

Assessment of U.S. Manufactured System built Wooden Homes as an Affordable Housing Alternative for Low-income Households in Developing Countries.

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Abstract

Millions of people around the developing world struggle to obtain safe, decent and affordable housing. The United States of America has substantially improved the residential construction sector by engineering new materials and developing efficient systems in wood construction.

The goal of this research was to assess the potential of introducing system built wood construction system manufactured in the United States in urban social housing markets of developing countries. Peru, Ecuador and Colombia were three countries chosen for this study. Stakeholders in social housing in these three countries were interviewed to assess key aspects of traditional construction, current social housing deficits, perception of wood use in construction, and policies associated with social housing in selected markets. Findings indicate developing custom housing products for urban social housing programs can provide access to this untapped markets. Awareness about wood construction was very limited in the studied region. System built wood construction manufacturers in the U.S. were assessed to identify barriers and incentives for internationalization. Manufacturers in the U.S. also identify the need to expand their existing customer base. Findings of the survey conducted among the manufacturers identified various barriers to export. This research contributes to opening of new markets for exports of prefabricated wooden buildings in new geographical regions.

General Abstract

Millions of people around the developing world struggle to obtain safe, decent and affordable housing. The United States of America has substantially improved the residential construction sector by engineering new materials and developing efficient systems in wood construction.

The goal of this research was to assess the potential of using wood houses manufactured in a factory in the U.S. for urban social housing markets of developing countries. Peru, Ecuador and Colombia were three countries chosen for this study. Stakeholders in social housing were interviewed to assess key aspects of traditional construction, current social housing deficits, perception of wood use in construction, and policies associated with social housing in selected markets. Findings indicate developing custom housing products for urban social housing programs can potentially provide access to untapped markets. System built wood construction manufacturers in the U.S. were assessed to identify barriers and incentives for internationalization. Existing policies and trade relations between the U.S. and countries in South America supports this development. Awareness about wood construction was very limited in the region. Lack of existing wood construction in markets indicates a possibility of resistance to acceptance but also assures no local competition. Manufacturers in the U.S. also identify the need to expand their existing customer base. Findings of the survey conducted among the manufacturers identified various barriers to export. This research contributes to opening of new markets for exports of prefabricated wooden buildings in new geographical regions.

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Contents

Abstract.....	i
General Abstract.....	ii
Acknowledgements.....	iii
List of Tables.....	vii
List of Figures.....	viii
Executive summary.....	ix
1. Introduction.....	1
1.1 Overview.....	1
1.2 Purpose of the study.....	6
1.3 Organization of the thesis document.....	8
2. Literature Review.....	10
2.1 Overview of residential construction industry in the United States.....	10
2.2 Construction technologies.....	12
2.2.1 Why wood framing?.....	15
2.2.2 Evolution of Building Systems in Wood construction.....	16
2.2.3 Prefabricated systems.....	17
2.2.4 Panelized systems.....	17
2.2.5 Modular systems.....	18
2.2.6 System built wood construction in the United States.....	18
2.2.7 Adoption of system built wood construction in the United States.....	20
2.2.8 Hurdles in implementing wood prefabrication in construction.....	22
2.3 Internationalization of U.S. manufacturing.....	26
2.3.1 Exports of factory built homes from U.S.....	27
2.4 Export Venture performance.....	29
2.4.1 Determinants of Export Performance.....	34
2.4.2 Theoretical Framework.....	36
2.5 Housing in Latin America.....	40
2.5.1 Social housing deficits: Defining the need.....	41
2.5.2 Peru.....	44
2.5.3 Colombia.....	48

2.5.4 Ecuador	51
2.5.5 Low Income Housing: Developing For Bottom of the Pyramid (BOP).....	53
2.6 Summary of the literature review.....	55
2.7 Research question	58
2.8 Goals and objectives	60
3. Methodology.....	61
3.1.1 Objective 1: Identify incentives and barriers for successful implementation of exporting prefabricated wood homes to developing countries.	61
3.1.2 Objective 2: Identify factors differentiating exporting firms from non-exporting firms and barriers of exporting system built wood construction.....	65
3.1.3 Objective 3: Establish and validate export assessment model using resources availability, capability and export venture strategy in system built wood construction industry.....	70
3.1.4 Objective 4: Develop a marketing training manual for the system built wood housing manufacturers in the United States to export to selected countries.	78
3.2 Means of assessing the results.....	78
4. Results	80
4.1 Objective 1	80
4.1.1 Lima, Peru	81
4.1.2 Bogota, Colombia	83
4.1.3 Quito, Ecuador	86
4.2 Objective 2	89
4.2.1 Overview of survey responses.....	89
4.2.2 General characteristics of the companies	89
4.3 Objective 3	98
4.4 Objective 4	100
5. Discussion	102
5.1 Exporting system built wooden houses	102
5.2 Market assessment	106
5.3 Assessment of wood house manufacturers.....	108
6. Conclusions	112
Specific Recommendations	116

References	120
Appendix A: Housing starts in the United States.....	132
Appendix B: System built wood housing assessment survey	133
Appendix C: Survey Instruments: Phase 1	134
Appendix D: Survey supporting documents: Phase 2.....	138
Appendix E: Survey Instrument and variable description: Phase 2.....	141
Appendix F: Export venture performance measurement.....	154
Appendix G: Floor plan layouts for low income housing in Peru	156
Appendix H: Marketing Report for system built wood housing manufacturers in the United States.....	164
Appendix J: IRB approval letter.....	217

List of Tables

Table 1 Biggest Challenges and Opportunities Anticipated by Giant Companies in 2016	11
Table 2 Industry Structure: Off-Site Construction in U.S. (2015) (Carter, 2015)	19
Table 3 Reviews on Export Performance	31
Table 4 Regional Housing Shortages in Latin America and the Caribbean 2009 (Percent of the Households) (Bouillon, 2012).....	42
Table 5 AVN Scheme	46
Table 6 CSP Scheme	47
Table 7 MV Scheme	47
Table 8 List of Hypotheses for Objective 2	66
Table 9 Barriers to Exporting System Built Wood Houses from the U.S.	68
Table 10 Correspondence Timeline for Implementation of Survey	76
Table 11 Details of Visits	80
Table 12 Response Summary on Different Construction Methods.....	90
Table 13 Export Share for Each Region.....	94
Table 14 Hypothesis Testing using Chi-Squared and Fisher's Test.....	97
Table 15 Cronbach's Alpha Coefficients	99
Table 16 Regression Models and Associated Coefficients for Each Independent Variable	100
Table 17 Major Activities Associated with Exporting (Evans, 1990).....	104
Table 18 Summary of the findings	107
Table 19 Type of Construction Method of New Single-Family Houses Completed in the United States.....	132
Table 20 Survey Population and Sample Description	133
Table 21 Variable Description for the Questionnaire	147
Table 22 Export Performance Measurement: Construct and Measurement Items.....	154

List of Figures

Figure 1 New Single Family Homes Completed in United States (1992-2014).....	4
Figure 2 Percent Distribution of Construction Method in New Single Family Homes Completed in the United States (1992-2014) (U.S. Census Bureau, 2016).....	5
Figure 3 Housing Units started in the United States (2000-2015).....	10
Figure 4 Housing Giants Market Share, 2016	11
Figure 5 Stakeholder's View on Factory Built Construction in the United States (McGraw-Hill Construction, 2011)	21
Figure 6 Cost Structure of the Off-site Manufacturing Industry in 2015 and Comparison with Wood Products Sector (Carter, 2015).....	25
Figure 7 Export Values for Major Forest Products, FY 2014 (Carter, 2015)	28
Figure 8 Exports of Factory Built Construction Industry (2015)	29
Figure 9 Conceptual Framework of Export Performance Measurement (Chen, Sousa, & He, 2016)	37
Figure 10 Theoretical Framework: Export Venture Performance Model.....	38
Figure 11 Housing Deficit by Countries, 2009 (Percent of Households) (Bouillon, 2012).....	43
Figure 12 Market Assessment Methodology used for Objective 1	64
Figure 13 Survey Design Methodology	74
Figure 14 Current Housing Solutions for Low income Households in Metropolitan Lima	81
Figure 15 Distribution of Respondents by Number of Employees	91
Figure 16 Distribution of Respondents by Sales and Value of the Company as Reported in Survey	92
Figure 17 Survey Responses to Business Success Factors	95
Figure 18 Survey Responses to Barriers to Export.....	96
Figure 19 Cover Letter for 1st Wave of Surveys	138
Figure 20 Reminder/ Thanking Postcard	139
Figure 21 Cover letter for 2nd Wave of Surveys.....	140

Executive summary

Sustainable housing is one of the fundamental necessities for socio-economic development. Yet a considerable population in the developing world is living in substandard houses. On the other hand, developed countries like the United States have substantially improved residential construction sector by engineering new materials and developing efficient systems.

This study attempts to link this supply capacity of system built wood construction sector in the United States to urban low-income social housing markets in Latin-American region. Expansion to new markets and diversification to new products can help expand wood construction industry in the U.S. Linking manufacturers with potential buyers overseas would need efficient production, logistics and marketing systems. This research is focused on assessment social housing market in developing countries to give them an affordable yet sustainable alternative to traditional systems. Interviews and survey tools were used to assess key aspects of social housing deficits in target demographics of South American region. System built wood construction manufacturers in the U.S. were assessed to identify barriers and incentives for internationalization and how they differ from exporting to non-exporting manufacturers within the same industry. Findings indicate developing products for social housing programs can provide access to potential untapped market. Lack of existing wood construction in these markets indicate the possibility of resistance to acceptance but also assures no local competition. These findings can also contribute to the opening of new markets for exports of prefabricated wooden buildings in other housing sectors.

