looking for new suppliers in the market, key suppliers deliver on: price, product and service. Offer good service	Improve on: price, performance, quality, value components. Good communication	Number does not change seasonally, tries to have even flow so does not have to lay off employees	Labor is more local than supplier, big company tends to strain relationship with smaller, local suppliers	Always looking at new wood products and different wood products for their uses	Big sales for company, have temporary employees for labor
VA	2	High volume production with low margin, lead time, price and quality go hand-in-hand	Bid 6 months ahead, share bids with multi-construction, lumber yards buy from middle-man	Have constant suppliers, always looking at new leads	Good relationship key, information as well, reliable sourcing	Pretty constant supplier source	No big preference, whoever is going to work well	All types of wood products, but mainly deal with lumber	Cannot really say, does not have information
SC	1	Biggest is price, relationships are there but not made without price	Quarterly process to put out bids, place to give feedback	Big distributors tend to be big suppliers, always want to look at new leads	Customer service, transparency	Around six suppliers	No preference, majority of suppliers are nonlocal	Nominal lumber, pressure treated, engineered wood products, oriented strand board	Around 2,000 home per year, size sometimes affects relationship with smaller suppliers
SC	2	Service, responsive sales, next is price	Before job start estimate is done, lead times are difficult	Three different companies with lumber yards, possibly interested in new suppliers	Honesty, communication, competitive pricing	Three local lumber yards, numbers do not change seasonally	More preference for local, makes for easier logistics	All wood products, lumber, millwork, trim-work, etc.	Small company, 3 employees, around \$6 million per year for sales, no stress over demand
GA	1	Cost, supply, quality for company	Bidding process, tries to have feedback loop during entire process	Big distributors	Communication and accurate lead times, good pricing	Hard to say, around 40 suppliers	No preference, have contracts with bigger distributors	Lumber, engineered wood products	Around 55 employees, tries to have steady workflow
GA	2	Cost, availability	Bidding process, feedback during it	Home centers and distributors	Trust and reliability, good communication	5-6 keep the number constant	Preference for local to make logistics easier	Lumber	90, steady workflow
FL	1	Cost, delivery time	Bids, want to have better communication	Big distributors, some smaller yards	Communication, product stands out	10 constant suppliers	No preference, nonlocal suppliers have better pricing for company	Lumber and engineered wood products	60, constant size
TX	1	Cost and quality	Quoting	Lumber yards	Service, delivery time, honesty	2-3, stays constant	Preference due to good service	Spruce-pine-fir lumber	Subcontract 50 employees
TX	2	Price, time, service	Calls certain people	Small distributors	Service, trust, speed	2-3, constant	Tries to buy local, cheaper	Everything needed for houses	5 employees, stays constant

Table 19 summarized responses from in-person interviews with construction companies. The in-person interviews used the questions asked during the telephone interviews and expanded upon them. Two to three companies per state were interviewed. However, one company was interviewed from Florida and zero companies were interviewed from Oklahoma due to the limitations of time constraints and unwillingness to participate. Companies responded that factors such as cost, service, and quality were important for their suppliers. For how the companies purchased wood products, companies often responded they have a bidding process for their suppliers to follow. Key suppliers were distributors or lumber yards. Home centers were mentioned as well. Construction companies emphasized trust, service, and delivery time in regards to the relationship with the supplier. As seen with the telephone interviews, companies replied that they had low numbers of suppliers, usually two or three. Companies tried to have more preference for local suppliers as it was cheaper and made for easier logistics. Companies responded they buy all types of wood products like lumber, engineered wood products, millwork, etc. Lumber was emphasized as being purchased often. The company size according to the employee number was varied. The in-person interviews had similar responses to the telephone interviews, these responses helped draft the survey questionnaire.

Appendix B has the detailed in-person interviews from the Virginia companies, Appendix C has the South Carolina companies, Appendix D the Georgia companies, Appendix E the Florida company, and Appendix F the Texas companies.

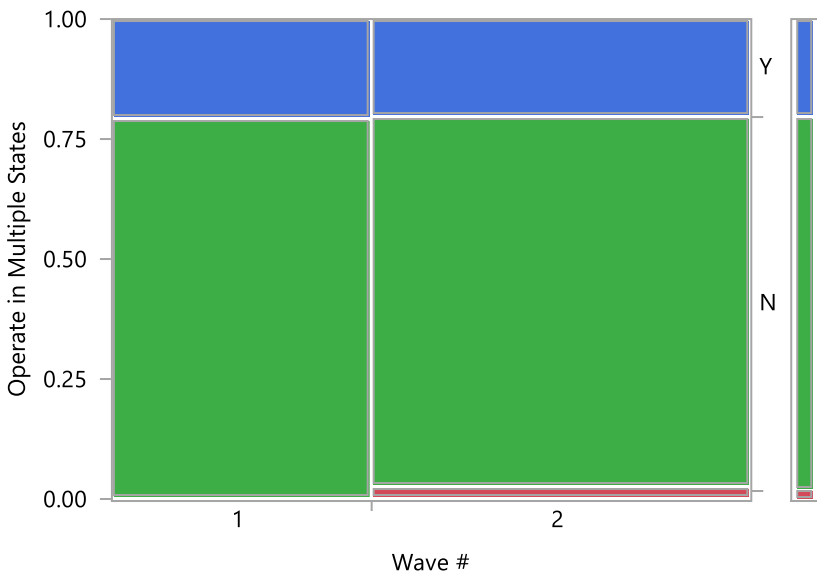
5.3 Objective 3: Produce recommendations for sellers and buyers to follow for selling and purchasing wood products.

5.3.1 Survey Management Procedures

The survey was sent out to 500 companies in each of the states involved in the study for a total of 3,000 companies. The survey was sent out twice in two waves along with a reminder that was sent out between wave one and wave two. The first wave was sent out the week of March 2nd, 2020 and a reminder to fill out the survey was sent out the week of March 30th, 2020. Due to COVID-19, a decision was made to wait to send out the second wave of surveys until the week of May 25th, 2020 since it was not known if companies were doing business during that time period. The survey was closed July 6th, 2020 and no further responses were recorded.

Fifty-nine survey responses were returned over the two waves. There was an issue of nonresponse bias due to lower response rate.

Mosaic Plot



Contingency Table

Wave # By Operate in Multiple States

Count	-	N	Y	Total
Total %				
Col %				
Row %				
1	0	19	5	24
	0.00	32.20	8.47	40.68
	0.00	41.30	41.67	

	0.00	79.17	20.83	
2	1	27	7	35
	1.69	45.76	11.86	59.32
	100.00	58.70	58.33	
	2.86	77.14	20.00	
Total	1	46	12	59
	1.69	77.97	20.34	

Tests

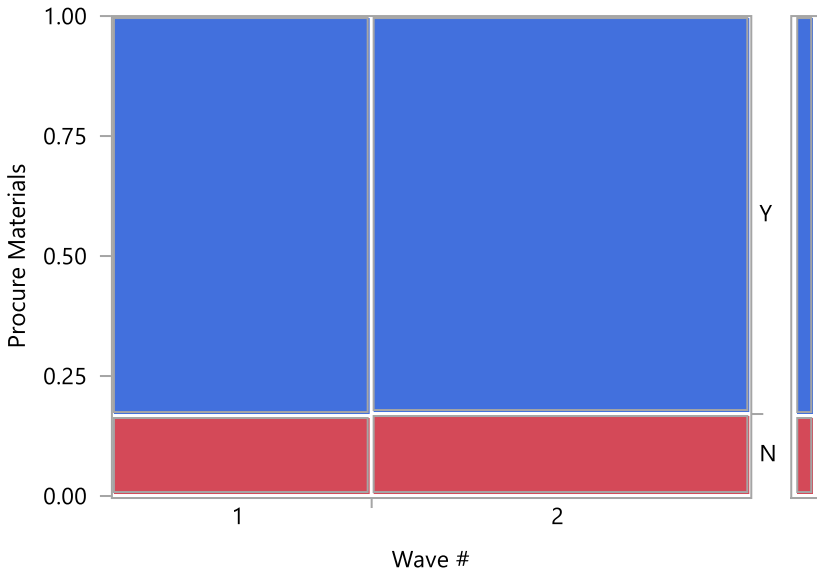
N	DF	-LogLike	RSquare (U)
59	2	0.52834767	0.0153

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.057	0.5896
Pearson	0.698	0.7054

Figure 8. Contingency Analysis for Wave Number by Operating in Multiple States

However, since the second wave had similar numbers of responses to the first wave, it can be inferred the second wave was representative of the population. The null hypothesis (H_0) was that the proportion of the data was the same, and the alternative (H_1) was that the proportion of the data was different. The P-Value for Likelihood Ratio was 0.5896, and for the Pearson test it was 0.7054. Since the P-Values were both over the alpha value of 0.05, the null hypothesis is not rejected so the proportion of Wave 1 responses was the same as Wave 2 responses.

**Contingency Analysis of Procure Materials By Wave #
Mosaic Plot**



Contingency Table

Wave # By Procure Materials

Count	N	Y	Total
Total %			
Col %			
Row %			
1	4 6.78 40.00 16.67	20 33.90 40.82 83.33	24 40.68
2	6 10.17 60.00 17.14	29 49.15 59.18 82.86	35 59.32
Total	10 16.95	49 83.05	59

Tests

N	DF	-LogLike	RSquare (U)
59	1	0.00114837	0.0000

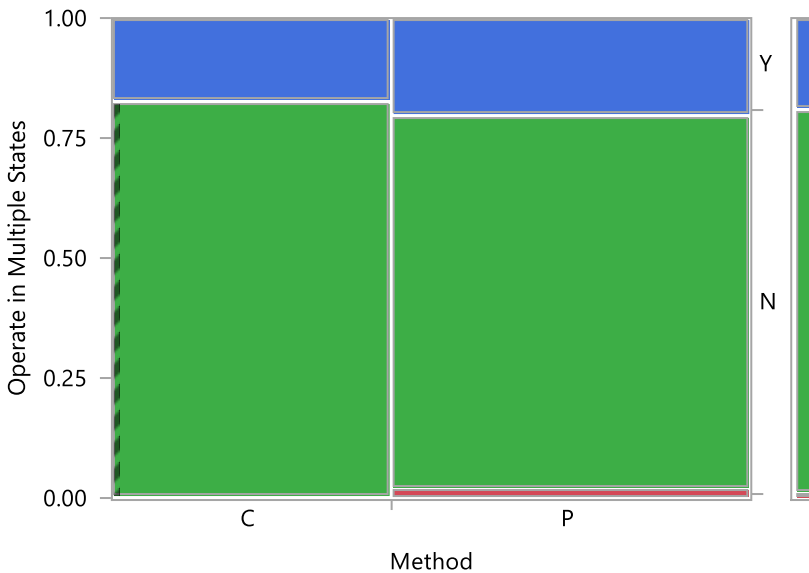
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.002	0.9618
Pearson	0.002	0.9618

Figure 9. Contingency Analysis for Wave Number by Procuring Own Materials

The null hypothesis (H_0) was that the proportion of the data was the same, and the alternative (H_1) was that the proportion of the data was different. The P-Value for Likelihood Ratio was 0.9618, and for the Pearson test it was 0.9618. Since the P-Values were both over the alpha value of 0.05, the null hypothesis is not rejected so the proportion of Wave 1 responses was the same as Wave 2 responses.

Due to this low response rate, phone calls were made to companies based on the list of companies generated from the third-party website. Forty-six companies were contacted for a total of 105 responses, when combined with the survey. Selected questions from the survey were asked on the phone calls to obtain further information.

Contingency Analysis of Operate in Multiple States By Method Mosaic Plot



Contingency Table

Method By Operate in Multiple States

Count	-	N	Y	Total
Total %				
Col %				
Row %				
C	0	38	8	46
	0.00	36.19	7.62	43.81

	0.00	45.24	40.00	
	0.00	82.61	17.39	
P	1	46	12	59
	0.95	43.81	11.43	56.19
	100.00	54.76	60.00	
	1.69	77.97	20.34	
Total	1	84	20	105
	0.95	80.00	19.05	

Tests

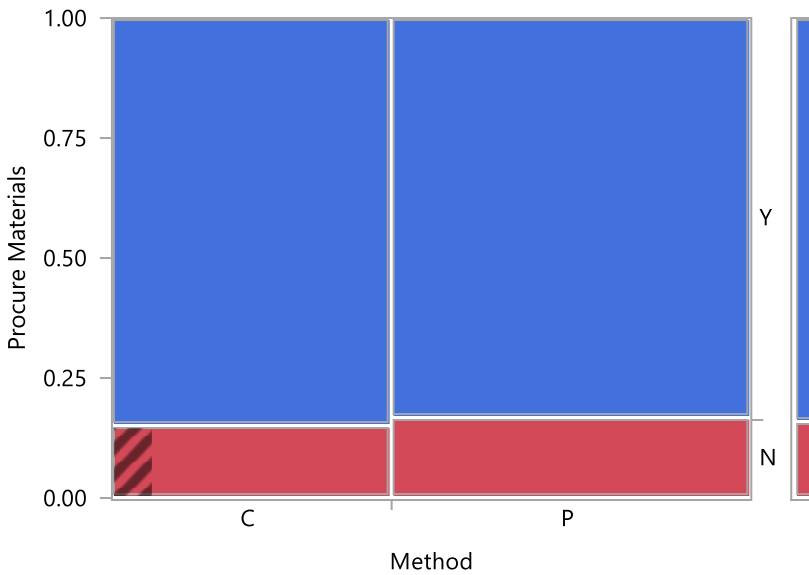
N	DF	-LogLike	RSquare (U)
105	2	0.67055720	0.0119

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.341	0.5114
Pearson	0.967	0.6166

Figure 10. Contingency Analysis for Survey Method by Operating in Multiple States

The null hypothesis (H_0) was that the proportion of the data was the same, and the alternative (H_1) was that the proportion of the data was different. The P-Value for Likelihood Ratio was 0.5114, and for the Pearson test it was 0.6166. Since the P-Values were both over the alpha value of 0.05, the null hypothesis is not rejected so the proportion of phone responses was the same as survey responses. Results from the phone calls and survey were combined and analyzed due to having similar responses as well as similar response rate.

Contingency Analysis of Procure Materials By Method Mosaic Plot



Contingency Table

Method By Procure Materials

Count	N	Y	Total
Total %			
Col %			
Row %			
C	7 6.67 41.18 15.22	39 37.14 44.32 84.78	46 43.81
P	10 9.52 58.82 16.95	49 46.67 55.68 83.05	59 56.19
Total	17 16.19	88 83.81	105

Tests

N	DF	-LogLike	RSquare (U)
105	1	0.02867759	0.0006

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.057	0.8107
Pearson	0.057	0.8111

Figure 11. Contingency Analysis for Survey Method by Procuring Own Materials

The null hypothesis (H_0) was that the proportion of the data was the same, and the alternative (H_1) was that the proportion of the data was different. The P-Value for Likelihood Ratio was 0.8107, and for the Pearson test it was 0.8111. Since the P-Values were both over the alpha value of 0.05, the null hypothesis is not rejected so the proportion of phone responses was the same as survey responses.