1. Introduction

1.1 Overview

With the advent of globalization and industrialization, urban migration and expansion of cities have become a global trend. South American countries are among being the most rapid urbanized countries in the world. As more people migrate to urban areas in search of better life, the cities of the region are growing in size and number (Ferguson & Navarrete, 2003). This problem is native to not just Latin American countries but is a major concern for most of the developing world. As estimated by the United Nations (United Nations, 2016), about 40 percent of the world population would be living in substandard housing as a result of urban expansions and population growth by 2050. This is perceived to be a direct impact of rapid urbanization and excessive strain on housing and serviced land. As estimated by UN (United Nations, 2016), slum population in Sub-Saharan Africa is 199.5 million, South Asia 190.7 million, East Asia 189.6 million, Latin America and Caribbean 110.7 million, Southeast Asia 88.9 million, West Asia 35 million and North Africa 11.8 million. The construction sector in these countries, along with other factors, have failed to match the demand using conventional systems forcing people to resort to informal slum settlements.

This global housing deficit, clearly demands for a significant change in residential construction methodology in order to provide these low income households with standard dwelling options. The best solution can be in those regions of the developed world where the housing deficit in not a major problem. The United States of America is among the few countries with low housing deficit. Wood is the primary structural component of these constructions and is used in

over 90 percent of houses (Piepkorn, 2014). This high use of wood is far more common than in any other regions of the world except Canada. Increased use of prefabrication within a controlled environment of a factory have further reduced the costs and improved the process efficiency in these countries. Though the findings may not be used directly, wood construction using techniques adapted to certain climatic conditions have proven to be successful in other regions as well. Thus, this wood frame construction system has been gaining acceptance worldwide owing to its affordability, waste reduction, aesthetics, low negative environmental impact, flexibility in design and ease of construction (Roche, O'Connor, & Tetu, 2003).

The current housing need in Latin America is estimated to be of 42 million units (United Nations, 2016). To bring it to a perspective, one out of every three families in this region lives in substandard housing. Nicaragua with 78% of its population living in substandard housing leads the region with highest recorded housing deficit. Bolivia (75%), Peru (78%), Guatemala (67%), El Salvador (58%) and Honduras (57%) are other countries with high deficit in the region (IDB, 2012). Though lack of available funding was identified to be underlying issue, a solution to this problem of the housing shortage can be multi-dimensional. Improvement of current construction practices, use of better materials, use of new techniques and government policies to support these changes are the few to start with. As demonstrated in Western Europe and America, support to and expansion of public housing programs can significantly promote private housing industry and in turn help in reducing the overall deficit (Chen, Stephens, & Man, 2013).

The construction industry in the United States is one of the major industries in the country. In 2014, the sector accounted for 3.8 percent of the annual Gross Domestic Product (Bureau of

Economic Analysis, 2016). Over the past 15 years, the sector has experienced market fluctuations and endured challenging time. Starting with a GDP share of 4.5% in the year 2000, the construction sector experienced a frenzy growth with flourishing US economy till 2006. The sector was badly hit during the December 2007-June 2009 recession with a net employment decline of 19.8 percent (Hadi, 2011). The loss of 1.5 million employment was the largest decline among the non-farm industries. Residential construction was the most badly hit with effect starting almost a year before the start of the actual recession. The overall market and condition of housing industry has improved, but this improvement is coming at a considerably slower pace (U.S. Census Bureau, 2016). As a result, the companies need to prepare themselves to face any similar market failure in future. Development of a robust business model with diverse market penetration could be one of the options to grow and prepare for any similar catastrophe (Baack, Harris, & Baack, 2013).

Based on the method of building, the wood residential construction sector in the U.S. is divided into two sectors, namely the site-built and the factory built (also called system built) homes. As the name suggests, the construction industry that uses dimensional lumber and/or engineered building components on the construction site is called site-built industry (Gurney, 1999). On the contrary, the factory built industries build the structures in controlled environment of a manufacturing facility and installed on site with reduced on-site construction (HUD, 2007). There is a considerable difference in the share of market between these sectors. Site-built residential construction essentially dominated the market with controlling as high as 97% of the market share in 2014 (U.S. Census Bureau, 2016). Figure 1 shows the trend of new single family homes completed in the U.S. over a period of 12 years (1992-2014).

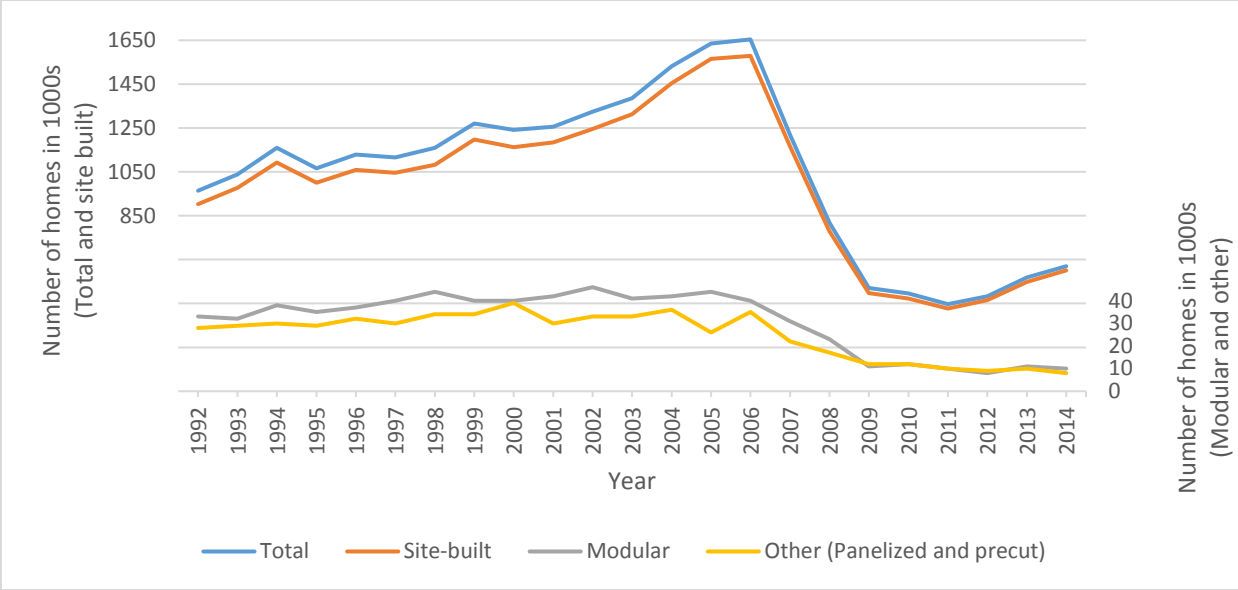


Figure 1 New Single Family Homes Completed in United States (1992-2014)

In order to better resolve and compare the trend of site built and factory built single family residential construction, the graph have been split into two axis. The axis on the left shows the number (in thousands) of the completed total and site-built houses. The axis on the right shows the number (in thousands) of the completed factory built (modular, panelized and precut) houses. Detailed information on the numbers of units in each category is included in the Appendix A. It is also important to compare the percent distribution to further the two methods of construction used in the U.S. Figure 2 shows how the site-built construction have dominated the market share over the years. The axis is again broken into two categories in order to resolve the low contributing factory built sector. Despite being mature a technology, the factory built sector has not made its mark in the residential construction market. This shows that there is a potential opportunity for the factory built sector to grow and improve its contribution. Several studies (Apgar, Calder, Collins, & Duda, 2002; Bady, 1996; Wherry, 2009) suggested an inherent potential in the factory built sector for increasing its market share.

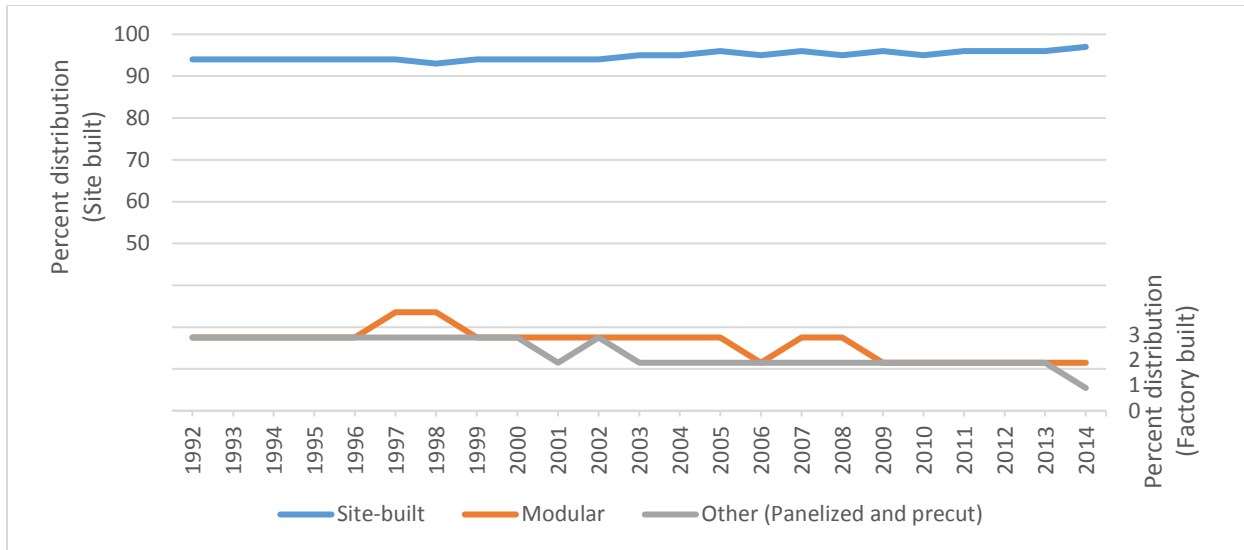


Figure 2 Percent Distribution of Construction Method in New Single Family Homes Completed in the United States (1992-2014) (U.S. Census Bureau, 2016)

Although prefabrication is a mature method of construction in many European countries and in the U.S., several countries in the study region of Latin America are still not familiar with this method. Because of the nature of their socio-economic system, Latin American countries tend to use more actual manpower for construction rather than prefabrication methods. Construction methods that require a lot of physical labor such as masonry, hand paint or cast-in-place concrete are common in the region (Brednoord, Lindert, & Smets, 2014). This gives companies in the U.S. a critical advantage to manufacture and fulfill this social housing demand in the region with the advancement in its prefabrication systems and application of sustainable practices in wood construction. The geographical proximity, trade relations and existing business corridors would further support this endeavor. Despite all these benefits, there is a considerable gap of knowledge in understanding the local regulating policies, construction codes, potential housing demand and segmentation, cultural aspects impacting the design and architecture. This information would also be useful in adjusting features to adapt to local

conditions, designing the marketing strategies and mode of introducing system built wood construction system in target countries (Baack, Harris, & Baack, 2013). The use of system built wood construction in residential construction in these countries can have a multifaceted impact. Construction in targeted countries will be benefited by reduced project time, less on-site activities, environment friendly, increased safety and performance in high seismic activity areas, standardized construction due to subject to model codes of construction.

The nationwide housing trends highlighted in the Figure 3 and regional trends in the U.S. forest products industry points to need of new structural changes in market penetration and potential prospects of growth (Na, 2015). International markets for wood houses may not be sufficient to increase the production and performance levels but like other forest products industries can lead to sustainable, long term growth by diversifying to new customers (HMR, 2012; Blanco, 2014). Moreover this future growth and improvement in the industry by exporting U.S. manufactured products will not lead to off-shoring skilled domestic jobs. Thus expansion of U.S. forest products exports can prove to be a lucrative prospect for sector's growth in future (Woodall, et al., 2011).

1.2 Purpose of the study

System built wood housing alternatives built in the United States has the potential to fulfill the social housing deficit gap in developing countries by developing and exporting an affordable substitute compared to current practices. It is important that the units are designed specifically to fulfill local needs and match required standards in order to be successfully accepted in the market. Companies manufacturing system built homes in the U.S. can also considerably

improve their business performance by exporting to these potential markets overseas. But there are many barriers associated with such an internationalization operation of factory built homes (Steinhardt, Manley, & Miller, 2013). Extensive analysis of the production process and supply chain structure, efficient logistics system including both the physical transportation and information exchange, role of intermediaries like architects, engineers and subcontractors linking the suppliers and end users, role of government, regulatory policies, predisposition of consumers and slow adaptation by builders are some of the key barriers associated with the supply chain. In this research, key factors impacting exports and selecting favorable markets were identified by interviewing and surveying the stakeholders.

This would give manufacturers in the United States an opportunity to expand to new and diverse markets as millions of families try to substantially improve their quality of living (Bouillon, 2012). Focusing on affordable housing would be a win-win situation where the manufacturers would get access to large potential markets and an opportunity to reduce social inequality by generating new employments and the households can get an affordable alternative for the traditional construction system in foreign target markets. This would also be beneficial for the governments of target export countries that are trying to promote environmentally sustainable alternatives in construction sector. Therefore the goal of this research is to assess the opportunity for introducing system built wood housing manufactured in the US in residential construction market of developing countries in South American regions to meet their social housing needs.

1.3 Organization of the thesis document

This document is organized according to the guidelines established by Graduate School, Virginia Tech. Chapter 1 gives a brief introduction to the reader about the topic of the research and presents the motivation of the research. Chapter 2 contains an extensive literature review on the system built wood construction system for residential construction used in the United States. Both domestic and export operations are analyzed to assess the current situation of the industry. The chapter also includes examination of current housing deficit in three countries, namely Peru, Colombia and Ecuador; of South American region. All three selected countries face considerable housing deficit (Bouillon, 2012) and thus can potentially offer a sizable market for new housing solutions. Demand and nature of housing requirements in the region were systematically examined and used to develop interview questionnaires. Finally, Export performance assessment frameworks are introduced. All this information in chapter 2 helped in identifying key characteristics of the housing value chain and developing the objectives of the research.

Chapter 3 covers the methodology behind this research. Case studies were used as a tool to assess social housing markets in target countries of the study. The system built construction was assessed by surveying the manufacturers of system built wood construction systems in the United States classified under North America Industry Classification System (NAICS) 32199201, 32199202, 32199205 and 32199206. The data was used to explore key barriers and success factors defining exporters and non-exporters in the industry. The survey data was also used to develop and test export an assessment model for system built wood manufacturing companies in the U.S. The results of this research are presented in chapter 4 along with summary of

conclusions, implications and limitations of the study. The appendix section have been placed at the end of the document that contain supplemental information, supporting documents, variable and model descriptions along with survey instruments which are referred throughout the document. The Appendix section includes a market report compiled for assisting system built wood construction industry and associated stakeholders with assessing the potential of exporting units manufactured in the U.S. to developing countries.

2. Literature Review

2.1 Overview of residential construction industry in the United States.

Several years after the market crisis of 2008, the U.S. housing market has started to revive. The Figure 3 below shows that how the market has slowly resurrected over the past 7 years (U.S. Census Bureau, 2016).

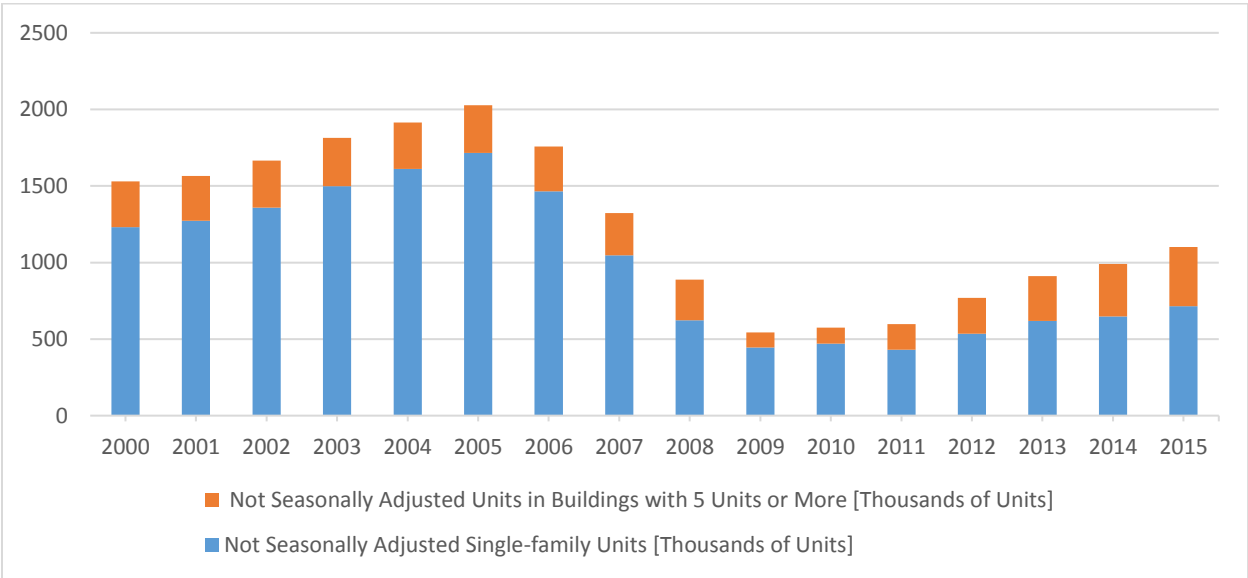


Figure 3 Housing Units started in the United States (2000-2015)

Residential home construction industry in the United States is extremely scattered by nature (ProBuilder, 2016). ProBuilder surveyed the residential construction industry and classified them into giants and non-giants based on the annual revenue. Top 20 giant construction companies in residential sector accounted for only 17 percent of the market share. The bottom hundred, companies from serial number 151 to 225, together accounted for only 2% of the market shares. Seventy percent of the market was operated by small companies (Figure 4). This shows that the majority of the market is being operated by small and medium companies which

might not be capable of making investments in capital intensive technology required to establish off site wood construction manufacturing.

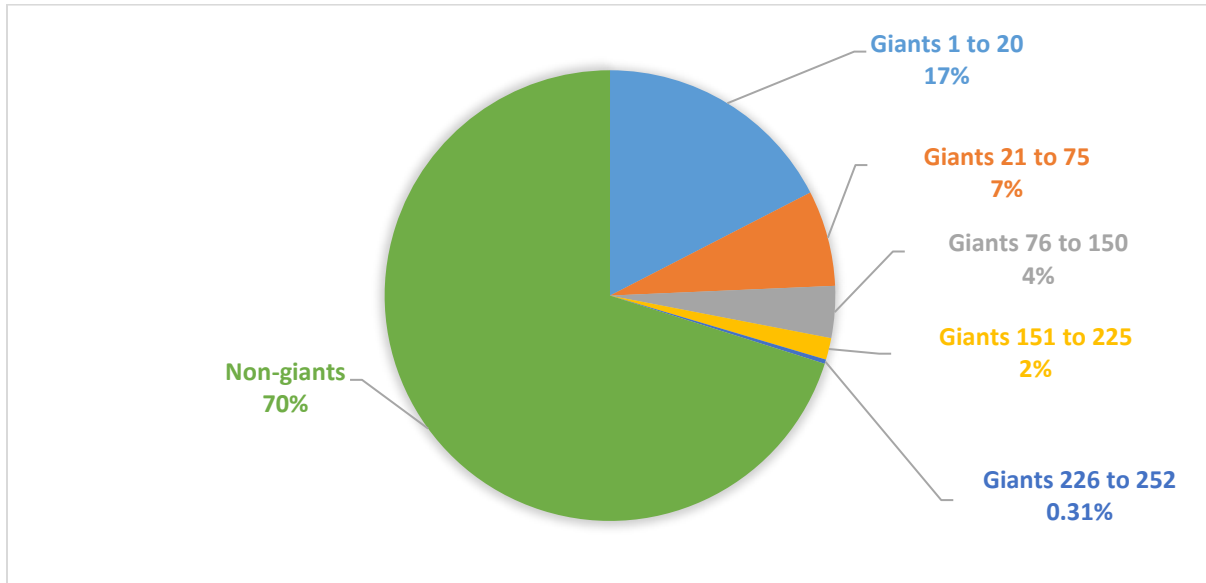


Figure 4 Housing Giants Market Share, 2016

ProBuilder (2016) also highlights major challenges and opportunities identified by the giant residential construction companies. Table 1 summarizes their findings in each of the two categories along with the proportion of responses.