Some survey questions were not combined with the phone call data because they were not asked. Those questions were analyzed separately.

5.3.2 Survey Collection Data

Survey and phone call data was collected and compiled into a statistical analysis software called JMP by SAS, an analytical software company. Certain questions were compiled separately from the survey and the telephone interviews. The survey collection data was summarized in the following figures.

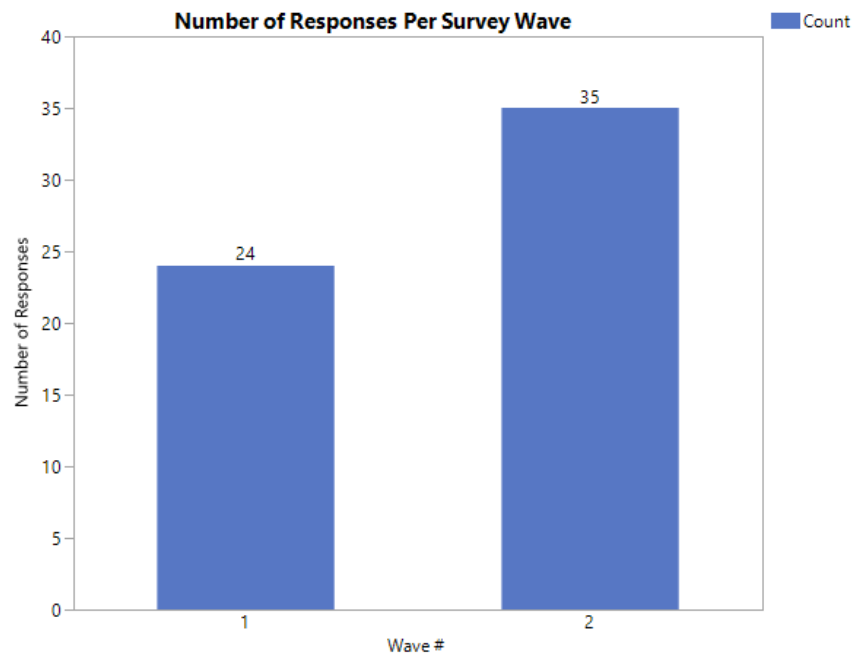


Figure 12. Number of Responses Per Survey Wave

This was not combined with the phone call data since it was survey only data.

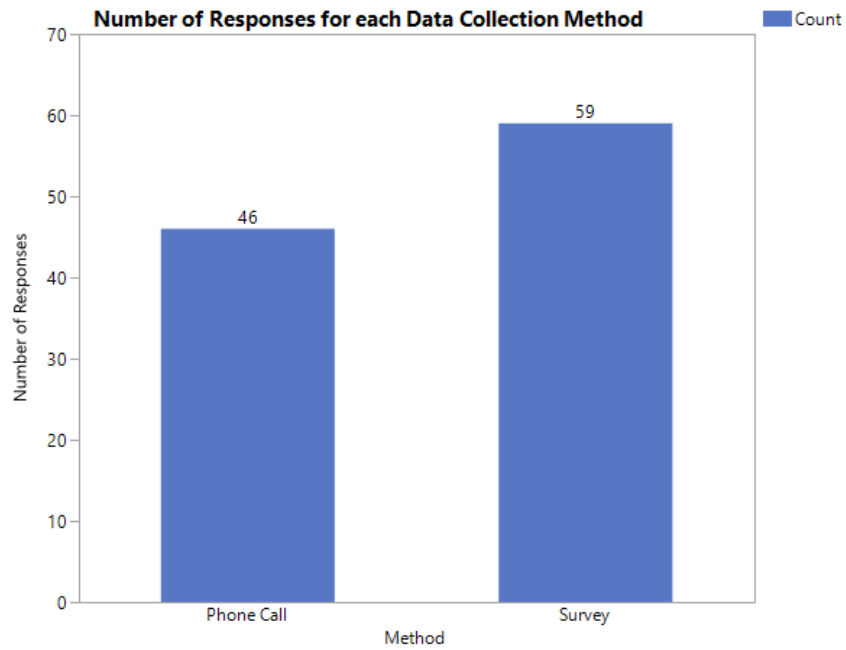


Figure 13. Number of Responses for each Data Collection Method

Phone calls were conducted to gain more responses. The number of phone call responses were similar to the total number of survey responses. The total number of responses was 105.

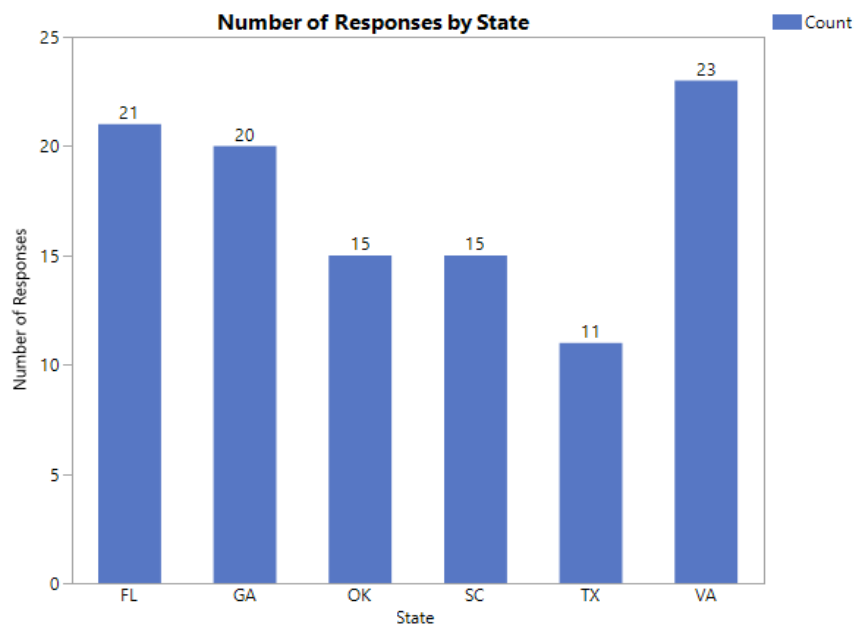


Figure 14. Number of Responses by State Involved in Study

The most responses came from the state of Virginia while the least came from Texas. The phone interview data helped boost responses in states that did not return many surveys.

5.3.2 Business Information/Sector Profile Data

The business information/sector profile section of the survey was summarized in the following figures.

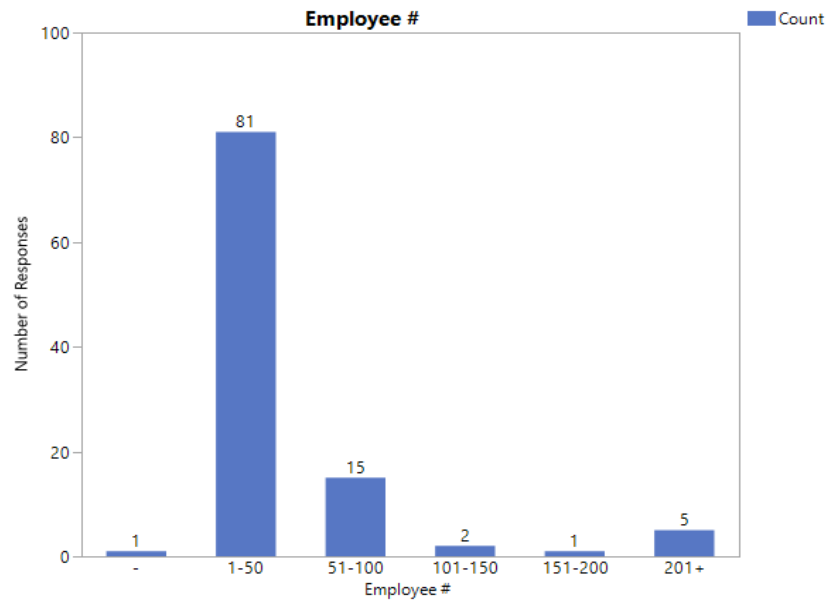


Figure 15. Number of Responses for Total Amount of Employees within a Company

A (-) indicates that a company did not respond to the question. Most companies responded that they had 1-50 employees. This indicated that most companies responding to this study were on the smaller size, in terms of personnel.

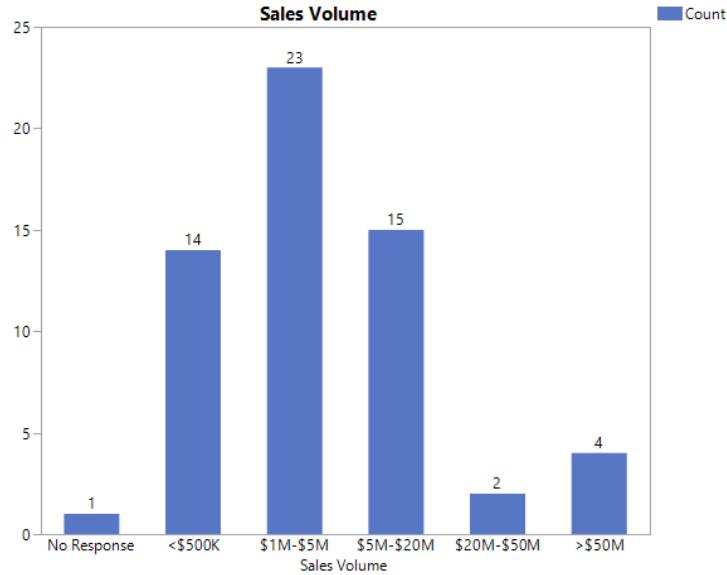


Figure 16. Construction Company Sales Volume

This question was not asked during the phone interviews, so that is why employee number had more responses than sales volume. Generally, companies had smaller sales volume with most responses being \$5 million or less. There were 15 responses for the \$5 million to \$20 million range.

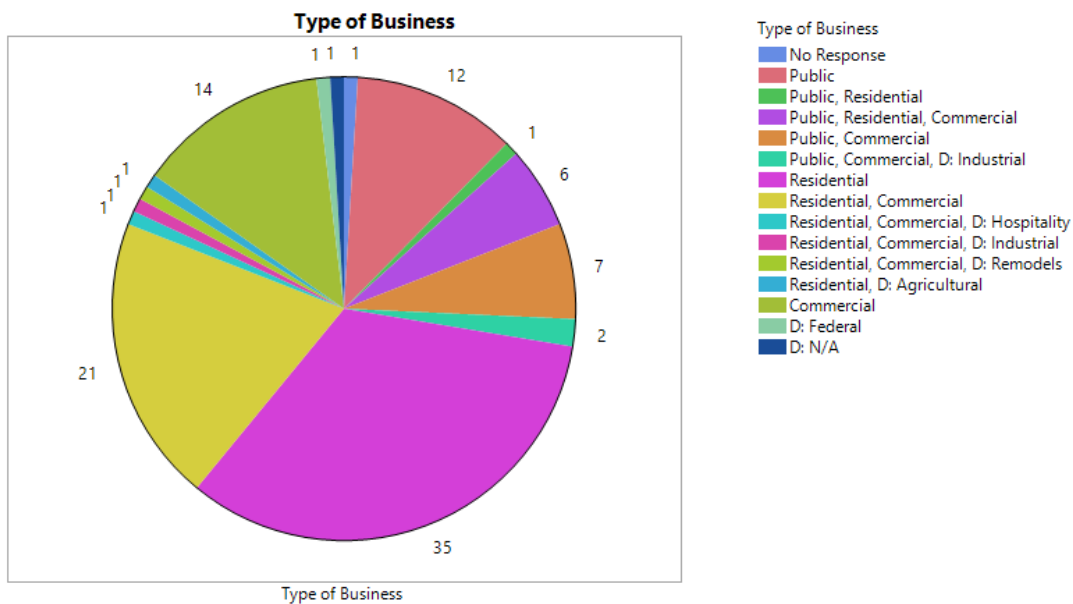


Figure 17. Number of Responses for Type of Business Conducted by the Company

A (-) indicates that a company did not respond to the question. Residential construction had the highest number of responses, followed by residential and commercial combined, then solely commercial construction, and finally solely public construction. Most companies that responded worked mostly in the residential and the commercial sector of the industry.

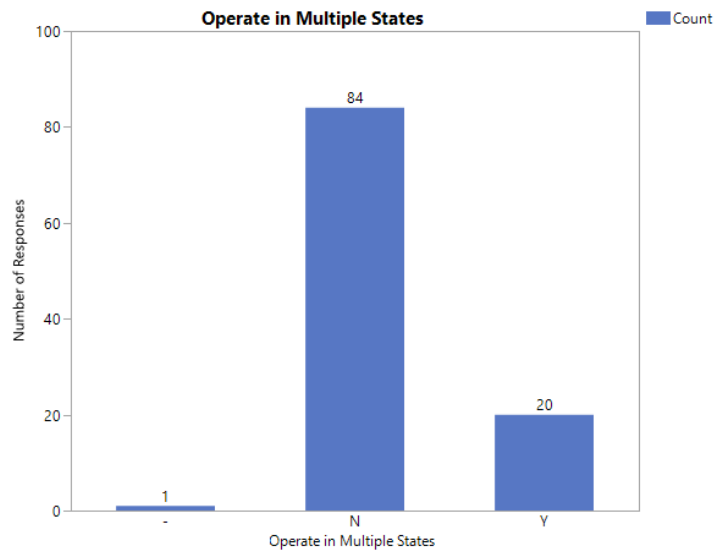


Figure 18. Number of Responses for if the Company Operated in Multiple States

A (-) indicates that a company did not respond to the question. Most companies responded that they did not perform work in other states. This means that the company had most project sites within the home state.

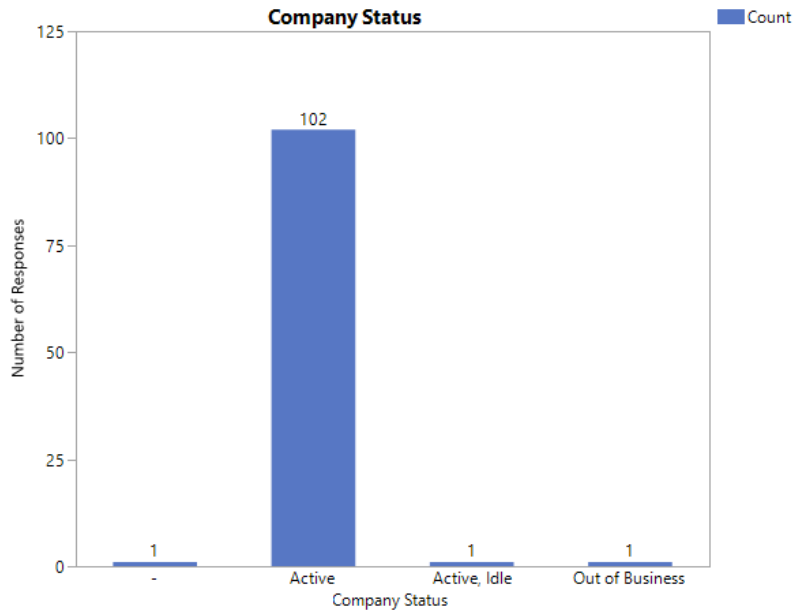


Figure 19. Number of Responses for the Status of the Company

A (-) indicates that a company did not respond to the question. Basically, every company responded that their company was active during 2019. Only one was active and then went idle, and only one went out of business. It was important to see if companies responding actually conducted business.