Table 1 Biggest Challenges and Opportunities Anticipated by Giant Companies in 2016

Challenges		Opportunities	
	Response Proportion		Response Proportion
Availability of land	51%	Operational efficiencies	56%
Scarcity of skilled labor	51%	Niche market opportunities	40%
Increased Competition	27%	Market expansion	39%
Rising Home Prices	19%	Economic recovery	28%
Government Regulations	15%	Better marketing	28%

Lack of skilled labor and increased competitions indicate that the construction companies need to diversify and mechanize their process in order to stay competitive. This also means that companies need to move to new market segments which is also seen as an opportunity by most of the major companies. The companies also feel that it is important to improve the operational efficiencies in their processes.

2.2 Construction technologies

Historically, humans have either inhabited protected enclosed naturally occurring spaces, such as caves, or built structures to define and enclose space. Earlier construction depended heavily on utilizing closely available resources such as sticks and stones. With further evolution, the human race moved to using other organic materials and water as binding agents to keep the components together (Carswell, 2012). Over time, we have advanced a lot in developing new materials and methods of constructing the same dwelling giving it a form of an industry. The industry that currently has huge impact on not only the U.S. but the global economy.

Construction technology is an act or process of constructing, or building a product, commonly known as a structure, using different materials, methods and equipment (Carswell, 2012). Different structures can be constructed depending upon the type of material or method employed giving a variety to the industry. Over time, the construction industry in the United States have grown and differentiated itself into different independent but functional categories. This transformation in construction industry has been relatively slower as compared to other areas of engineering and technology (Gianino, 2005). Residential construction is one of

the major sections of construction sector and this research addresses this section of the industry only.

Different factors contribute to the selection and design of a house. These can be characterized into three major categories. These categories are biophysical, socio-psychological and technological (Gianino, 2005). Biophysical factors include natural biological and physical components like weather conditions, environmental and geographical factors surrounding the structure and the construction site. Socio-psychological factors mainly include the intangible features like culture, heritage, individual and societal needs along with political and economic policies of the region. These factors in turn shape both quantitative and qualitative demand of housing in the market. Technological factors are more concerned with the supply side of the value chain. Level of technical development in the construction sector of the region along with the availability of resources affect the diversity of techniques used in construction (Chiang, Chan, & Lok, 2006).

Though at a small pace, construction industry has evolved a lot over time. The development extended in both materials and use of techniques. Substitution of materials often led to substitution of techniques to use those materials. The motivation behind this change was always to fulfill demand in the most effective way. The housing industry in the U.S. has always been one of the major contributors in the nation's GDP (Bureau of Economic Analysis, 2016). Industrialized wood construction started in the U.S. after Swedes introduced log cabins in Delaware in 1638. During the period from 1600-1800, several other variations of wood construction were introduced by other immigrants like Germany, Scotland, Ireland and Russia. It was the beginning of 19th Century that the light frame construction, as we know it today, was

introduced in the U.S. “Balloon” framing was developed and commonly used in residential construction. This method employed long continuous framing members, known as studs, running through the entire building. Floors were then nailed to these studs. It was also called western framing. The technology was extensively adopted and was used commonly till mid-1950s (Carswell, 2012). But this method faced some disadvantages that amplified over time as the demand of housing increased. High associated fire risk, scarcity of long studs and difficulty in handling them made balloon technology questionable to use. Eventually the industry saw this problem and a new technology for constructing residential building was evolved. It still is light frame construction technology like balloon framing but method now shifted to use modified method to design load transfer paths. In this method, the framed structure is built on a concrete or treated wood foundation. Sill plate anchored to the foundation serves to keep the structure in its place. Subfloors (or platforms), walls and roof are then built over it. These platforms are erected using joists or other engineered wood products that rest on the supporting walls, beams or girders (Carswell, 2012).

The third and the central topic of analysis for this study is the system built wood buildings constructed majorly in the controlled environment of a facility. This is also known as off-site construction or factory built construction. Thus the residential construction can now be separated into two types depending upon the technique used. It can be either on-site or off-site construction. Depending upon the extent of prefabrication, these off-site manufactured systems can vary from just pre-cut and prefabricated components to panelized leading up to fully advanced volumetric modular systems. These are also called building systems (Na, 2015). Factory manufactured components in these systems replace some of the on-site labor built

structures. The process is mainly feasible in repetitive components of house like, walls, floors, doors and windows etc. which when assembled easily on site can be very effective in saving time.

2.2.1 Why wood framing?

Sixty percent of the raw materials extracted from earth are used in construction (Bribian, Capilla, & Uson, 2011). From this volume, buildings represents 40 percent and the rest is infrastructure like roads, bridges etc. Thus the sector alone contributes a substantial share in resource consumption. But this also means that there is a possible opportunity to invent and improve this usage. Consumption of nonrenewable and non-replenishable resources can lead to devastating effects on the environment. Wood is extensively used as a construction material in many parts of the world because of its availability, cost, ease of working, renewable nature, attractive appearance and performance and serviceability if built and maintained properly. Consortium for Research on Renewable Industrial Materials (CORRIM) group showed using Life Cycle Assessment (LCA) of wood, steel and concrete frame housing that the net CO₂ emissions from wood construction was 55 metric tons while steel and concrete had higher carbon footprint with 185 and 167 metric tons of CO₂ emitted respectively (Consortium for Research on Renewable Industrial Materials (CORRIM, 2004)). With responsible forest management practices assuring a sustainable supply, wood have been proven to be a better choice of construction material (Smith, 2010). Certain concerns like fire, structural durability and moisture damage always put wood construction in an inferior spot. Bad heat conducting nature of wood and use of proper fire prevention structural and non-structural components in construction assures enough safety (Smith, 2010). Building design according to performance

codes and timely maintenance can assure better structural performance and prevention from any moisture damage.

2.2.2 Evolution of Building Systems in Wood construction

Home manufacturers provide builders with a different product types with varied degree of prefabrication. These houses in the United States are manufactured strictly according to the concerned state wide building codes. Using advanced technologies in design and manufacturing, the factories can now mass produce complicated building panels with ease (Smith, 2010). Evolution of BIM (Building Evolution System) is one such example where architects and engineers can envision and execute the projects more efficiently using 3D models. These models are also helpful in producing the building components in a factory. “McGraw-Hill Construction (MHC) found that the use of BIM model-driven prefabrication on more than one quarter of their projects is expected to increase from 37 percent to 73 percent among practitioners who use BIM for green work. Even those who are currently not using green BIM expect an increase from 22 percent to 57 percent” (McGraw-Hill Construction, 2011). This report does not include the manufactured/mobile housing which is regulated under Manufactured Home Construction and Safety Standards administered by the U.S. Department of Housing and Urban Development (HUD) codes (HUD, 2017). The following section of this chapter introduces different types of systems covered under system built construction category.

2.2.3 Prefabricated systems

This is the most basic type of off-site factory manufacturing of building components. This system evolved with the wide spread of lumber mills which started to supply processed dimensional lumber to the builders. All of the cutting, drying and processing is done in a central location and then supplied to the builder on the construction site. The builder would then use these to make walls, floors or roof systems. This system further gained popularity with the development of engineered wood products like Structural Insulated Panels (SIP), trusses, I-joists (WoodWorks, 2014; WRAP, 2007) etc. which required mechanized manufacturing by skilled labor and cannot be done easily on the construction site. The manufacturers now make them in many configurations and types giving builders a wide variety to select from to fulfill the design and regulatory requirements.

2.2.4 Panelized systems

With further development in factory manufacturing of wood products, the wood products industry moved to assembling the prefabricated products into larger panels or complete assemblies. These panelized systems can be engineered according to construction design. Use of computer added design further helps the manufacturers to manufacture exact dimensions quite easily (WoodWorks, 2014; Chiang, Chan, & Lok, 2006). Using panelized systems, complete wall panels, floor and roof systems can be delivered to the site ready for assembly and installation. Some systems even come with plumbing and electric fittings so that factory built systems are not tampered.

2.2.5 Modular systems

This is the most advanced building system in which the entire house is divided into independent modules during the design. These modules are then built in a factory on a production line like any other manufacturing (Anderson & Anderson, 2007). Controlled environment, skilled labor and use of automation in construction make this off-site manufacturing very quick as compared to on-site construction. These modules are fitted with all the utility fittings and insulated properly before they leave the facility. Some modules can come with interior finishing like carpeting, kitchen cabinets and shelves etc. A complete module is transported to the job site where it would be connected and sealed with the rest of the structure to complete the building. This type of the building system has maximum amount of prefabrication ranging up to 95 percent of the total construction work done off-site. In order to assure sufficient safety and durability, the modules are inspected at factory during construction and on site at the time of installation as well. This method can complete a project in half the time as compared to traditional stick built on-site construction (WoodWorks, 2014; Blismas, Pasquire, & Gibb, 2006).

2.2.6 System built wood construction in the United States

Carter (2015) reported a detailed analysis of the off-site construction industry in the United States. A total of 717 businesses together were estimated to generate a revenue of \$7.4 billion. \$226.8 million out of these revenues were expected from exports. The expected profits for the year were \$161.8 million. The industry showed a decent growth of 4.9 percent for the period of 2010-15 which is expected to reduce to 2.3 percent in the next 5 year period. It is alarming as the author mentions that “Despite slow sales growth, the industry will lose ground to

traditional housing”. Table 2 summarizes the current structure of off-site construction sector in the United States.

Table 2 Industry Structure: Off-Site Construction in U.S. (2015) (Carter, 2015)

Factor	Status	Factor	Status
Life cycle Stage	Decline	Industry assistance	Low
Revenue Volatility	Medium	Capital Intensity	Low
Concentration Level	Medium	Regulation Level	Medium
Technology Change	Medium	Barriers to Entry	High
Industry Globalization	Low	Competition Level	High

Due to slow and decreasing growth rate, the sector is in declining stage of its life cycle. Owing to major acquisitions and mergers post 2008-09 economic downturn, the sector is fairly concentrated now with few companies contributing considerably to the overall revenues. This also makes it harder for new business to enter and compete at the top of the sector. Despite the usual belief, the industry is less capital intensive and more labor intensive because of a higher share of customized orders instead. The industry has a very low level of globalization with limited businesses across the globe. According to the Consumer Financial Protection Bureau, the median annual household income of manufactured homebuyers is slightly over \$26,000. This is roughly half the median income for families buying other homes. When traditional site-built homes drop in price and become more widely affordable, demand for manufactured and modular homes declines because of consumer’s preference for traditional on-site constructed homes. Suppressed conventional home prices spurred many of these low-income consumers to purchase traditional homes. The system built industry is thus consequently forced to price their

products competitively. According to the Census Manufactured Homes Survey, the real average price of a manufactured home grew at a tepid annualized rate of 1.5 percent over the five years to 2016 (latest data available). Combined with rising input prices, this trend has led to declining profit margins for this industrial segment (O'Hollaren, 2017).

Three companies in the sector together controlling more than 45 percent of the market share in 2015 were Berkshire Hathaway Inc. (28.0%), Champion Enterprises Inc. (10%) and Cavco Industries Inc. (7.8%). In terms of product segmentation in 2015, 55.3% share was expected to be of manufactured mobile homes, 33.6% of prefabricated wood buildings that includes panelized and precut buildings and remaining 11.1% was nonresidential mobile buildings. Manufactured mobile homes shared the largest fraction of the product sales. In terms of market segmentation, 60.3% of the revenue was generated from the retail trade where most operators either have their own stores or market to multi-brand stores. Wholesalers generated 36.6% of this sales. Existing international trade for the industry is very low at mere 3.1% of the annual revenue (Carter, 2015).

2.2.7 Adoption of system built wood construction in the United States

Prefabrication and modular construction was developed to build faster and more economical decades ago. But these processes somehow developed the negative impression of being cheap and of poor quality. With the advent of modern technologies, this perception has changed for good. The focus now has also shifted to improve the productivity of construction industry rather than just being a “go to” option. As reported by McGraw-Hill Construction (2011), 85% of the construction sector stakeholders are using factory building in one form or the other. This

includes 90% of the engineers, 84% contractors and 76% architects. But the degree of usage is fairly low. About 37% of these have used it in more than 50% of their projects. This adoption is mainly motivated by resultant improvement in productivity, competitive advantage, greater economic benefits and client demands. Figure 5 highlights the drivers and ratio of adopters of factory-built construction in their project for engineers, contractors and architects.

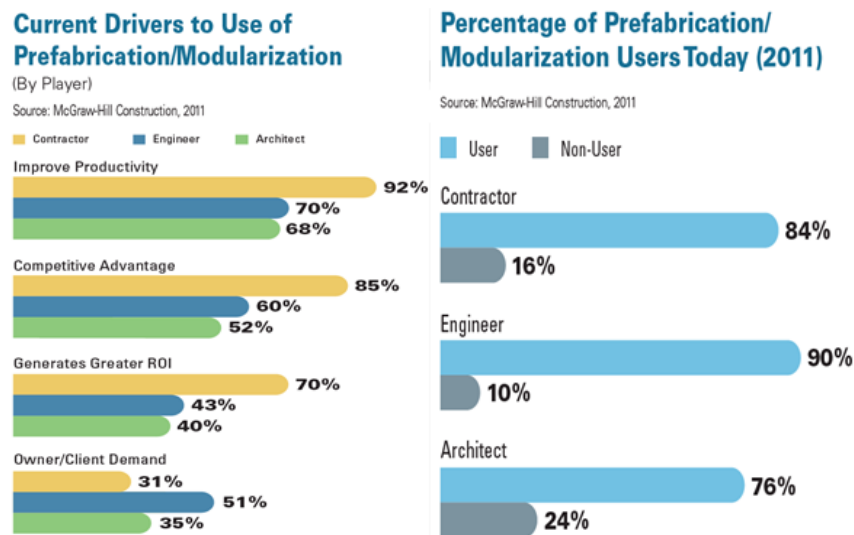


Figure 5 Stakeholder's View on Factory Built Construction in the United States (McGraw-Hill Construction, 2011)

Architecture designs and owner's resistance were reported to be major hindrances to extensive adoption highlighted in the report. The majority of construction using factory built systems is done for commercial projects. "In particular, main applications are in healthcare facilities (49%), college buildings (42%) and manufacturing buildings (42%) as reported by the respondents. They also see future opportunity in healthcare facilities (14%), hotels and motels (11%) and other building types that includes data centers, prisons, power and oil refineries" (McGraw-Hill Construction, 2011).

2.2.8 Hurdles in implementing system built wood construction

Use of system built construction may add additional processes to the project as compared to using on-site construction (Prefabitats, 2016). Key drawbacks with the practice of building off-site are:

- **Design limitations:** Despite the ease of working with wood, the architects and engineers are limited by the feasible manufacturing configurations. For example, simple rectangular wall with parallel top and bottom plates is far easier to automate and produce in a factory than walls with irregular dimensions and/or sloped tops. There is also a limitation of dimensions of panels due to machine and transportation medium restrictions (Anderson & Anderson, 2007).
- **Shipping:** The units, irrespective of their intermediary form, are required to be shipped to the construction site. Shipping costs associated with modules are considerably larger than that associated with panels and kits owing to the large size. This post manufacturing transportation is generally limited by the medium of transportation, distance and route followed and are often viewed as incremental costs. But it is also important to note that not all of these costs should be considered additional as the traditional site built system also requires raw materials to be delivered to site. This increase in turn also limits the size and scale of manufacturing operations.
- **On-site installation:** Prefabricated construction requires the use of cranes and associated skilled labor at the time of installation on site. The requirement and complexity depends upon the nature of prefabrication; modular, panelized or precut along with the complexity in each design. The cranes act as a fixed cost and when coupled with the costs of hiring

skilled operators can act as significant incremental cost. Such heavy machinery is not otherwise commonly implemented in on site traditional construction system. Degree of prefabrication is an important metric in this system. It differentiates the amount of work completed in the controlled environment of the factory and the remaining amount of work done on site. The costs fractions will then depend upon the nature and location of project (Anderson & Anderson, 2007).

- **Manufacturing overhead:** This is the major fraction of manufacturing cost which is usually omitted when comparing with on-site construction (Prefabits, 2016). Overhead costs associated with the production facility like rent, depreciation, management, utilities and insurance, safety and quality control and unallocated personnel. The best way to minimize these costs like any other manufacturing process is using economics of scale and scope provided there is a potential market.
- **Company Overhead:** The prefabricated systems are can be more expensive than the traditional construction because the manufacturing companies tend to keep considerably higher margins as compared to traditional contractors. This can be to cover corporate overheads. These companies also offer better working conditions, assures safety of the workforce and have different departments (marketing, design, engineering and procurement) as compared to general contracting firms (Ludeman, 2008).
- **Negative perception of quality:** Off-site construction even in the domestic residential construction market of the United States is widely associated with a stigma of being built, low quality buildings that have a short life span and would need replacement. The

technique of off-site construction is also regarded to in achieving efficient quality and detail as traditional on-site construction.

- Fear of innovation: As with any other mature industrial sector, fear of change also holds back the innovation in construction. Builders often try to avoid using system built components as they perceive it to be inconvenient and expensive.
- Lack of information and understanding: It is really important for all the stakeholders (clients, developers, owners, designers, engineering and construction professionals) to have confidence and clarity of the approach to implement prefabrication. There is a deficit of reliable information allowing owners and building professionals to make informed decision while selecting a particular building system or approach.

Thus in order to be competitive with the traditional site built homes, the prefab companies need to cover these incremental costs. This can be achieved using economies of scale and scope (Baack, Harris, & Baack, 2013). Large scale provide companies the benefits of reduced material, shipping, craning and site development costs. This also leads to decrease in manufacturing and corporate overheads. The prefab companies can invest in automated production lines, develop multiple configurations with the same facilities, reduction in inventory and labor costs. But all of this is possible only when there is enough demand in the market. This can be bit difficult when a variety of market is being targeted and no single location is capable of offering enough volume on its own. Figure 6 illustrates the financial performance of secondary wood products industrial sector in 2015 (Carter, 2015). After hard hit by the recession, a total profit of only 2.2% was expected in the fiscal year 2015. The majority (62.2%) of the revenue is used to purchase raw materials. Surprisingly, the labor costs accounts

for considerably higher than the wood products sector by 7.4 percent. This could be because of labor intensive customizations, smaller size of firms with inability to invest in more automated facilities. Other expenses includes but not limited to rent and utilities, interest, general selling and administrative expenses, restructuring, marketing and legal expenses, among others.