5.3.3 Wood Materials Used within the Company Data

The wood materials used with the company section of the survey was summarized in the following figures.

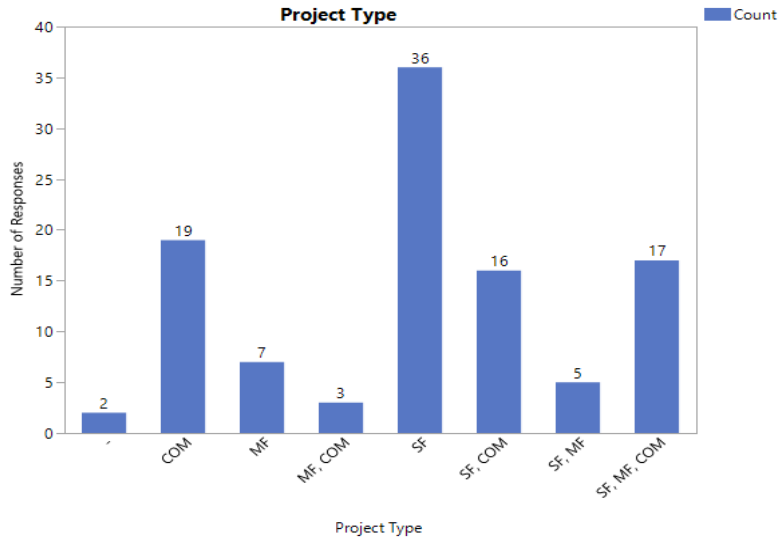


Figure 20. Number of Responses for the Type of Project the Company Worked on

A (-) indicates that a company did not respond to the question. Abbreviations for the construction projects are as follows: single-family homes (SF), multi-family homes (MF), and commercial construction projects are (COM). The most common type of projects worked on by companies were single-family style of homes. Commercial projects were the second most common response. Multi-family projects did not have many responses even when combined with other projects.

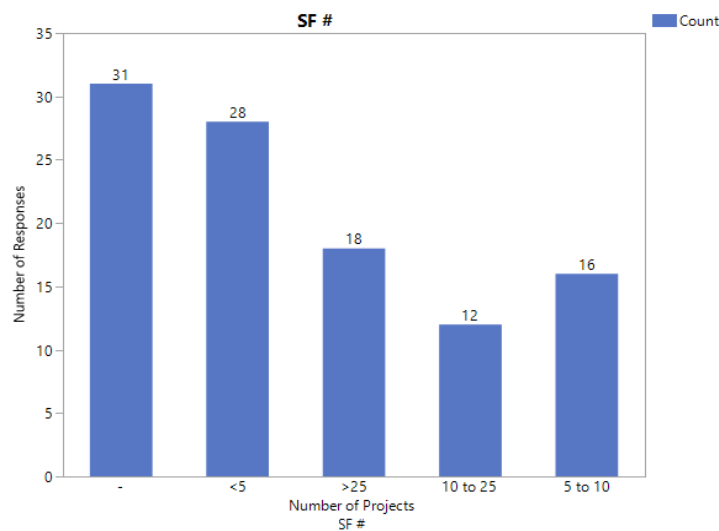


Figure 21. Number of Responses for Number of Single-Family Projects

A (-) mark in this case meant the company did not work on this type of project. Most companies that worked on single-family projects responded that they had a lower number of projects; fewer than five was the most common answer and five to ten was the third most common (not including the (-) mark response.).

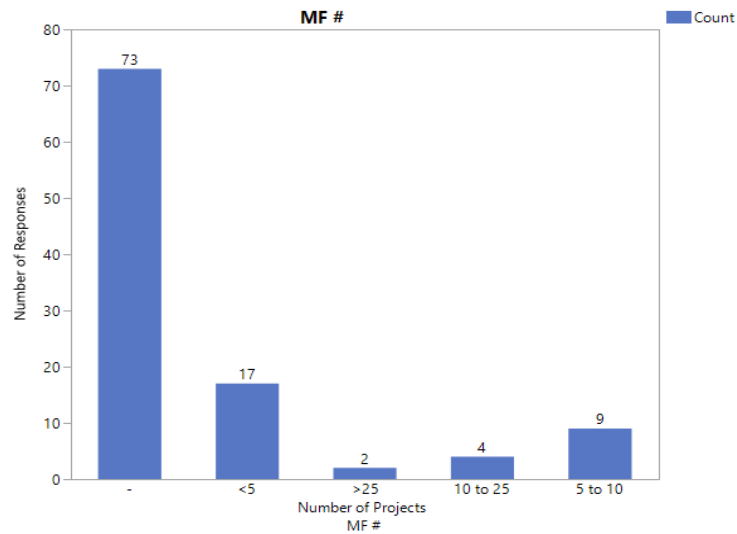


Figure 22. Number of Responses for Number of Multi-Family Projects

A (-) mark in this case meant the company did not work on this type of project. The majority of responses indicated that companies did not work on multi-family project types. If companies did work on multi-family homes, there were not many; the most common responses were less than five and five to ten projects.

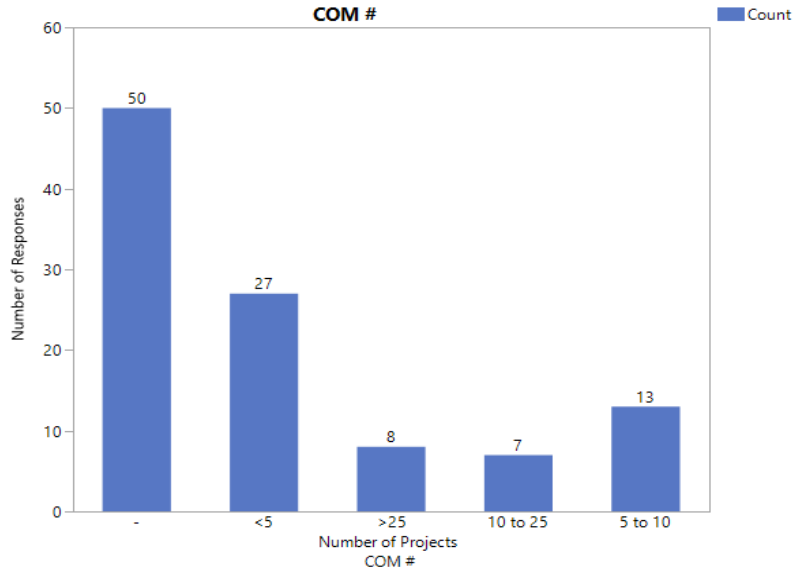


Figure 23. Number of Responses for Number of Commercial Projects

A (-) mark in this case meant the company did not work on this type of project. Most companies responded that they did not work on commercial projects, and if they did the number of projects was low. The most common responses were less than five projects and five to ten projects.

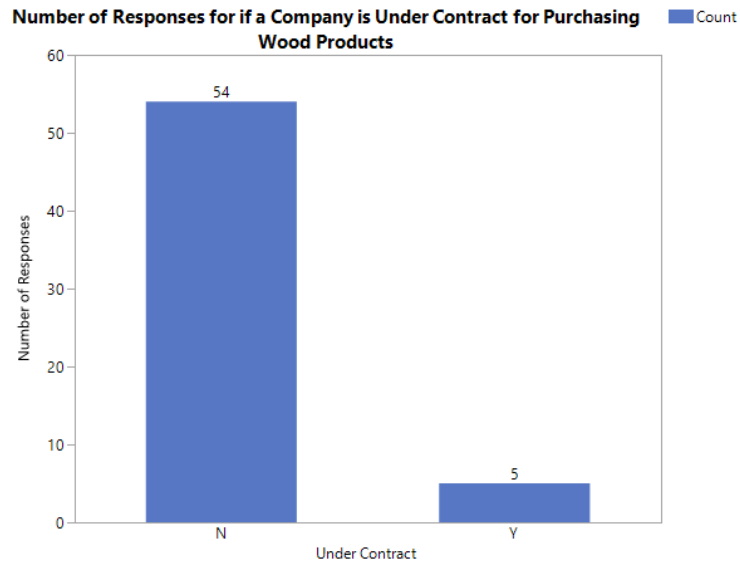


Figure 24. Number of Responses for if a Company was Under Contract for Purchasing Wood Products

This question was not asked during the phone interviews so only the survey data was counted.

The companies under contract mainly used large distributors to purchase wood products.

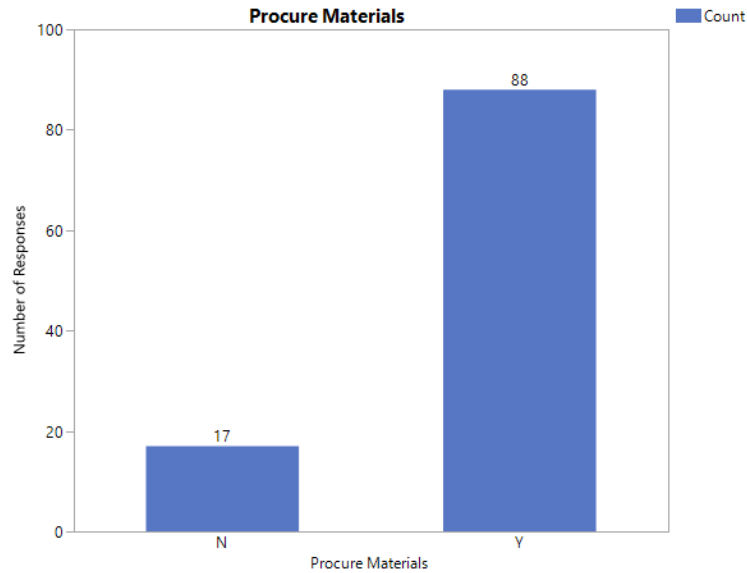


Figure 25. Number of Responses for if a Company Procured its Own Materials

A majority of companies responded that they procured their own wood product materials. This means that most companies were aware of purchasing their own materials, not necessarily where the materials came from

	SL Location		AL Location		ENGWP Location		PLY Location		FLOOR Location	
	N	% of Total	N	% of Total	N	% of Total	N	% of Total	N	% of Total
-	3	5.08%	5	8.47%	5	8.47%	5	8.47%	8	13.56%
DIS	10	16.95%	11	18.64%	10	16.95%	11	18.64%	10	16.95%
DIS, I-S	22	37.29%	19	32.20%	18	30.51%	19	32.20%	16	27.12%
DIS, I-S, OoS	3	5.08%	2	3.39%	4	6.78%	3	5.08%	2	3.39%
DIS, I-S, OoS	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1.69%
DIS, MAN, I-S	0	0.00%	0	0.00%	2	3.39%	0	0.00%	0	0.00%
DIS, MAN, I-S, OoS	1	1.69%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
DIS, OoS	1	1.69%	3	5.08%	1	1.69%	2	3.39%	3	5.08%
DIS, UNK	4	6.78%	4	6.78%	5	8.47%	5	8.47%	5	8.47%
I-S	8	13.56%	8	13.56%	8	13.56%	8	13.56%	7	11.86%
MAN	1	1.69%	0	0.00%	1	1.69%	0	0.00%	0	0.00%
MAN, I-S	0	0.00%	2	3.39%	1	1.69%	0	0.00%	1	1.69%
MAN, OoS	1	1.69%	2	3.39%	0	0.00%	0	0.00%	1	1.69%
MAN, OoS + OoC	0	0.00%	0	0.00%	1	1.69%	1	1.69%	0	0.00%
UNK	5	8.47%	3	5.08%	3	5.08%	5	8.47%	5	8.47%

Figure 26. Number of Responses for if a Company Purchased from a Distributor or Manufacturer and the Location of the Wood Product Purchase

This question was not asked during the phone interviews, so only the survey data was recorded. A (-) meant that the company did not respond. Abbreviations are as follows: SL for structural lumber, AL for appearance lumber, ENGWP for engineered wood products (oriented strand board, fiber board, etc.), PLY for plywood, and FLOOR for flooring. DIS designated the company purchased from a distributor, MAN designated the company purchased from a manufacturer, I-S the company purchased in-state, OoS designated the company purchased out of state, OoC designated the company purchased from outside the country, and UNK designated the company was not aware of where the wood products were purchased. The majority of companies responded they purchased most of their wood products from in-state distributors.

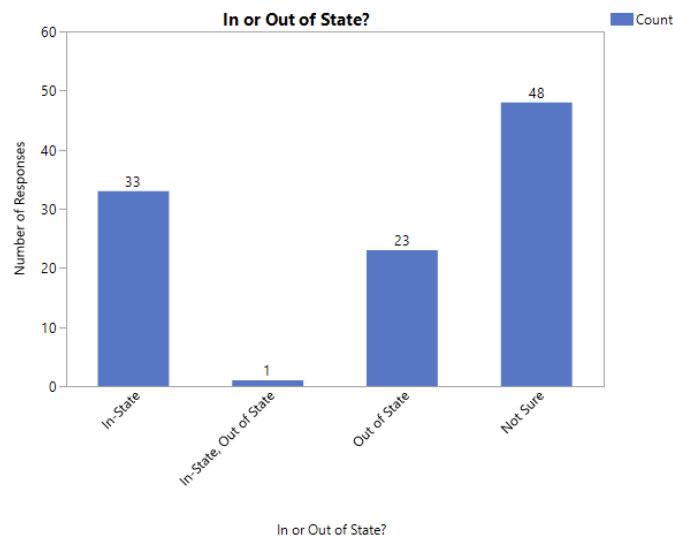


Figure 27. Number of Responses for if the Company Mainly Purchased In or Out of State

A majority of companies responded that they were not aware where their wood products purchases came from. The second most frequent response was that the companies purchased in-state. This indicates that construction companies are mostly unaware of where the products they purchase come from.