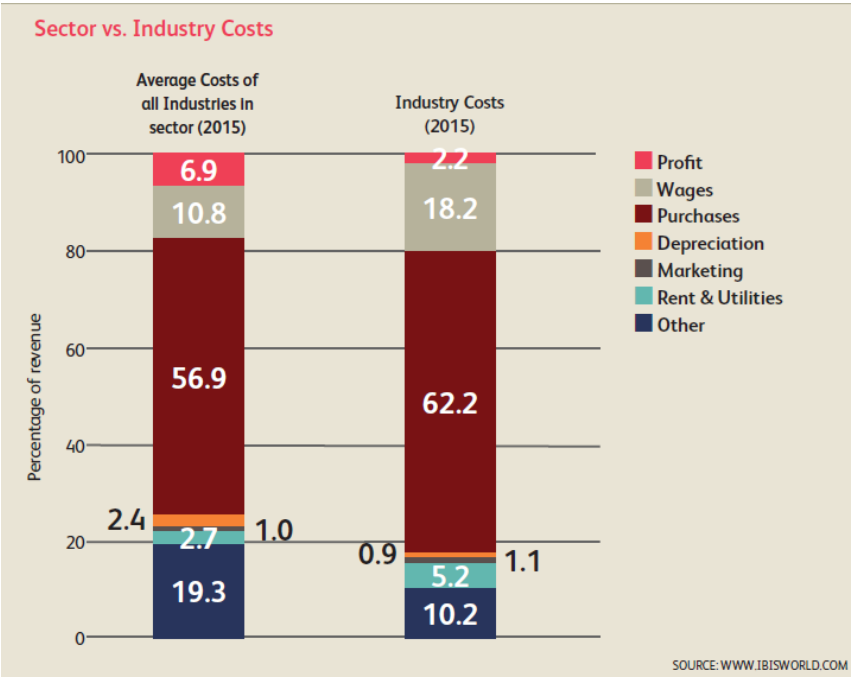


Figure 6 Cost Structure of the Off-site Manufacturing Industry in 2015 and Comparison with Wood Products Sector (Carter, 2015)

Despite the above mentioned hurdles, the prefabricated companies are more capable to incorporate green technologies and design efficient buildings. This can be achieved through centralization and incorporation of design, engineering, procurement and manufacturing making it a competitive advantage over the traditional site built construction technology (McGraw-Hill Construction, 2011).

2.3 Internationalization of U.S. manufacturing

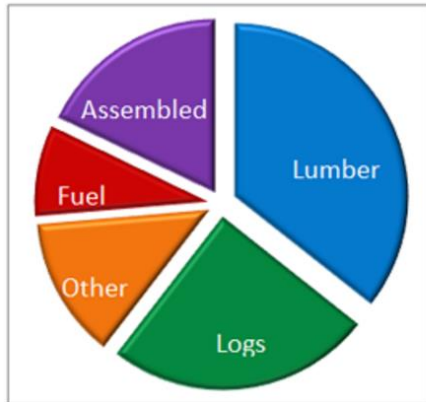
Geographical expansion is an essential opportunity for the growth and value creation for an organization. However, a foreign expansion would involve many particular challenges additionally to the ones related to the growth of firms in their home market. The knowledge and capabilities acquired for the existing markets may not be appropriate for the new markets making learning and knowledge gaining a central aspect of internationalization (Eriksson, Johanson, & Majkgard, 2000; Lu & Beamish, 2001). As highlighted before, the residential wood construction sector in the U.S. is characterized by large number of small firms using mainly on-site construction. Of this sector, “System” built wood prefabricated systems have a strong manufacturing and engineering background and have operated predominantly in the domestic markets. This is not too surprising because of the nature of business which is mostly concerned with constructing single family homes or small commercial buildings, as discussed before. This nature of the sector itself imposes several challenges to go international. First the size of the firm and availability of resources. Most of the firms in the industrial sector are small and medium enterprises (Carter, 2015) which poses a challenge for them to expand internationally. Secondly, the building customs and styles, customer preferences and building regulations are mostly location specific and differ even from one state to another. Technical aspects of design and prefabrication are not a major challenge once the project details are finalized. But it is important to make sure that all the stakeholders approve the final design as customization at a later stage might not always be possible. This makes communication and timely flow of information extremely important for successful implementation. Other challenges like difference in language, culture, and consumer mindset, same as with any other industry

impacts the system built wood housing industry as well. Moreover, the houses need to be shipped from the U.S. and assembled on the construction site in the foreign country using on-site support.

Exporting plays a key role in firms' survival and growth as the industry becomes more global. Export activities increase organizational capabilities, which, in turn generate additional resources that boost the firm's performance (Filatotchev, Liu, Buck, & Wright, 2009). Global trade of U.S. manufactured secondary wood products is increasing gradually over past two decades (Carter, 2015). The share of international operations for system built wood construction sector, as highlighted in the next section have not been growing at the same pace. Thus the companies from this industrial sector can look into expanding to new markets by acquiring knowledge concerning local regulations, market specifics, get access to sales channels and thereby reduce the barriers to becoming international.

2.3.1 Exports of factory built homes from U.S.

Exports of U.S. forest products have grown over 80 percent in the period of 5 years from 2009-14 with majority of increase due to volume as prices stayed uniform (Inouye, 2015). This was after record exports of \$9.7 billion in 2014 fiscal year. The main share of this growth has come from hardwood lumber and softwood logs exported to China making them a top forest product export. But compared to other goods, forest products are more sensitive to economic changes (Carter, 2015) and thus need more robust strategies. Figure 7 below shows the division of different product groups and their share in the total export. Notice that EU and Canada are next big markets for U.S. forest after China for exports.



Group	FY 2014 Value	5-Year Growth	Top Market
Logs	\$2.4 billion	85%	China
Lumber	\$3.4 billion	141%	China
Assembled Products	\$1.3 billion	73%	Canada
Fuel	\$820 million	139%	EU
Other Products	\$1.7 billion	34%	China

Figure 7 Export Values for Major Forest Products, FY 2014 (Carter, 2015)

The assembled products that includes factory built wood buildings, fabricated structural membranes, assembled casks, door frames and joinery together had a share of \$1.3 billion.

In 2015, the factory built home industry alone recorded total exports of \$226.8 million. Seventy four percent of it was to Canada mainly because of geographical proximity (Carter, 2015). Japan, Australia and Mexico together accounted for another 15.7 percent. Remaining 10.3 percent of the share is dispersed among rest of the global market. Figure 8 shows the distribution of exports and share of each country. This shows that the export market for this product category is under exploited and there can be an opportunity for companies manufacturing wooden homes to exploit new markets.

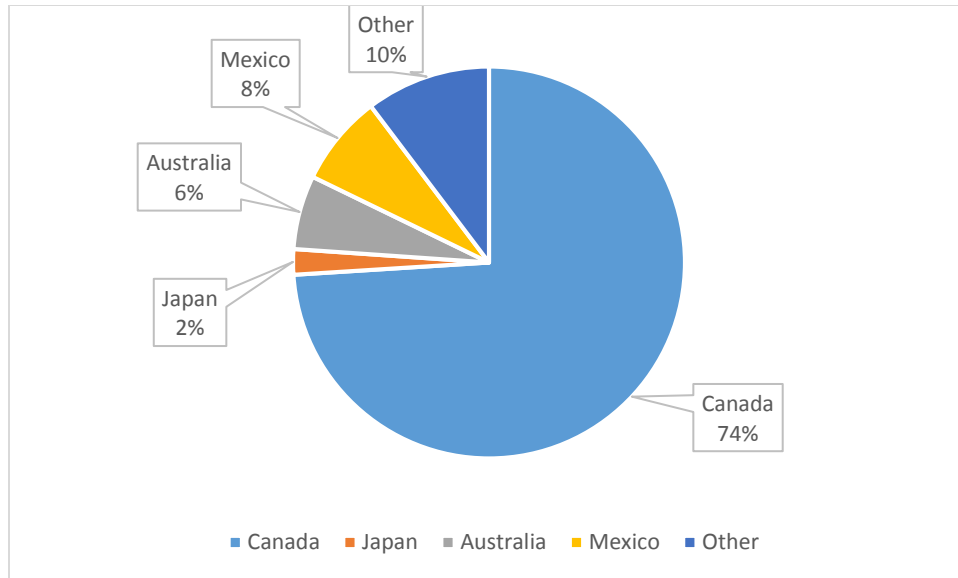


Figure 8 Exports of Factory Built Construction Industry (2015)

This also shows that the factory built home industry has a very small share in exports as compared to other forest products. This is despite the fact that the manufacturing needs considerable capital investment in setting up and maintaining the facility. The processed product creates more jobs and value for the U.S. economy as compared to raw products. Thus there is a need to further promote and increase the global operations of this sector in order to benefit the economy.

2.4 Export Venture performance

Performance measurement, both in domestic and international markets, is one of the important tools for measuring a company's success. Export is the most commonly used initial entry mode used by companies (Baack, Harris, & Baack, 2013). The term "export" is derived from the conceptual meaning as to ship the goods out of a country. The seller of such goods, based in the country of export, is referred to as an "exporter" whereas the overseas buyer is referred to as an "importer". The companies need to carefully evaluate and assess the

advantages and challenges of exporting before committing its resources to an operation (Tan, Brewer, & Liesch, 2007). As a result of the increasing tendency towards a global economy and the severities of trade deficit pressures by many countries, firm behavior and performance in export markets has received considerable research attention over the last two decades (Katsikeas, Leonidou, & Morgan, 2000). The competitiveness of these firms depends upon the way of operations in domestic and international markets (Blanco, 2014). The study to address the factors determining success of an organization in achieving its objectives in international marketing is called “*export performance*”. Performance is a measure of the results achieved. Export performance is the relative success or failure of the efforts of a firm or nation to sell domestically-produced goods and services in other nations (Zhang & Toppinen, 2011).

Export performance can be described in objective terms such as sales, profits, or marketing measures or by subjective measures such as distributor or customer satisfaction (Morgan, Kaleka, & C.S., 2004). It has been widely studied as a key indicator of firm’s ability to successfully leverage its resources and capabilities in international context (Spasova, 2014). The study of export behavior of firms is important for academic, professional and public authorities. Katsikeas *et. al.* (2000) highlight the importance of exports from three perspectives. First, for the politicians that analyze exports as a way to accumulate foreign currency reserves, increase levels of employment, productivity and social prosperity. Second, exports for managers are a form of corporate growth that imply an increase in production capacity, an improvement in financial results and business competitiveness, and also to ensure the survival of the company in a highly globalized marketplace. And third, for researchers, who consider exports as a changing but promising area to develop theories. Hence, a detailed understanding of exporting

as a means of internationalization is very important (Sousa, Ruzo, & Losada, 2010; Leonidou L. , Katsikeas, Paliawadana, & Spyropoulou, 2007).

Export venture performance have been widely studied. Careiro *et. al.* (2007) analyzed review articles on export performance till 2007 published in prominent marketing journals. There were certain other quality reviews on export performance measurement after 2007 as well. Table 3 contain list of prominent review studies on the topic.

Table 3 Reviews on Export Performance

(Bilkey, 1978) (43)	(Madsen T. , 1989) (n.a.)
(Madsen T. , 1987) (17)	(Shoham, 1998) (e.s.)
(Aaby & Slater, 1989) (55)	(Zou & Stan, 1998) (50)
(Chetty & Hamilton, 1993) (111)	(Katsikeas, Leonidou, & Morgan, 2000) (103)
(Cavusgil & Zou, 1994) (e.s.)	(Leonidou, Katsikeas, & Samiee, 2002) (36)
(Da Rocha & Christensen, 1994) (17)	(Sousa, Martínez-López, & Coelho, 2008) (52)
(Matthyssens & Pauwels, 1996) (15)	(Chen, Sousa, & He, 2016) (124)

* Number of articles reviewed in each study shown in parenthesis.

(n.a): Not applicable as not reported in the original study; (e.s): Empirical Study

A review of these studies indicate that researchers have correctly acknowledged the complex and multidimensional nature of export performance measurement (Carneiro, Rocha, & Silva, 2007; Chen, Sousa, & He, 2016). Theoretical development is a primary objective of academic research through the construction of a systematic set of relationships providing a consistent and comprehensive explanation of phenomena (Katsikeas, 2003).

Chen *et. al.* (2016) found that Resource Based View (RBV), Contingency theory, Institutional-Based View (IBV), and Organizational Learning Theory (OLT) are the most commonly used underlying theories in developing export performance measurement framework. These theories are discussed below in further detail.

Resource Based View (RBV) emerged as a theoretical perspective during the late 20th century and claims that companies can be seen as bundles of resources, that resources are heterogeneously distributed across companies, and that the market for resources is imperfect (i.e., resource differences persist over time) (Eisenhardt & Martin, 2000). These resources include tangible and intangible assets, capabilities, organizational processes, attributes, information, knowledge etc. that are under firm's control. As a consequence, firms can create and sustain competitive advantage by acquiring and leveraging resources that are valuable, rare, inimitable and non-substitutable (Barney, 2001; Grant, 1991). RBV has an underlying assumption that the product markets are stable and constant, as the resources cannot be perfectly imitated and transferred (Kraaijenbrink, Spender, & Groen, 2010) (Barney, 1991). However competitive advantage for exporting firms is not just determined by the resources available to the firm but also depends upon the environmental and external market factors (Peng, Wang, & Jiang, 2008).

Contingency theory is based on developing a fit between strategic factors including firm's internal resources, marketing strategies and external forces with an inclusive overall context (Chen, Sousa, & He, 2016). According to this theory, superior export performance is generated by the contingent compatibility between external and external factors. This compatibility is changeable and individualized to each firm or export venture (Harrigan, 1983). The effectiveness of export promotion strategy is contingent on a complex interaction between export experience and external sociocultural distance. Export success is determined by the alignment among strategic decisions, experiences and sociocultural contexts. Such contingency analysis has limited general application as it only provides descriptive conclusions about

individual case of export performance in specific situations (Hultman, Katsikeas, & Robson, 2011).

Institutional-Based View (IBV) theory is based on the importance of institutional environment. It suggests that institutional forces shape firms' strategic decisions which in turn effect their performance (Dacin, Goodstein, & Scott, 2002). Thus it is quite relevant to exporting firms as they are subjected to different institutional forces both at domestic and international markets (Peng, Wang, & Jiang, 2008). But Chen *et. al.* (2016) in their review found that the use of IBV theory for studying export performance is not common and was not used at all before 2008. But they also recommend it to use for future research as it "offers broader theoretical insight into export performance determinants by considering the effect of institutional forces".

Organizational Learning Theory (OLT) is based on transition mechanism between previous organizational operations and the organization's future behavior and outcomes (Santos-Vijande, López-Sánchez, & Trespalacios, 2012; Wei, Samiee, & Lee, 2014). Export managers learn from past exporting activities and gain a better understanding of the causality among export strategies, surrounding conditions and corresponding export performance (Lages, Jap, & Griffith, 2008; Fiol & Lyles, 1985). Such knowledge impacts current strategic decisions thus in turn influencing the future export performance (Lages, Jap, & Griffith, 2008; Ruigrok & Wagner, 2003). For instance, Lages *et al.* (2008) indicate that export performance of the previous year plays a significant role in shaping the following year's export marketing strategy. It provides a longitudinal view that explains the inter-temporal effect on export performance over time (Chen, Sousa, & He, 2016).

2.4.1 Determinants of Export Performance

With fast expansion of international business activities, exporting play a key role in many organization's survival and growth. Several reports have analyzed the literature for achievements and limitations in the field of export performance since 1970s (Sousa, Martínez-López, & Coelho, 2008; Bilkey, 1978; Aaby & Slater, 1989; Zou & Stan, 1998; Chen, Sousa, & He, 2016). Despite a plethora of research on determinants on export performance, the conclusions drawn from the literature are often conflicting and characterized by divergence and discordance (Katsikeas, Leonidou, & Morgan, 2000). A major cause of the conflict arises from the utilization of different measures and theories of export performance used in the popular studies (Chen, Sousa, & He, 2016). Despite studies covered in these reviews considered a range of theories, each individual theory only provides a fragmented view of export performance. As such, a systematic theoretical basis and framework that could comprehensively explain all of the drivers of export performance remains absent (Lages, Jap, & Griffith, 2008; Wheeler, Ibeh, & Dimitratos, 2008) (Sousa & Lengler, 2011). Shoham (1998) identified 29 measures of export performance found in the literature. More recently Sousa (2004) reviewed 43 empirical studies published between 1998 and 2004 and noted 50 different operational aspects of export performance. Zou and Stan (1998) recommended using financial and non-financial measures as two principal modes for looking at export performance. Most of the studies use export sales intensity, export market share, export profit intensity and export sales growth (Shoham, 1996; Kaynak & Kuan, 1996; Morgan, Kaleka, & C.S., 2004). Financial measures less commonly used in export performance measurement include returns on assets (Shoham, 1996), return on investment (Carpano & Chrisman, 1995), export intensity growth compared to competitors,

export sales growth compared to competitors, export sales return on investment compared to competitors, export sales volume compared to competitors, export market share, market diversification, rate of new market entry (Spasova, 2014) and number export employees (Diamantopoulos & Inglis, 1988).

But there are some inherent limitations of using financial measures exclusively (Axinn, Sinkula, & Thach, 1994; Katsikeas, Piercy, & Ionnodos, Determinants of Export performance in European Context, 1996; Madsen T. , 1989). Managers may be able to evaluate firm's export performance while taking into account organizational and environmental factors using both financial and non-financial measures (Bonoma & Clarke, 1988; Lages, Marketing lessons from Portuguese wine exporters: the development and application of a conceptual framework, 1999). Studies recommend use of non-financial measures like goal achievement (Katsikeas, Piercy, & Ionnodos, 1996; Cavusgil & Zou, 1994), satisfaction (Evangelista, 1994; Seifert & Ford, 1989), perceived success (Cavusgil & Zou, 1994; Singer & Czinkota, 1994) strategic and overall export performance, building brand image overseas, gaining new technology/expertise, quality of distributor relationships, reputation of the firm (Spasova, 2014) and perceived importance of export performance by the firm (De Luz, 1993) to be used along with the financial measures to make the assessment complete. Though it is possible to measure export success with just one set of variables, it thus is clearly better to construct scales to include different set of variables to capture the complexity of measuring export performance and success.

Despite this long list of variables representing measures of export performance, several measures (both financial and non-financial) appear to be used considerably more than the others, such as sales growth, export share as financial measure and satisfaction with overall

performance, export experience and effect of exporting as non- financial measure (Sousa, Martínez-López, & Coelho, 2008; Chen, Sousa, & He, 2016).

Thus there are a variety of identified factors impacting a firm's performance in exports. But only few of them are studied in detail. Most of the studies aim at investigating direct relation between antecedents and export performance but fail to include interacted and nested relationship among these causes. These studies, despite using advanced methodologies, still suffer from estimation bias (Chen, Sousa, & He, 2016).

2.4.2 Theoretical Framework

Assessing export performance is a complex task and its usefulness depends upon the way of measurement and credibility of measures. This would be further complicated as the export performance can be conceptualized and operationalized in many ways (Das, 1994; Diamantopoulos & Inglis, 1988).

Chen *et. al.* (2016) based on their review of available literature purposed a theoretical framework composing all the 4 popular theories behind firm's export performance. These theories, as discussed in section 2.4, are Resource Based View (RBV), Contingency theory, Institutional-Based View (IBV), and Organizational Learning Theory (OLT). Figure 9 shows the framework how internal and external factors associated with a firm impacts its performance in export operations. The framework developed by Chen *et. al.* (2016) also shows the 4 most popularly used theories used in the literature to measure the export performance of a venture.