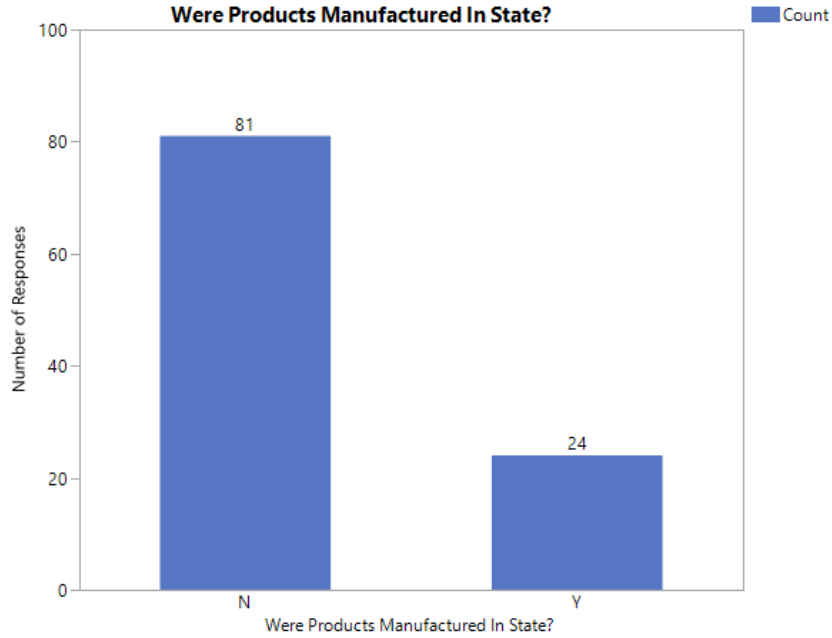


Figure 28. Number of Responses for if the Company was Aware if the Products they Purchased were Manufactured In-State

A majority of companies responded that they were not aware if a product was manufactured within their own state. A product that was purchased within the home state does not necessarily mean that the product was manufactured within that state. Nonetheless, companies were mostly unaware of where the product was purchased nor where it was manufactured.

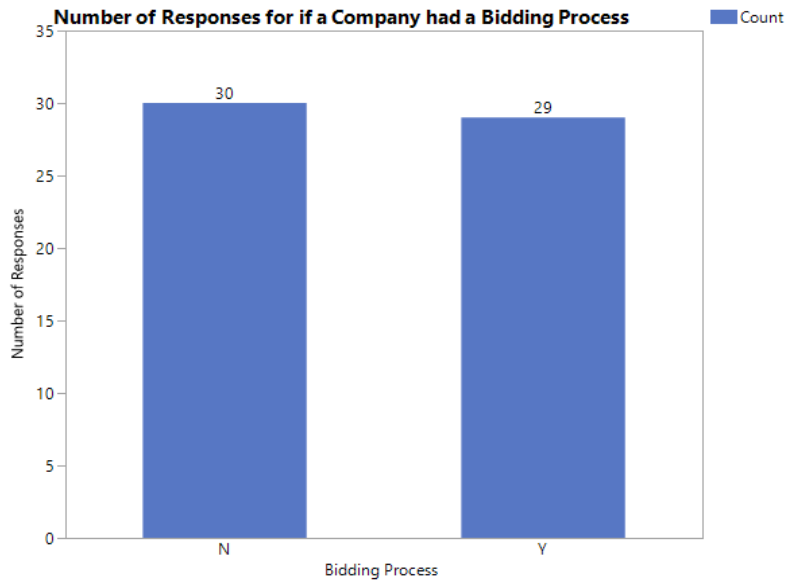


Figure 29. Number of Responses for if the Company had a Bidding Process

This question was not asked during the phone interviews, so only the survey data was recorded.

The responses were split evenly. For those companies that replied that they did not have a bidding process, most of them replied they directly purchased.

	SL %		AL %		ENGWP %		PLY %		FLOOR %	
	N	% of Total	N	% of Total	N	% of Total	N	% of Total	N	% of Total
-	4	6.78%	8	13.56%	5	8.47%	6	10.17%	10	16.95%
0-20%	8	13.56%	11	18.64%	11	18.64%	10	16.95%	12	20.34%
21-40%	7	11.86%	6	10.17%	3	5.08%	5	8.47%	3	5.08%
41-60%	2	3.39%	0	0.00%	1	1.69%	0	0.00%	0	0.00%
61-80%	4	6.78%	0	0.00%	4	6.78%	3	5.08%	1	1.69%
81-100%	8	13.56%	9	15.25%	8	13.56%	9	15.25%	4	6.78%
UNK	26	44.07%	25	42.37%	27	45.76%	26	44.07%	29	49.15%

Figure 30. Number of Responses for Percentage of Wood Materials Purchased In-State

This question was not asked during the phone interviews, so only the survey data was recorded.

A (-) meant that the company did not respond. Abbreviations are as follows: SL for structural lumber, AL for appearance lumber, ENGWP for engineered wood products (oriented strand board, fiber board, etc.), PLY for plywood, and FLOOR for flooring. UNK designated the company was not aware of the percentage of wood products purchased in-state. Most companies responded that they were not aware of the percentage of wood products purchased in-state. The next highest response was that companies purchased 0-20% of their wood products in-state. This indicated that again construction companies were unaware of where their wood products came from and that they did not purchase in-state often.

	SL Supplier		AL Supplier		ENGWP Supplier		PLY Supplier		FLOOR Supplier	
	N	% of Total	N	% of Total	N	% of Total	N	% of Total	N	% of Total
-	3	5.08%	6	10.17%	3	5.08%	4	6.78%	7	11.86%
1 to 3	47	79.66%	41	69.49%	44	74.58%	39	66.10%	35	59.32%
10 to 12	1	1.69%	1	1.69%	1	1.69%	1	1.69%	1	1.69%
4 to 6	7	11.86%	11	18.64%	11	18.64%	13	22.03%	16	27.12%
7 to 9	1	1.69%	0	0.00%	0	0.00%	2	3.39%	0	0.00%

Figure 31. Number of Responses for Number of Suppliers for Each Wood Product

This question was not asked during the phone interviews, so only the survey data was recorded. A (-) meant that the company did not respond. Abbreviations are as follows: SL for structural lumber, AL for appearance lumber, ENGWP for engineered wood products (oriented strand board, fiber board, etc.), PLY for plywood, and FLOOR for flooring. A majority of companies responded they only have one to three suppliers per wood product. The next highest response was four to six suppliers. This implied that most companies responding did not expand much in their supplier pool and most likely were smaller construction companies.

5.3.4 Wood Products Supplier Selection Data

The wood products supplier selection section of the survey was summarized in the following figures.

Table 20. Number of Responses for Purchasing Decisions a Company Made

Factor Ranking	How Often use PO's		How Often Invoices are Ready		How Often Suppliers Do Not Have Required Licenses		How Often Searched for New Suppliers		How Often an Internal Pool is Used Rather than Open Sources		How Often Purchase In-State	
	N	% of Total	N	% of Total	N	% of Total	N	% of Total	N	% of Total	N	% of Total
1	19	33.93%	0	0.00%	29	63.04%	3	5.36%	7	12.96%	6	13.04%
2	8	14.29%	1	2.04%	8	17.39%	19	33.93%	7	12.96%	7	15.22%
3	9	16.07%	1	2.04%	0	0.00%	27	48.21%	11	20.37%	6	13.04%
4	7	12.50%	21	42.86%	4	8.70%	2	3.57%	22	40.74%	17	36.6%
5	13	23.21%	26	53.06%	5	10.87%	5	8.93%	7	12.96%	10	21.74%

This question was not asked during the phone interviews, so only the survey data was recorded. Using a categorical scale, a 1 indicated “never”, a 2 “rarely”, a 3 “sometimes”, a 4 “most of the time”, and a 5 “always”. Companies mostly responded that they never used purchase orders

(PO's) for purchasing wood products. Suppliers had their invoices ready most of the time or always on time, and suppliers had the required licenses needed to conduct business. Companies sometimes or rarely searched for new suppliers often, companies sometimes or most of the time used an internal pool of suppliers rather than open sources, and companies purchased in-state most of the time or always purchased in-state.

Table 21. Number of Responses for Purchasing Factors a Company Made

Factor Ranking	Flexible Lead Time	Focus Quality over Cost	Prefer Higher Production Over Lower Production	Preference for Local Suppliers when Searching for New Suppliers	Purchase More Often if Better Business Relationship	Prioritize Loyalty Over Other Factors
1	1	1	6	9	2	1
2	8	2	11	7	3	2
3	28	26	27	13	11	27
4	17	22	8	25	30	19
5	1	5	2	1	8	6

This question was not asked during the phone interviews, so only the survey data was recorded.

On a categorical scale, a 1 indicated “never”, a 2 “rarely”, a 3 “sometimes”, a 4 “most of the time”, and a 5 “always”. Companies responded that they sometimes or most of the time had a flexible lead time with products, and they responded that they focused on quality over the cost of the product most of the time or sometimes. Construction companies responded they rarely or sometimes prioritized higher production over lower production, and they responded they sometimes or most of the time had preference for local suppliers when searching for a new supplier. A vast majority of companies responded that they purchased more often from a supplier if they had a better business relationship most of the time, and companies responded that they sometimes or most of the time prioritized loyalty over other factors.

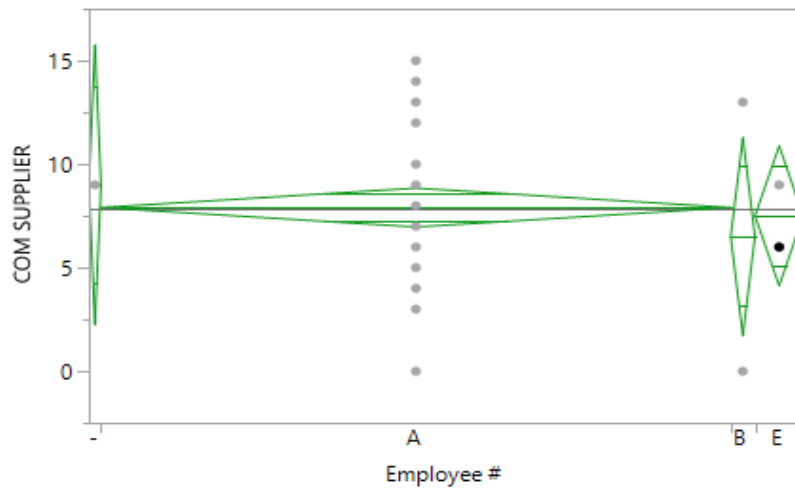
Chronbach's alpha test

Entire set		α			
Entire set	0.8342				
Excluded Col		α			
How Often Contact w/ Suppliers over Month	0.8162				
How Often Contact Potential Suppliers	0.6777				
How Often Suppliers Contact You to Improve Their Business	0.8123				

Figure 32. Chronbach's Alpha Test on Communication with Suppliers

A Chronbach's alpha test was conducted on the communication with suppliers set of categorized questions. It is a measure of internal consistency; how closely related the set of groups are to each other (UCLA Institute for Digital Research & Education). An alpha value over 0.70 for the set meant the variables could be added together called a latent variable. The null hypothesis (H_0) tested was company size is equal to communication with suppliers, bigger companies have better communication than smaller companies. The communication factor was tested because construction companies listed communication as a major supplier selection factor. It was tested against the size of the company because it was thought bigger construction companies could communicate better with suppliers.

Oneway Analysis of COM SUPPLIER By Employee #



Oneway Anova

Summary of Fit

Rsquare	0.008907
Adj Rsquare	-0.04515
Root Mean Square Error	3.368353
Mean of Response	7.847458
Observations (or Sum Wgts)	59

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Employee #	3	5.60789	1.8693	0.1648	0.9197
Error	55	624.01923	11.3458		
C. Total	58	629.62712			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
-	1	9.00000	3.3684	2.2497	15.750
A	52	7.90385	0.4671	6.9677	8.840
B	2	6.50000	2.3818	1.7268	11.273
E	4	7.50000	1.6842	4.1248	10.875

Std Error uses a pooled estimate of error variance

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

Level	Count	Score Sum	Expected Score	Score Mean	(Mean-Mean0)/Std0
-	1	39.500	30.000	39.5000	0.533
A	52	1565.00	1560.00	30.0962	0.106
B	2	57.500	60.000	28.7500	-0.084
E	4	108.000	120.000	27.0000	-0.349

1-Way Test, ChiSquare Approximation

ChiSquare	DF	Prob>ChiSq
0.4471	3	0.9304

Figure 33. ANOVA and Wilcoxon Tests for Communication of Suppliers by Employee Number

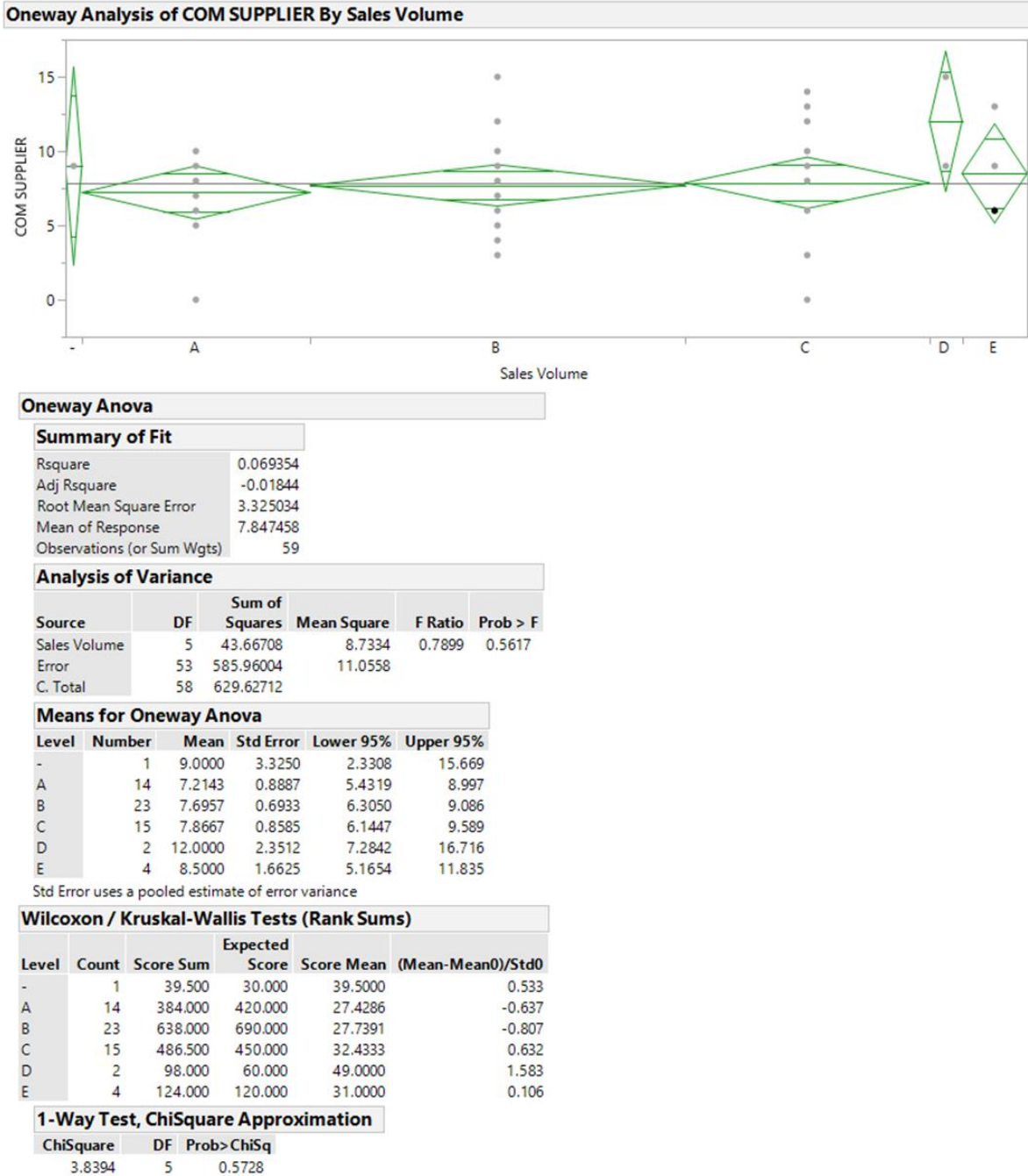


Figure 34. ANOVA and Wilcoxon Tests for Communication of Suppliers by Sales Volume

For the response of employee number, a (-) mark indicated a no response to the question, “A” meant 1-50 employees, “B” meant 51-100 employees, and “E” meant 201+ employees. In terms of sales volume for a given construction company, a (-) mark indicated no response to the

question, “A” meant less than \$500 thousand, “B” meant \$1 million - \$5 million, “C” meant \$5 million - \$20 million, “D” meant \$20 million - \$50 million, and “E” meant greater than \$50 million. Since the probability (P-Value) was greater than 0.05, the null hypothesis was not rejected because company size does not affect communication with suppliers. An ANOVA test was conducted on the employee number responses and the sales volume responses to see if the size of a construction company did have an effect on the communication. A Wilcoxon test was conducted because it was not known if the assumptions of the ANOVA test were met, the P-Values for both factors were still greater than 0.05. Small companies with low employee and sales volume numbers communicated just as well as bigger companies with high employee and sales volume numbers. Suppliers had the chance to communicate well with both types of companies to try to get more product sold. This meant that construction companies with any number of employees and sales volume communicated with suppliers. Communication was not favored for companies with high employee numbers and high sales volume, nor was it favored for companies with low employee numbers and low sales volume. Companies of any size could communicate well with suppliers; which meant suppliers had an opportunity to communicate with construction companies of any size.

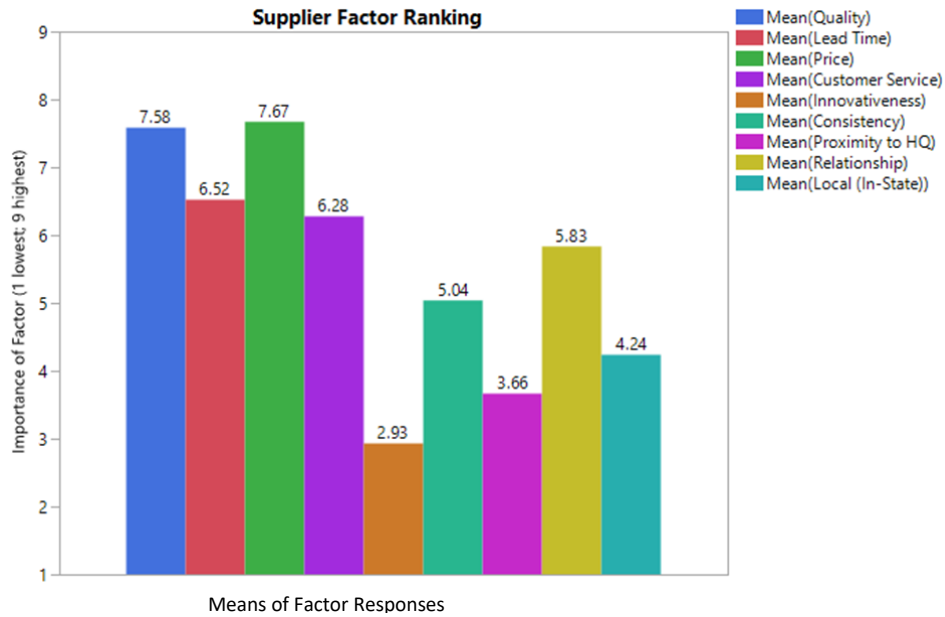


Figure 36. Means of Supplier Factor Ranking (1 Lowest; 9 Highest)

The most important factors to construction companies when selecting a supplier were: price, quality, lead time, and relationship. This was highlighted in literature as well as interviews with construction companies, but the survey and phone interview data showed these results as well.

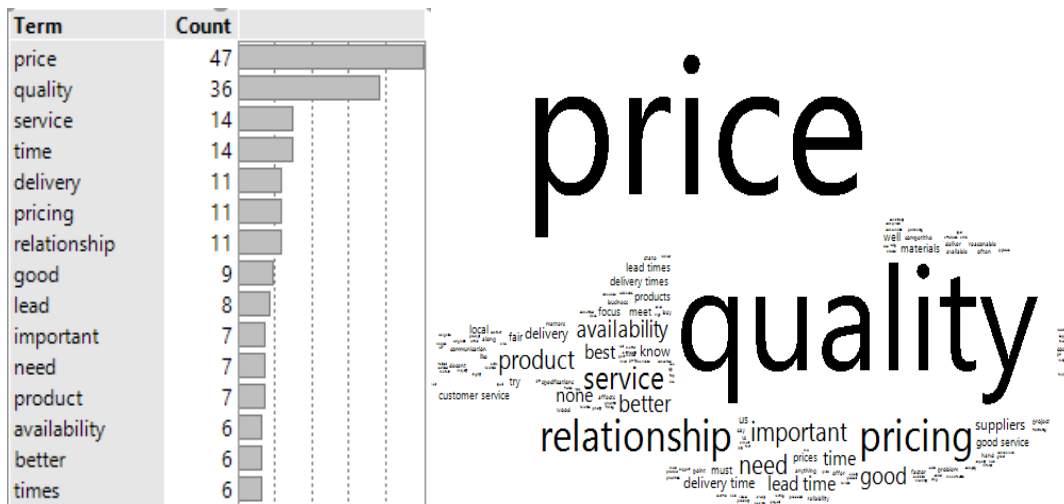


Figure 37. Common Phrases and Criteria for a Company to Purchase Local Wood Products

Companies were asked what they looked for in suppliers in open ended questions. Again, price, quality, service, time, delivery, and relationship were highlighted as factors in the open-ended responses.

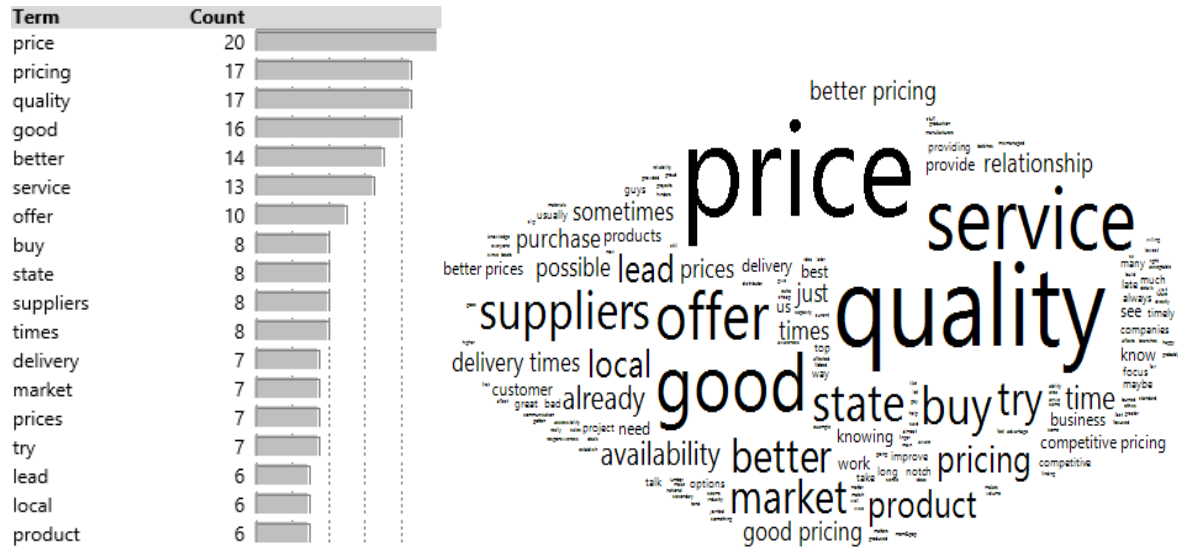


Figure 38. Common Phrases and Criteria for a Company to Purchase More In-State

For construction companies to purchase more products in-state, they would consider better pricing, quality, service level, and delivery times. This was highlighted in the previous open ended question as well as the supplier factor rankings.

6. Conclusions and Discussion

6.1 Survey Collection Discussion

The second wave of surveys had a greater response rate than the first wave. This could be partially due to COVID-19 affecting the American workforce around the same time the first wave of surveys and reminders were sent out (March 30th, 2020). COVID-19 also affected the timing of the second wave being sent out; which was the week of May 25th, 2020. There was an issue of non-response bias due to the low response rate of 59 total returned surveys. However, due to the second wave of surveys having the same numbers as the first wave, it can be inferred that the second wave was representative of the population. This helps avoid the nonresponse bias associated with low response rates. Since there were only fifty-nine survey responses, phone interviews were conducted using the same industry lists. Forty-six phone interview responses were recorded and added to the survey data; the response number was also similar to the total number of survey responses.

State participation was generally even throughout both data collection methods. Virginia had the most with twenty-three responses and Texas had the least at eleven responses. This was reflected in companies' willingness to participate in interviews, whether it was phone or in-person.

Virginia likely had the highest response due to the study being conducted by an in-state University. The south-eastern states involved in the study generally had good response rates. The phone interviews helped boost response rates in those states that did not return as many paper surveys.

6.2 Business Information/Sector Profile Discussion

Most construction companies answered that they had 1-50 employees in their company, indicating that they were smaller sized companies. Company size did not affect communication with suppliers and potential suppliers. Company sales volume was generally \$5 million or less, which confirmed the majority of the construction companies responding were on the smaller side due to lower sales and employee numbers. Most companies responded that the types of businesses worked on were residential projects, commercial projects, or both. This indicated that the construction sector mainly focused on the residential or commercial construction as opposed to public construction.

An overwhelming majority of companies responded that they did not work in multiple states. This was an important discovery as most construction companies had one central location for conducting business. This implies that the construction company might not outsource their purchase of wood products. However, it seems that most of them were unaware of where the wood products were coming from. Almost every company that responded to the survey and phone calls indicated that their business was active for in 2019. This confirmed the companies responding were conducting business and active.

6.3 Wood Materials Used Within the Company Discussion

Most companies responded that they worked on single-family home projects. The second most common response was commercial as well as single-family homes combined with commercial projects. Combined with the low employee numbers and low sales volumes, single-family home projects would make sense as the highest number of responses. Construction companies mostly responded that they worked on fewer than five projects within the given year. For multi-family home projects, a majority responded that they did not work on that type of project, with a similar response for commercial projects. Given the number of projects conducted in a year (i.e. less

than five, five to ten, etc.), it can be inferred that when a company started a project they needed to order materials before the project began. So, if a company had fewer than five projects a year they would order wood materials approximately five times a year to fulfill their needs, depending on the lead time given by the supplier. Since a majority of companies responded that they only had one to three suppliers for each wood product, those companies would contact only a few suppliers every time they required wood products. Companies responded that they were not under contract for purchasing wood products. They also responded that they procured their own materials. This should be helpful for new suppliers trying to break into the market.

There were a lot of unknowns regarding where the company purchased their various wood products, and most answering they were unaware if a product was manufactured within their own state. It was odd to observe that even with smaller companies, purchases were made out of state or the company did not know where the purchase came from. Despite most companies having one central location within the respective state, most were unaware of where the product came from or out of state purchases. It may be possible that the construction companies thought of national chain stores are not local and thus a lot of unknowns on if a product purchased was local or not. Another possible explanation could be that the companies had subcontractors purchasing materials and doing the project work. Despite this possibility, the results highlighted the need for better knowledge of suppliers within the state. With this knowledge, transportation costs and perhaps product costs could be reduced.

6.4 Wood Products Supplier Selection Discussion

Construction companies rarely used purchase orders (PO's) when purchasing from suppliers. This could pose a problem to some suppliers who require the use of purchase orders when selling products. Construction companies indicated that suppliers often have invoices ready on time,

which is good for conducting business. They also indicated suppliers had the required business licenses. Suppliers should take into account that timely invoices and having licenses up to date would help their case when breaking into the market. Construction companies indicated that they sometimes or rarely searched for new suppliers, also that they sometimes or most of time use an internal pool of suppliers rather than open sources. This would be difficult for a new supplier, but during the times that the construction companies are searching and not using their internal pool, suppliers have to be diligent in promoting their product. Construction companies indicated that they mostly purchase in-state when possible, so in-state suppliers could have a chance to make sure their product is being purchased by these companies.

Construction companies indicated that they sometimes have flexible lead time with products and sometimes focus on quality over cost of the products. This would give suppliers more opportunities to differentiate themselves, if cost is not the ultimate factor. Sacrificing cost for quality or better lead time of products would be ways for suppliers to gain more ground in the market. Higher production is sometimes or rarely preferred over a smaller producer, so suppliers of all sizes can have an opportunity for market impact. Construction companies had a preference for local suppliers when searching for new suppliers most of the time. They also purchased more from in-state suppliers if there was a better business relationship and sometimes prioritized loyalty over other factors.

The size of the company did not impact the communication factor of suppliers. Construction companies with high employee numbers and sales volume communicated just as well with suppliers as construction companies with small employee numbers and sales volume. Suppliers had an opportunity to engage with construction companies of all sizes.

According to the results with the most responses, companies already had a working relationship with their wood products supplier. However, suppliers contacting the company and sales representatives also had high response numbers. The most difficult part for suppliers was developing this relationship so that the construction company would purchase from them more often. There were other factors involved in purchasing, though. Not many companies used a wood products industry directory, which could be due to a lack of research, lack of effort on the company's part, or that they already had their suppliers selected.

6.5 Wood Products Supplier Evaluation Discussion

According to construction companies, the most important factors for supplier selection, in order of most important to least important were price, quality, lead time, and customer service.

Business relationship was not far behind customer service in terms of average ranking. Based on the open ended responses, price, quality, service, lead time, and relationship were highlighted as well. These factors were the most important to construction companies when looking for new suppliers as well as how well their current suppliers were performing. Another phrase that was common in the open ended questions was that suppliers were not aware of market pricing. The construction companies were looking for suppliers who paid attention to these factors and those suppliers; were more likely to see increased business.

6.6 Recommendations

Based on the results, suppliers should strive for fair pricing on their products as well as having a high quality product. Also, making sure the product arrives on time and having good service/communication were quite important to construction companies. While it would be difficult to try to focus on every factor highlighted, it is important to emphasize one or two of the

factors. For instance, to set a certain supplier apart from the rest, they could focus on having the best quality product, while having good delivery times. This would mean the price would probably be more of a premium, but companies are willing to pay that price in return for better quality and the product arriving on time. Prioritizing a few factors rather than all of them can differentiate what a supplier can do.

Suppliers should focus on differentiating their products based on several factors highlighted by construction companies. For instance, the suppliers could focus on producing higher quality products that might cost more but would be more in line with what the construction company was looking for. Another example could be a supplier delivering the products faster to help reduce wait time on the project site by the construction company. Differentiation of products and companies helps suppliers gain more market share within the construction industry. Since it did not matter if a company was large or small (in terms of employee size and sales volume) regarding communication with suppliers, suppliers have an opportunity to market their products to the entire industry. Narrowing their vision in terms of products while having an open communication system with construction companies would help suppliers gain more market share. A report was sent to the South Carolina Forestry Commission with recommendations for suppliers, a copy of those recommendations are in Appendix G.

6.7 Conclusions

- Construction companies are unaware of wood products suppliers that are located in-state which can lead to higher transportation costs, as the companies pay more to transport material over a greater distance.
- Local suppliers may also provide benefits such as better business relationships, and better-quality wood products.

- There is waste involved with outsourcing purchases, or not purchasing from close proximity suppliers. Wasted costs include: materials, production times, increased lead time, etc.
- An issue shown in the results was the lack of awareness regarding where the product was purchased and where it was manufactured.
- It is possible some companies used subcontractors who purchased the majority of the wood products. There were no questions asked about subcontractors specifically through the survey or phone interviews; it would be interesting to see if that had an effect.
- There is a difference between purchasing products in-state and products that were manufactured in-state.
- Not many construction companies used a wood products industry database. In order for in-state wood products suppliers to get more attention, it would be valuable if construction companies used a database to search for more options.
- Having more options through a database would benefit the construction company as they could search for better pricing, better quality, closer options, etc. The database would help the suppliers sell more of their products through as well.
- The size of the construction company in terms of employee size and sales volume did not impact how they communicated with suppliers.
- Suppliers should follow the factors highlighted by construction companies so they can have more market impact.

6.8 Recommendations for Future Research

- A specific study comparing purchasing from manufacturers of wood products to suppliers of wood products; there is a difference between a product that is manufactured within the state and a product that is sold within the state.
- If subcontractors affected the knowledge of where construction companies purchased their wood products from. It is possible that some construction companies let the subcontractors purchase the wood products. Research on subcontractor purchasing would be interesting.
- More research on construction company size, it seemed a lot of responses for this study came from smaller companies, so getting a broader picture of the industry would be helpful.
- Research into how wood products suppliers sell their products, the main focus of this study was from a buyer perspective, a seller's perspective could produce more insight.

6.9 Limitations of Study

- The willingness of companies to participate in interviews and surveys.
- COVID-19 affecting the workforce when the survey was sent out, it possibly could have affected response rate.
- There was a lack of information from Oklahoma due to low participation from companies and the state representative.
- There were time constraints with interviewing companies in person due to attempting to send the survey out sooner, so only one company from Florida was interviewed in-person.

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Appendix A. Copy of the Survey Questionnaire

Questionnaire

Identifying the demand for local (in-state) wood product supplies within the U.S. Southern States from the construction sector

With the intention to improve demand for local (in-state) wood product suppliers in the construction sector within U.S. southern states, Virginia Tech's Department of Sustainable Biomaterials would greatly appreciate your help to complete the enclosed questionnaire.

The main purpose of this survey is to identify factors of wood products supplier selection within the construction industry, emphasizing drivers for local wood products suppliers. This in turn would help save your company time and money, as well as supporting the local economy. Your company could benefit from having more suppliers to choose from, allowing you to get the best price and quality for the wood products you purchase. The survey will take around 15 minutes to complete.

Your responses and associated analysis would remain strictly confidential and will only be used for this study. Only aggregated data will be used for reporting purposes.

Participation in this survey is 100% voluntary. The identity of yourself and your firm will not be disclosed in any communication from this study.

This research is being conducted by your state's local forestry agency, the United States Forest Service, and Joseph Pomponi, a Graduate Research Assistant and MS student in the Department of Sustainable Biomaterials at Virginia Tech, Blacksburg, VA.

If you have any questions or comments about this study, please contact Joseph Pomponi by email at jpp5251@vt.edu or by phone at (410) 292-8826.

Business Information

1: What is your job title within the company?

A: _____

2: How many employees are at your company?

A: 1 – 50 B: 51 – 100 C: 101 – 150 D: 151 – 200 E: 201+

3: What is your company's sales volume per year?

A: <\$500K B: \$1M-\$5M C: \$5M-\$20M D: \$20M - \$50M E: >\$50M

4: What type of business, in terms of construction projects, does your firm conduct? (Select multiple options if applicable.).

A: Public B: Residential C: Commercial D: Other _____

5: What year was your firm established?

A: _____

6: Does your company operate in multiple states?

A: Yes B: No

If you answered yes to the previous question, list the states your company operates in.

7: What state is the headquarters of your company located?

A: _____

8: What was the status of your company in 2019?

A: Active B: Idle C: Out of business

9: Do you want your company to be included in an industry directory for wood products companies in the South-Eastern United States (free of charge)?

A: Yes B: No

10: Would you like a free copy of the report/results of the study being conducted?

A: Yes B: No

Wood Materials used in your Company

11: Please check the box for where your company falls in terms of projects worked on 2019.

Project Type	Number of Projects (in terms of homes for Single and Multi-family projects)			
	Less than 5	5-10	10-25	More than 25
Single Family				
Multi-family				
Commercial				

12: Is your company under a contract/contracts for buying its wood product materials?

A: Yes B: No

If you answered yes, please list the wood products purchased from the contract/contracts.

13: Does your company buy/procure its own materials?

A: Yes B: No

14: Please indicate (via check-mark) if the specific wood product your company purchases is purchased by a distributor or manufacturer, as well as if it is purchased in-state, out of state, out of country, or don't know where the product is purchased.

Raw materials	Distributor	Manufacturer	Purchased in-state	Purchased out of state	Purchased out of country	Don't know where product is purchased
Structural Lumber						
Appearance Lumber						
Engineered Wood Products (OSB, LVL, MDF, etc.)						
Plywood						
Flooring						

15: Do the wood products your company purchase mainly come from in-state or out of state?

A: In-state B: Out of state C: Not Sure

16: Are you aware if the wood products you purchase are manufactured in your state?

A: Yes B: No

17: In the purchasing process, does your company require a bidding process?

A: Yes B: No

If you answered no, how does your company purchase its wood products? (ex: direct purchase)

18: What is the percentage of in-state wood products purchased for your company? Check the box where your company falls for each product.

Wood Product	0-20%	21-40%	41-60%	61-80%	81-100%	Not Sure
Structural Lumber						
Appearance Lumber						
Engineered Wood Products (OSB, LVL, MDF, etc.)						
Plywood						
Flooring						

19: How many suppliers does your company have for the following products? Check the box where your company falls for each product.

Wood Product	1-3 Suppliers	4-6 Suppliers	7-9 Suppliers	10-12 Suppliers	13+ Suppliers
Structural Lumber					
Appearance Lumber					
Engineered Wood Products (OSB, LVL, MDF, etc.)					
Plywood					
Flooring					

Wood Products Supplier Selection

20: Please answer the following questions within the table regarding purchasing decisions with suppliers. Circle the box where your company falls in reference to the category scale.

Question	Never	Rarely	Sometimes	Most of the time	Always
How often does your company use purchase orders for your wood products suppliers?	1	2	3	4	5
How often do your in-state wood products suppliers have invoices ready on time for your company?	1	2	3	4	5
Do in-state wood products suppliers often not have the required licenses in order for your company to do business with them?	1	2	3	4	5
How often does your company search for new wood products suppliers?	1	2	3	4	5
When a bid for a new project is won, how often does your company use wood products suppliers from its own internal pool rather from open sources?	1	2	3	4	5
How often does your company purchase from an in-state wood products supplier as opposed to outsourcing the purchase from the state?	1	2	3	4	5

21: Please answer the following questions within the table regarding purchasing factors with suppliers. Circle the box where your company falls in reference to the category scale.

Question	Never	Rarely	Sometimes	Most of the time	Always
Is your company flexible with the lead time of a product arriving from a wood products supplier?	1	2	3	4	5
Does your company focus more on the quality of a wood product rather than the cost of it?	1	2	3	4	5
How often does your company select a wood products supplier who has higher production rather than a smaller producer?	1	2	3	4	5
How often does your company give more preference towards in-state wood products suppliers when looking for new wood products suppliers?	1	2	3	4	5
Does your company purchase from in-state wood products suppliers more often if your company has a better and existing business relationship with them?	1	2	3	4	5
Does your company prioritize loyalty over other factors such as cost when deciding on wood products suppliers?	1	2	3	4	5

22: Please answer the following questions within the table regarding communication with suppliers. Circle the box where your company falls in reference to the category scale.

Question	Never	Rarely	Sometimes	Most of the time	Always
How often does your company have contact with your wood products suppliers over a monthly timeframe?	1	2	3	4	5
How often does your company communicate with potential wood products suppliers?	1	2	3	4	5
How often do in-state wood products suppliers contact your company to try to improve their business?	1	2	3	4	5

23: Where does your company find its wood products suppliers?

- A: Wood Products Industry Directory B: Previous Relationship C: Cold Calling
D: Suppliers Contacting Company E: Sales reps F: Internet and Social Media G:
Trade directories H: Trade shows I: Other: _____

Wood Products Supplier Evaluation

24: For the following criteria, rate them from 1-9 when selecting a new wood products supplier. (1 being least important; 9 being most important)

- a. Quality: _____
- b. Lead time: _____
- c. Price: _____
- d. Customer service: _____
- e. Innovativeness: _____
- f. Consistency: _____
- g. Proximity to HQ: _____
- h. Relationship: _____
- i. Local (in-state): _____

25: What are the criteria in your company to buy local (in-state) wood products?

26: What would it take your company to purchase more from in-state suppliers?

27: Is there anything else you would like to share on purchasing wood products from in-state suppliers?

.....
Thank you for taking a few minutes to participate in this survey. Your responses and associated analysis would remain strictly confidential and will only be used for this study. Please return the completed questionnaire in the provided pre-paid envelope. If you would like a summary of this study, please complete the **Request for Information** section below. For any questions, comments, suggestions or additional information, please contact me at below listed address at any time.

Sincerely,

Joseph Pomponi

Graduate Research Assistant

Department of Sustainable Biomaterials

Virginia Tech

Phone: (410) 292-8826

Email: jpp5251@vt.edu

Request for Information

Please send a summary of the study results to the address listed below

Name: _____

Address: _____

Appendix B. Full In-Person Interviews with Virginia Companies

Company 1

- 3 types
 - Lumber, component manufacturing (pallet, poles, etc.), general contract (single or multi)
- High volume low margin
- Company buys from mills and all over world
- Lumber yards buy from middle-man
- Sell to those retail stores i.e. Home Depot, Lowes, etc.
- Share bids with multi-construction places
 - Bid 6 months ahead
 - Need # of trucks to do pricing
 - Pricing decisions from market (risk involved)
 - If source is reliable (count on getting wood)
 - Wood bought of total package
 - **Relationship, consistency, then price key factors**
 - Build right relationship
 - Everything comes secondary
- Info is key
 - Price guidelines published but just guideline
 - Market price really drive home buying and selling
- Important for buyers to stay on top of market
- Buy from mills all over then sell to construction/other markets
- **Price – high volume low margin**
- **Lead time is important**
 - Buyer along with price, quality, use certain mills
 - Important factor if buyer can get product
- **Stock**
 - Factors to convince customer
 - Then if complaints deal with that after
 - Resolution
- Payment terms
- “We pay mill and take risk to bring liquidity”
 - Small yards usually influenced by cash flow

Company 2

- What are the most important aspects in selection of wood products suppliers?
 - Why does your company focus on factor X (cost, quality, etc.)?

- General: not going to take cheap thing
 - Evaluate long and short term of product; want to stand behind product
 - Will pay for better quality however won't pay for Cadillac when Chevy can do it
 - Use most of same products; same specs
 - If problem look into it
 - For these factors, how do you think your suppliers can improve on them?
 - Billing some struggle
 - Break costs up into different phases
 - Sloppy, multiple invoices that don't add up
 - PO's don't add up
 - Late with invoices
 - Creates a lot of work that is unnecessary
 - Small company might be less sophisticated with paperwork
 - Not business minded
- What is your purchasing process? Describe.
 - Is there any place is this process where your company can give feedback to the supplier?
 - Bidding process based on price if new
 - Communication constantly through process
 - Back and forth conversation
 - Once on board: multiple points for conversation and feedback
 - Production team steps in
 - Software system to track people based on schedule
 - Surveys of project managers
 - Top performers and bottom performers have meetings
 - What is the hardest part of the purchasing process and why?
 - Complicated system, big company data driven
 - Small builders; breaking down all the parts of a house building
 - Cost savings takes a lot of effort
 - Any way to improve the process on both ends?
 - What is the structure of the procurement process?
 - How does your company purchase wood products?
 - Purchase wood products – have own lumber yards
 - Plants in MD
 - Manufacturing plants around country
 - Lumber bought at plant
 - Build frames and trusses at plant
 - Locally: decks; relationship with company and bid it out
- Who are your key suppliers?
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - Growth mode; looking for new suppliers and vendors

- Offer better price, product, service
 - What do the key suppliers do well to maintain your company's interest in them?
 - Price and performance
 - Quality, value, good work
- What is important in the relationship with your suppliers?
 - How can the relationship be improved?
 - Improve on: price, performance, quality, value components
 - Not hitting on them; something we're not doing internally?
 - Vendor: lead time, job ready, pay in time
 - Do those 3 things
 - Have to do our part as well
 - Good communication is key
 - 2-way street
 - What do these suppliers do well to maintain relationship?
 - Hit on factors described above
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Need to work with procurement team
 - Best competitive price and value
 - Is there supplier training involved in the buying process?
 - Not really
- Number of wood suppliers you have
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - Number doesn't change seasonally
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Try to do even flow to avoid peaks and valleys
 - So, don't try to lay off guys if work is slow
 - Driven on sales; if no sales don't have homes to give to vendors
 - Again, communication is key
 - Always looking for new vendors
- Do you require bids/multiple quotations?
 - Is there any way for one supplier to put itself above another?
 - Better factors like price, communication, quality, etc.
 - Do you have a preference for these suppliers who have the better business relationship?
 - Yes and no to preference to doing business if good relationship
 - If similar vendors offering similar things; go with guy easier to deal with
- Do you have preference for purchasing from local suppliers?
 - What is the rough percentage of local to not local suppliers?
 - Rough percentage: relationship with local and huge company

- Labor much higher percentage of local
 - Material supplier bigger larger company
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - Nice having local rep that knows the market
 - Understands local market
 - What could local suppliers do to get more of their product purchased from the company?
 - Hard to say, not really involved in process of picking supplier
- What wood products do you use that are purchased within your state?
 - Have you looked into other wood products and their uses?
 - Use a lot of MDF, OSB, TGI joice, LVL
 - Done more at company level
 - Always looking at new products
 - What would you say is the best product you purchase and why?
 - Not sure of best product
 - Have a lot of good quality products
- Size of the company
 - Does the size change seasonally, i.e. are there temporary employees?
 - Vendors have temporary employees
 - Hourly crews
 - Peace workers
 - Paid for work/job
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - Size does affect relationship with smaller local suppliers
 - Waynesboro example “Oh, big box builder coming to town”
 - Smaller construction companies use that hate/misinformation to advantage
 - People’s perception is reality
 - Overcome the perception
 - Open to a lot of liability
 - Vendors Class A contractor’s license
 - Smaller guys don’t have it
 - Some guys don’t want to go through it
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Sales wise: 18,000 homes across USA
 - 200 homes Charlottesville
 - Projected: 275 Charlottesville; 19,000 USA
 - Use size to advantage
 - Get deals because of size
 - When buy lumber: power of 18,000 homes instead of 20 homes

- Get better pricing deals
- Vendors want to know how much work is to be expected

Appendix C. Full In-Person Interviews with South Carolina Companies

Company 1

- What are the most important aspects in selection of wood products suppliers?
 - Factors #1- service, getting lumber when needed
 - Responsive sales
 - Next is price
 - Why does your company focus on factor X (cost, quality, etc.)?
 - We're more custom so material is needed
 - For these factors, how do you think your suppliers can improve on them?
 - More focus on industry practices
 - Seeing what is needed
- What is your purchasing process? Describe.
- Before job start, do an estimate on quantity of lumber
 - Look in price
 - Whenever need wood, call lumber guy; get wood in stages
 - Is there any place in this process where your company can give feedback to the supplier?
 - Not really a feedback loop, just call a guy
 - What is the hardest part of the purchasing process and why?
 - Hardest: structural and engineered lumber because the lead times are difficult
 - Estimating works well
 - Any way to improve the process on both ends?
 - Improvements: communication with lumber yard
 - Deliveries and pickups
 - What is the structure of the procurement process?
 - Small company-3 people essentially
 - Dad emailing and texting order to salesman
 - How does your company purchase wood products?
 - Through a lumber salesman
- Who are your key suppliers?
 - Multiple lumber yards – 3 different companies
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - Possibly interested in new suppliers, comes down to customer service
 - What do the key suppliers do well to maintain your company's interest in them?
 - Key suppliers do estimates for us, through a professional service
 - Takeoffs, saves time, guarantee buy lumber through that supplier
 - Supply lumber in timely fashion
- What is important in the relationship with your suppliers?

- Honesty, communication, knowing/competitive pricing
- How can the relationship be improved?
 - Do what you say you're going to do
- What do these suppliers do well to maintain relationship?
 - See above
- Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Reach out to builders and competitive pricing, possibly better products
- Is there supplier training involved in the buying process?
 - No supplier training on our part-lumber yard training
 - Like to sit down with new salesperson
- Number of wood suppliers you have
 - 3 local lumber yards, 3 suppliers on the secondary
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - Doesn't change seasonally
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Stays the same, buying less quantity
- Do you require bids/multiple quotations?
 - Don't necessarily bid every project
 - Check every now and then
 - Is there any way for one supplier to put itself above another?
 - Customer service goes long way and trust of good prices
 - Do you have a preference for these suppliers who have the better business relationship?
 - Preference for suppliers with better relationship
- Do you have preference for purchasing from local suppliers?
 - More preference for local suppliers
 - Don't buy out of state
 - What is the rough percentage of local to not local suppliers?
 - 100% local
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - Preference of local because it's closer and easier logistics
 - What could local suppliers do to get more of their product purchased from the company?
 - Outreach and meeting other builders
- What wood products do you use that are purchased within your state?
 - All the wood products: lumber, osb. Millwork, trimwork, etc.
 - Have you looked into other wood products and their uses?
 - Occasionally look at different wood products
 - Subflooring, wall shading as examples
 - What would you say is the best product you purchase and why?

- Roof trusts-costs less for labor and material
 - Speeds up building process
- Size of the company
 - 3 people
 - Does the size change seasonally, i.e. are there temporary employees?
 - Subcontractors-long term relationships
 - Not cheapest but quality work, can advertise quality of homes
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - Size affects relationship with other suppliers
 - Suppliers like working with us because easy to work with
 - Don't beat them up on pricing
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Gross ~\$6 million/year
 - Average 8 houses/year
 - Don't stress out too much over demand of lumber
 - But if there is a trend then will look into it

Company 2

- What are the most important aspects in selection of wood products suppliers?
 - Biggest – price
 - Why does your company focus on factor X (cost, quality, etc.)?
 - Buying from big distributors
 - Relationships are there but aren't made without good price
 - Do a quarterly system
 - For these factors, how do you think your suppliers can improve on them?
 - Issues with quality of certain wood products like OSB
 - “turn and burn” products
 - Issue occurs when supply runs low
 - Lumber ~14% of price of home
 - Lumber big part of base house cost
- What is your purchasing process? Describe.
 - Quarterly: put out email/letter to bid lumber
 - 10-12 days before a bid
 - Is there any place in this process where your company can give feedback to the supplier?
 - There is a place to give feedback
 - Human element involved
 - In past had issues with OSB
 - What is the hardest part of the purchasing process and why?
 - Hardest part is analyzation

- Do it every quarter
 - A lot of work involved
 - Any way to improve the process on both ends?
 - Always room for improvement
 - Tricky because of negotiations
 - Make guys show what they have
 - Honesty and analyzation
 - What is the structure of the procurement process?
 - Structure is excel sheet
 - Feeds into other sheet take plans and measure out costs
 - How does your company purchase wood products?
 - Buy from distributor
 - Purchase straight up without purchase order
- Who are your key suppliers?
 - Big distributors
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - Always want to meet with new guys and do business
 - What do the key suppliers do well to maintain your company's interest in them?
 - Biggest thing is they keep supply there
 - Know when they're doing bad
- What is important in the relationship with your suppliers?
 - Customer service is important
 - Transparency, let them know
 - How can the relationship be improved?
 - More transparency
 - Keep stock up
 - What do these suppliers do well to maintain relationship?
 - Again, customer service and keeping stock up
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Get out there on doors to get the products out
 - Go in front of lower guys on management tree first
 - Some salespeople don't pay attention
 - superintendents
 - Is there supplier training involved in the buying process?
 - Only training is on computer system
 - How to read it, etc.
 - How we want to do it
- Number of wood suppliers you have
 - ~6 wood suppliers 12 with a relationship
 - Does the number of lumber/OSB/etc. suppliers change seasonally?

- Some come and go
 - Change suppliers quarterly
 - 6 quarters was longest a supplier had business with us
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Try to keep market strong
 - 1,000 houses in Colombia
 - Keep people honest
- Do you require bids/multiple quotations?
 - Require bids, sometimes rebid
 - Is there any way for one supplier to put itself above another?
 - Customer service to put above
 - Do you have a preference for these suppliers who have the better business relationship?
 - Yes, preference for better business relationship
- Do you have preference for purchasing from local suppliers?
 - No preference for local suppliers
 - What is the rough percentage of local to not local suppliers?
 - ~80% nonlocal
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - We're price driven so no preference
 - What could local suppliers do to get more of their product purchased from the company?
 - Attempt to price better, or have a superior quality for price
- What wood products do you use that are purchased within your state?
 - Nominal lumber, pressure treated, engineered wood products, floor joists, osb
 - Have you looked into other wood products and their uses?
 - Look into other products sometimes
 - There needs to be a need for the new wood product
 - Always open to new products and their uses
 - What would you say is the best product you purchase and why?
 - Just nominal lumber because it is what it is
 - LVLs are also good
- Size of the company
 - 2,000 homes/year
 - Does the size change seasonally, i.e. are there temporary employees?
 - Not often
 - Construction crews do the building
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - Size affect relationship with smaller local suppliers
 - Sometimes negative connotation

- Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Sell ~2100 homes
 - Demand for lumber affects relationship definitely

Appendix D. Full In-Person Interviews with Georgia Companies

Company 1

- What are the most important aspects in selection of wood products suppliers?
 - Cost, supply, quality for our company
 - Why does your company focus on factor X (cost, quality, etc.)?
 - Want to get best product for price
 - Enough supply for our projects as well
 - If quality poor, then can't use it; not up to our standards
 - For these factors, how do you think your suppliers can improve on them?
 - Better communication if supply is low would be helpful
- What is your purchasing process? Describe.
 - Usually a bidding process
 - Is there any place in this process where your company can give feedback to the supplier?
 - We try our best to have a feedback loop with our suppliers so we can continue to improve
 - What is the hardest part of the purchasing process and why?
 - Probably the whole human element of it, everyone is trying to get the best deal so negotiations can be hard
 - Any way to improve the process on both ends?
 - Better communications help every side
 - What is the structure of the procurement process?
 - Once a supplier wins a bid, we contact them with what we need and where
 - How does your company purchase wood products?
 - Through distributors
- Who are your key suppliers?
 - The big guys like 84, Weyerhaeuser, etc.
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - I would like to believe so we're always looking for better deals and better quality products
 - What do the key suppliers do well to maintain your company's interest in them?
 - Sometimes give us deals, always communicating, and having supply as well as good price points
- What is important in the relationship with your suppliers?
 - Pretty important, we want to know how their business is doing because it affects us
 - How can the relationship be improved?
 - Again, better communication
 - What do these suppliers do well to maintain relationship?

- Better communication and having more accurate lead times
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Try to communicate with the builders and differentiate your product, like what makes their product better. Good pricing helps too.
 - Is there supplier training involved in the buying process?
 - We train our buyers on our process, and I think our suppliers train their sellers, we try to meet with them in person every now and then
- Number of wood suppliers you have
 - Hard to have rough number, usually around 40
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - Depends more on the market at the time
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - We try to have constant suppliers but sometimes it will change
- Do you require bids/multiple quotations?
 - We usually take the best bid
 - Is there any way for one supplier to put itself above another?
 - Having good communication and good price for high quality product
 - Do you have a preference for these suppliers who have the better business relationship?
 - Yes, we want to do business with those who are easy to work with
- Do you have preference for purchasing from local suppliers?
 - We don't have a preference
 - What is the rough percentage of local to not local suppliers?
 - Tends to be more 50/50, but usually around 70% non-local
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - We have some contracts with bigger distributors and they offer us better deals
 - What could local suppliers do to get more of their product purchased from the company?
 - Again, promote that they have better pricing and better product
- What wood products do you use that are purchased within your state?
 - Lumber, engineered wood products, LVL, simple trusts, etc.
 - Have you looked into other wood products and their uses?
 - Always looking for new products and their uses in our business
 - What would you say is the best product you purchase and why?
 - Lumber because it is what it is, hard to mess up
- Size of the company
 - 55 employees
 - Does the size change seasonally, i.e. are there temporary employees?

- We try to keep steady workforce, I'm sure our subcontractors use temporary employees
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - I don't think so, we aren't the biggest company but the relationship can be hard at times
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - We try to go for a certain number of projects per year, don't know it off top of head. The demand for lumber can sometimes strain the relationship if supply is low but we try our best to avoid it

Company 2

- What are the most important aspects in selection of wood products suppliers?
 - Cost influences our decisions heavily as well as the availability of the product
 - Why does your company focus on factor X (cost, quality, etc.)?
 - Cost because it affects bottom line and availability because we need the product at our sites
 - For these factors, how do you think your suppliers can improve on them?
 - Making sure they have competitive pricing and communication is supply is dwindling
- What is your purchasing process? Describe.
 - Bidding process
 - Is there any place in this process where your company can give feedback to the supplier?
 - Definitely try to communicate with our suppliers often
 - What is the hardest part of the purchasing process and why?
 - The negotiation aspect of it
 - Any way to improve the process on both ends?
 - Better communication
 - What is the structure of the procurement process?
 - When a company wins a bid, we contact them and go from there
 - How does your company purchase wood products?
 - Through distributors usually
- Who are your key suppliers?
 - Home centers.
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - We try to look at what they have to offer and if they have good price points
 - What do the key suppliers do well to maintain your company's interest in them?
 - Making sure supply is up and the cost is fair
- What is important in the relationship with your suppliers?

- Having trust and being reliable with their products
- How can the relationship be improved?
 - All boils down to good communication
- What do these suppliers do well to maintain relationship?
 - Again, good communication is key for business
- Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Try to have open lines of communication, high quality products that are fairly priced
- Is there supplier training involved in the buying process?
 - Not on our side
- Number of wood suppliers you have
 - Around 5-6
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - We try to have constant supply so want to avoid dips in suppliers
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Again, try to keep suppliers constant so we can keep product moving in
- Do you require bids/multiple quotations?
 - Yes, require bids
 - Is there any way for one supplier to put itself above another?
 - Having a good price for good quality. Also having availability/supply.
 - Do you have a preference for these suppliers who have the better business relationship?
 - We try to do business with those who we have worked with before.
- Do you have preference for purchasing from local suppliers?
 - Preference for local suppliers
 - What is the rough percentage of local to not local suppliers?
 - 25% non-local to 75% local
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - Logistics wise, makes it easier for us if the supplier is close to us
 - What could local suppliers do to get more of their product purchased from the company?
 - Having good price points and promoting themselves as well as their products
- What wood products do you use that are purchased within your state?
 - Lumber is a big part of that
 - Have you looked into other wood products and their uses?
 - We try to see new products in the market and their uses, but have to have a use in our projects
 - What would you say is the best product you purchase and why?
 - Lumber is simple and easy to work with

- Size of the company
 - 90 employees
 - Does the size change seasonally, i.e. are there temporary employees?
 - We try not to change our employees i.e. stay constant throughout the year
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - Since we try to focus on local suppliers, we don't think it affects our relationship.
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Sell based on project, hard to say. The demand for lumber doesn't really affect the relationship with us and our suppliers

Appendix E. Full In-Person Interviews with Florida Companies

Company 1

- What are the most important aspects in selection of wood products suppliers?
 - Cost and delivery times
 - Why does your company focus on factor X (cost, quality, etc.)?
 - Want the cheapest product while being delivered in timely matter
 - For these factors, how do you think your suppliers can improve on them?
 - Better lead times and giving fairer pricing
- What is your purchasing process? Describe.
 - We bid out projects
 - Is there any place in this process where your company can give feedback to the supplier?
 - Not really, try to keep in loop with suppliers but hard to do
 - What is the hardest part of the purchasing process and why?
 - Keeping in contact with all of our suppliers
 - Any way to improve the process on both ends?
 - More communication would be beneficial to both sides I think
 - What is the structure of the procurement process?
 - When supplier wins a bid for a project, we contact them to get supplies
 - How does your company purchase wood products?
 - Usually through big distributors
- Who are your key suppliers?
 - Big distributors and some smaller yards
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - Always looking into different products
 - What do the key suppliers do well to maintain your company's interest in them?
 - Good supply and good pricing
- What is important in the relationship with your suppliers?
 - Pretty important that they have good communication
 - How can the relationship be improved?
 - Have better communication when supply might be down
 - What do these suppliers do well to maintain relationship?
 - Good communication
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Be different and what makes your product stand above the rest
 - Is there supplier training involved in the buying process?
 - Not on our side, the suppliers I'm sure train their sales
- Number of wood suppliers you have

- Hard to pinpoint specific number but around 10
- Does the number of lumber/OSB/etc. suppliers change seasonally?
 - We try to have constant suppliers
- Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Again, try to keep the suppliers constant so we don't scramble for product
- Do you require bids/multiple quotations?
 - Yes, there is a bidding process
 - Is there any way for one supplier to put itself above another?
 - Competitive pricing and plenty of supply
 - Do you have a preference for these suppliers who have the better business relationship?
 - We tend to work with those who have a good relationship with us already
- Do you have preference for purchasing from local suppliers?
 - No preference.
 - What is the rough percentage of local to not local suppliers?
 - Hard to say but probably around 80% non-local
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - We tend to buy from nonlocal because of their pricing and deals
 - What could local suppliers do to get more of their product purchased from the company?
 - Have good supply, good product, and good pricing
- What wood products do you use that are purchased within your state?
 - Lumber, LVL, engineered wood products, etc.
 - Have you looked into other wood products and their uses?
 - Not really, pretty satisfied with our current products as of now, might change in the future when better products come out
 - What would you say is the best product you purchase and why?
 - Probably the engineered wood products, really good bang for the buck
- Size of the company
 - Around 60ish
 - Does the size change seasonally, i.e. are there temporary employees?
 - We try to stay a constant size and no temporary employees
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - I'd say so, they might look at us as a bigger builder and might not want to do business
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Sales wise in the millions, and the demand of lumber sometimes strains the relationship but we always try to work it out best we can

Appendix F. Full In-Person Interviews with Texas Companies

Company 1 (Phone Interview; unable to do in-person)

- What are the most important aspects in selection of wood products suppliers?
- Delivery on time is biggest factor then cost.
 - Why does your company focus on factor X (cost, quality, etc.)?
 - It's all about money; table stakes to be a qualified bidder, have to preform for guys in the field. People don't get to bid until they get to prove they deliver on time. Then comes cost, we bid lumber out every 6 months. Based off of market dynamic to sell home.
 - For these factors, how do you think your suppliers can improve on them?
 - For delivering on time, right equipment, attentive, right people. Cost: how well they manage commodities market and buy wood, how creative they can get. Their people trading lumber based on market dynamic.
- What is your purchasing process? Describe.
- For loose lumber, go out to bid, 39 divisions to bid in December. Sort of a live event, whoever wins have that communities. Doesn't have to be all one guy (i.e. split). Own that community for 6 months. Take random lengths. Average within the weeks and take it all together. 6 months is our baseline.
 - Is there any place is this process where your company can give feedback to the supplier?
 - Yes, we have a bid tool. Bid goes live on Monday morning, closes Wednesday. Look at totals/plan, individual/item, reorganize however they want. There is where they can give feedback. Create a "war room" where all this stuff is up on screens.
 - What is the hardest part of the purchasing process and why?
 - For me, we buy on calendar as opposed to market dynamic. Need good communication, always that guy who gets upset when he doesn't get called. Making sure bidders use right unit of measure.
 - Any way to improve the process on both ends?
 - Yes, our end is one of the bigger issues (the wrong units of measure). Developing one master item sheet to clear confusion.
 - What is the structure of the procurement process?
 - It is just our bidding process.
 - How does your company purchase wood products?
 - We do a bidding system and true-up.
- Who are your key suppliers?
- 84 lumber, BFS, BNC – 3 biggest distributors
 - Can new suppliers enter the market and would you be interested in what they have to offer?

- New suppliers can, but have to be qualified bidder. Division has to sign off that they can bid.
 - What do the key suppliers do well to maintain your company's interest in them?
 - Good service and good pricing.
- What is important in the relationship with your suppliers?
- We have relationships called strategic partnerships. Culturally same values have to be shared. Do the right thing for the right reasons. If good cultural fit, and alignment of values that is important to us, how people grow with us.
 - How can the relationship be improved?
 - Good and honest communication.
 - What do these suppliers do well to maintain relationship?
 - Good honest communication, and they bring solutions (especially cost solutions) proactively.
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - If you got good service and price aggressive and know our guys in the field, (be proactive) and you'll have business with us.
 - Is there supplier training involved in the buying process?
 - Only for the software (bid tool) we use.
- Number of wood suppliers you have
- Around 30
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - No, same guys for the most part.
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - It'll move depending on the market, not drastically.
- Do you require bids/multiple quotations?
- Yes.
 - Is there any way for one supplier to put itself above another?
 - Good and honest communication, proactively trying to find ways to lower cost of home.
 - Do you have a preference for these suppliers who have the better business relationship?
 - Yes. Cultural alignment and understanding my business.
- Do you have preference for purchasing from local suppliers?
- No preference. Depends on the capabilities of the execution of the local guy. Depends on the product, price, and if my guys like it.
 - What is the rough percentage of local to not local suppliers?
 - Do a lot by default with the bigger guys. Percentage all over the place.
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - The guy that is going to take care of my construction managers the best is going to get the job. How well the guy performs.

- What could local suppliers do to get more of their product purchased from the company?
 - Honesty, being proactive, get with our guys.
- What wood products do you use that are purchased within your state?
- OSB, don't really look at it that way honestly. Use SYP.
 - Have you looked into other wood products and their uses?
 - Yes, market is traditionally SPF, switched to KD Douglas-Fir instead.
 - What would you say is the best product you purchase and why?
 - Differs by market here. Don't have a product that really stands out (have 39 markets); nothing really stands out.
- Size of the company
- 50,000 homes this year.
 - Does the size change seasonally, i.e. are there temporary employees?
 - No, we do not do temporary employees. Size doesn't change seasonally.
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - Probably it would affect the relationship; we have a higher expectation.
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - 12.65 Billion. Yes, we expect to be first in receiving the product.

Follow-up: Do the mills take up bids with you?

No, it goes with the brokers/salespeople. We have relationships with mills however, and are looking to grow.

Lumber dealers know about our own bidding process.

We do specify the species because of how the wood may react. Reason we want KD Douglas-Fir instead of something else is that it won't move as much in certain weather. Species does come into play. We do challenge grade occasionally. SYP not great for studs due to of low grade and it movement, drywall does not like it. A lot of our trusses are SYP.

Company 2

- What are the most important aspects in selection of wood products suppliers?
- Cost factor for sure; straightness and quality of lumber
 - Why does your company focus on factor X (cost, quality, etc.)?
 - Cost so can compete with other builders, straightness of lumber is important for building
 - For these factors, how do you think your suppliers can improve on them?
 - Grading of lumber can be spotty
- What is your purchasing process? Describe.
- Generally, work with 1 supplier, give the biggest discount, lumber yard will send quotes back based on blueprints

- Is there any place in this process where your company can give feedback to the supplier?
 - Other than calling owner, not really, have an understanding with supplier
- What is the hardest part of the purchasing process and why?
 - Not so much difficulty, because worked together for a while
- Any way to improve the process on both ends?
 - Can't think of much improvement
- What is the structure of the procurement process?
 - Quoting described above
- How does your company purchase wood products?
 - See above
- Who are your key suppliers?
- 1 key supplier
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - Would think so if they can compete
 - What do the key suppliers do well to maintain your company's interest in them?
 - Service to me
- What is important in the relationship with your suppliers?
- Service, delivery time, honesty
 - How can the relationship be improved?
 - Maintaining service and competitive pricing
 - What do these suppliers do well to maintain relationship?
 - Service, delivery, then cost
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Make sure service is top notch and competitive pricing
 - Is there supplier training involved in the buying process?
 - Not really sure
- Number of wood suppliers you have
- 2-3, 1 main guy
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - Stays the same
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Stick to same number of suppliers
- Do you require bids/multiple quotations?
- Require quotes to keep everyone honest
 - Is there any way for one supplier to put itself above another?
 - Really, it's about the service
 - Do you have a preference for these suppliers who have the better business relationship?
 - We do have a bigger preference

- Do you have preference for purchasing from local suppliers?
- Do have a preference for local guys
 - What is the rough percentage of local to not local suppliers?
 - 90% local to 10% non-local
 - Why do you have no preference for local suppliers/have more preference for local suppliers?
 - Service and the price they provide
 - What could local suppliers do to get more of their product purchased from the company?
 - Corporations set in their way, hard to sway bigger guys
- What wood products do you use that are purchased within your state?
- Spruce, pine, fir lumber
 - Have you looked into other wood products and their uses?
 - Roofing products change frequently
 - What would you say is the best product you purchase and why?
 - OSB probably up there, very reliable
- Size of the company
- I subcontract so around 50 employees
 - Does the size change seasonally, i.e. are there temporary employees?
 - Seems pretty consistent
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - I would say so
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Around 3-4 million/year in gross sales about 10-12 homes/year
 - Somewhat affect relationship but not too bad

Company 3

- What are the most important aspects in selection of wood products suppliers?
- Price, time, someone who has everything I need
 - Why does your company focus on factor X (cost, quality, etc.)?
 - Price is self-explanatory, time – could order from a big distributor but won't see it for 2 days. Personal service makes it better
 - For these factors, how do you think your suppliers can improve on them?
 - Supplier can be more technical, not really technologically advanced
- What is your purchasing process? Describe.
- Lumber package, call framer on what I need, get about 1-page list
 - Is there any place is this process where your company can give feedback to the supplier?
 - Pick up phone to call guy, immediate feedback, easier to call smaller guys and get something done
 - What is the hardest part of the purchasing process and why?

- Multiple steps involved
 - Any way to improve the process on both ends?
 - My end not too sure, their end needs to get more tech savvy
 - What is the structure of the procurement process?
 - Figure out who gives good price and stick with them
 - How does your company purchase wood products?
 - Order directly, usually locally sourced, framer gives initial list
- Who are your key suppliers?
- 85% from one company, other is from a different company
 - Can new suppliers enter the market and would you be interested in what they have to offer?
 - Suppliers for certain things
 - What do the key suppliers do well to maintain your company's interest in them?
 - Service is the number 1 priority
- What is important in the relationship with your suppliers?
- Trust, supply, speed
 - How can the relationship be improved?
 - No answer
 - What do these suppliers do well to maintain relationship?
 - Communicate and deliver product
 - Do you have any advice for smaller, local suppliers to try to get their product pushed for companies such as yours?
 - Build the personal relationships to build the business
 - Is there supplier training involved in the buying process?
 - Learning curve, but not necessarily provided training
- Number of wood suppliers you have
- 2-3 accounts we buy from
 - Does the number of lumber/OSB/etc. suppliers change seasonally?
 - Been the same since I've started so no
 - Is the number of lumber/OSB/etc. suppliers constant, or does it increase/decrease when demand for your company increases/decreases?
 - Constant
- Do you require bids/multiple quotations?
- Don't require either, price out 1/year
 - Is there any way for one supplier to put itself above another?
 - Service goes a long way, pay more for better service over price
 - Do you have a preference for these suppliers who have the better business relationship?
 - Yes, more preference
- Do you have preference for purchasing from local suppliers?
- Yes, try to buy local
 - What is the rough percentage of local to not local suppliers?
 - 90% local to 10% non-local

- Why do you have no preference for local suppliers/have more preference for local suppliers?
 - Typically, they are cheaper, better for economy
- What could local suppliers do to get more of their product purchased from the company?
 - Advertise, or have a better relationship, more community involvement
- What wood products do you use that are purchased within your state?
- Everything for a house, lumber, trim, trusses, etc.
 - Have you looked into other wood products and their uses?
 - Always looking for new products
 - What would you say is the best product you purchase and why?
 - Probably this type of trim replaced a lot of other needs
- Size of the company
- 5 employees
 - Does the size change seasonally, i.e. are there temporary employees?
 - No
 - Do you think the size of your company affects the relationship between you and smaller, more local suppliers?
 - Yes, size definitely affects the relationship
 - Sales wise, how big is your company and does the demand for lumber affect the relationship of your company with suppliers?
 - Don't think it strains the relationship that bad, there is no shortage

Appendix G. South Carolina Forestry Commission Report Supplier Recommendations

Based on the results, suppliers should strive for having fair pricing on their products as well as having a high quality product. Also, making sure the product arrives on time and having good service were quite important to the construction companies asked in the study. While it would be difficult to try to focus on every factor highlighted, it would be important to emphasize one or two of the factors. For instance to set a certain supplier apart from the rest, they could focus on having the best quality product while having good delivery times. This would mean the price would probably be more of a premium, but companies are willing to pay that price in return for better quality and the product arriving at better times. Prioritizing a few factors rather than all of them can differentiate what a supplier can do.

An issue that was seen in the results were the unknowns involving where the product was purchased from and where it was manufactured. Perhaps some companies used subcontractors and the subcontractors would do most of the purchasing of the wood products. There were no questions asked about subcontractors specifically over the survey and phone calls; it would be interesting to see if that had an effect. Maybe a separate survey or study could be conducted to look into subcontracting and if that is why the location for purchasing of products was such a big unknown. There is a difference between purchasing products in-state and products that were manufactured in-state. It would be interesting to look into if manufacturers of wood products get their products mainly purchased in their own respective states or if they get transported elsewhere.

Not many construction companies used a wood products industry database. In order for in-state wood products suppliers to get more attention it would be very valuable if construction companies used a database to search for more options. Having more options would benefit the construction company as they can search for better pricing, better quality, closer options, etc. The

database would help the suppliers try to push more of their products through as well. It would be beneficial to both parties to invest resources into a database. Some suppliers seemed to not be aware of market pricing so perhaps the database could help with general pricing points as well.