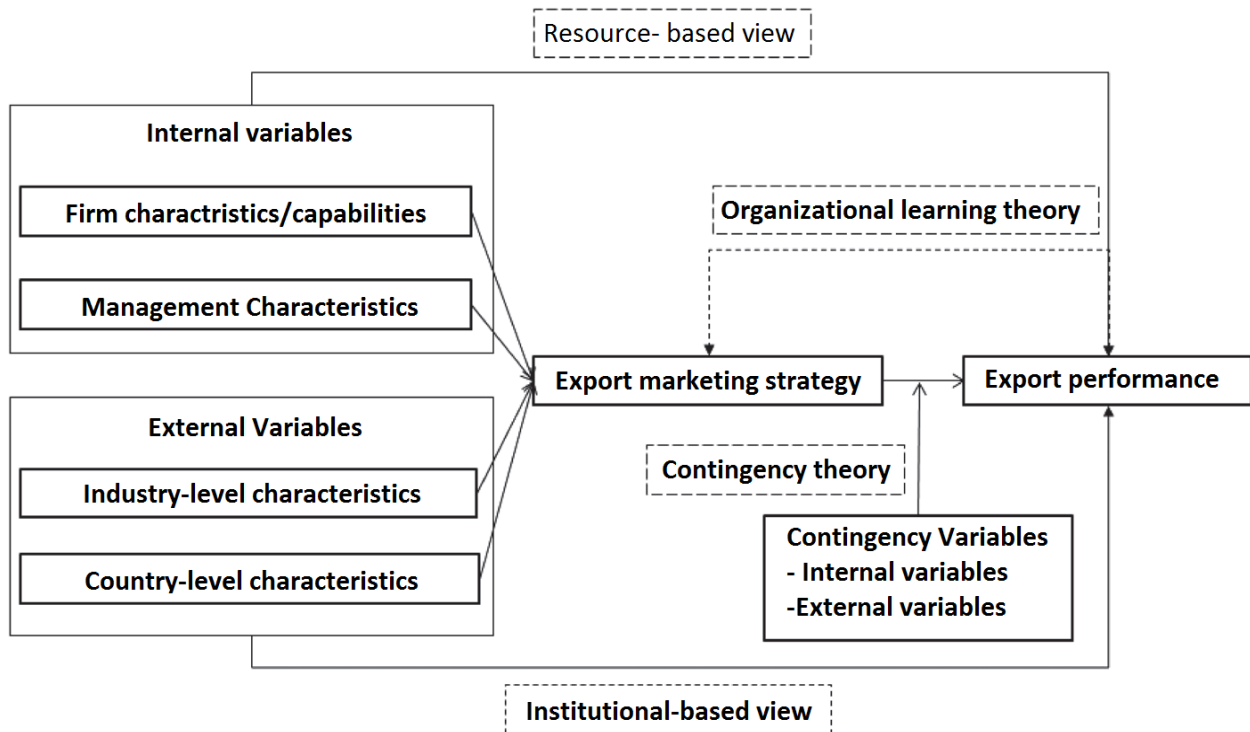


Figure 9 Conceptual Framework of Export Performance Measurement (Chen, Sousa, & He, 2016)

The review found that multiple antecedents of export performance reported in the literature and classified the constructs based on two distinct aspects of determinants, i.e., internal and external variables. The internal factors consist of firm-level factors which refer to the export marketing strategy, firm characteristics, firm capabilities and management characteristics. External factors are classified into country and industry-level characteristics. The authors also reported the use of multiple mediating variables commonly used in the literature that intervene between predictors and consequences. They can be used to explain indirect relationship between determinants and export performance (Baron & Kenny, 1986). Export marketing strategy was found to be as an important mediator bridging the internal, external factors and export performance. The fourth component of export performance framework identified by Chen *et. al.* (2016) is the set of moderating variables. They represent the conditions that

validate/invalidate the relationship and can be used to explain inconsistent empirical results. But for developing an assessment model, as a case in this study, they can be ignored (Blanco, 2014).

This framework is also supported by previous work. For example, Sousa and Matinez-Lopez (2008) in their review of literature from 1998 to 2005 found that export performance depends upon at least 4 elements: internal factors, external factors, control variables and moderating variables. Internal factors relate to firm specific characteristics like experience, marketing strategy and management characteristics. External factors associate with environment surrounding the firm in domestic and international market. Control and moderating variables may be either or external are the ones that can impact the export performance and needs to be identified and controlled by the firm. These findings are in line with the theoretical framework developed by Chen *et. al.* (2016) shown in Figure 9.

Figure 10 shows the framework used in this study the export venture performance developed from the factors discussed in the literature review. Following, the framework is detailed explanation.

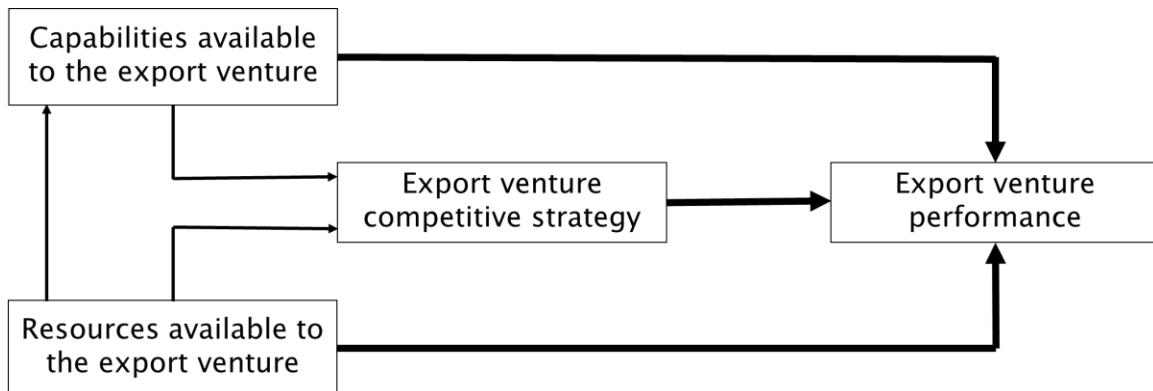


Figure 10 Theoretical Framework: Export Venture Performance Model

Based on the framework in Figure 10, regression equation developed to measure Export Venture Performance is

$$EVP = R.A. + C.A. + C.S. + Constant + error$$

where, EVP = Export Venture Performance

R.A. = Resources available to the export venture

C.A. = Capabilities available to the export venture

C.S. = Export venture competitive strategy

The regression model would also have some constant along with independent variables. And finally an error component that the statistical model can not assess.

2.4.2.1 Capabilities available to the Export Venture

Literature suggests that the capabilities available to a venture to support its export operations can be classified into two important categories. First, the firm's characteristics such as its experience, scale of operations, revenue and market's value experiences, enable the venture to fulfill the needs of channel members and customers (Daily, Certo, & Dan, 2000; Morgan, Zou, Vorhies, & Constantine, 2003). Second, firm's capabilities to develop or modify products and successfully deliver it to the foreign markets by meeting standards of quality, time and value (Cooper & Kleinschmidt, 1985).

2.4.2.2 Resources available to the Export Venture

Resources available to any business can be classified at two different levels: Industry level and Country Level (Daily, Certo, & Dan, 2000). Industry level factors includes the way the enterprise views its own capabilities to successfully conduct its export operations. Country level factors include regulatory, trade, site support and ease of forming partnerships that depends upon both the domestic and international markets where enterprise attempts to expand.

2.4.2.3 Export venture competitive strategy

The competitive strategy defines success of a business in the market. The willingness and ability of rivals to respond to competitive moves in the export market as an important antecedent of export venture performance (Cavusgil and Zou 1994). Factors leading to success of a business form the basis of competitive strategy.

2.4.2.4 Export venture performance

As highlighted in the section 2.4.1, the performance of an export venture can be accessed through various parameters. But it is important to measure success through both financial and non-financial parameters. Using this foundation, various measurement parameters were identified under each construct and implemented through the survey (explained later on the methods section). Appendix D highlights all constructs and measurement parameters used in this study.

2.5 Housing in Latin America.

Latin America (including the Caribbean) is among the highly urbanized regions of the world. It is estimated that this urban population will grow from 75.5 percent (2010) to 84.6 percent (2030) and match the likes of developed regions of Western Europe and North America. (McBride & French, 2011) These cities are attracting jobs, investments and people leading to the growth of the region. This fast growing urban population would mean increased need of housing in the cities of the region. This becomes a major challenge in accommodating increasing populations with services, employment and shelter. But majority of these countries have not been able to withstand the immense pressure on the supply and cost of urban land and housing. This is

visible from the appalling differences in the living conditions of rich and poor in the region (Bouillon, 2012). As a result, housing affordability have become a critical issue in the region due to this increasing gap in the society, lack of flexible financing options and high costs of key inputs to housing (Brednoord, Lindert, & Smets, 2014). “Of 130 million urban families in the region, 5 million rely on another family for shelter, 3 million live in houses that are beyond repair, and another 34 million live in houses that lack either title, water, sewage, adequate flooring, or sufficient space” highlights Bouillon (2012). Housing conditions strongly influence physical and mental health of the dwellers, education, access to economic opportunities and vulnerability to social ills. Thus it is extremely important for the people to have sufficient and sustainable housing at affordable prices. Three major but interrelated factors commonly cited for region’s poor performance in housing sector are high housing prices relative to family income, lack of access to mortgage credit, and high land and construction prices (Bouillon, 2012; Ferguson & Navarrete, 2003).

2.5.1 Social housing deficits: Defining the need

Based on the nature and additional efforts required to achieve minimum standards of dwellings, housing gaps can be classified as quantitative and qualitative shortages. Quantitative shortage includes housing units that are damaged beyond repairs and are not suitable for living. Qualitative shortages include households living in units with insecure tenure or illegal titles, temporary structure, inadequate sanitation and overcrowding (Bouillon, 2012, p. 26; Rojas & Medellin, 2010). Bouillon (p.27, 2012) also quantified both of these qualitative and quantitative shortages in the region of Latin America and the Caribbean. Table 4 summarizes the findings. Due to inequality in household income in the region, the populations per quintile vary a lot. As

a result despite majority of the poor suffer from housing shortage, most of the households that fall in higher quintiles experience housing deficit. As reported, the poor with housing deficit consisted of 9.8 million households but 32.3 million households facing deficit in the region were not poor.

Table 4 Regional Housing Shortages in Latin America and the Caribbean 2009 (Percent of the Households) (Bouillon, 2012)

Housing Gaps	National	Urban	Rural	Urban quintiles by per capita household income				
				I	II	III	IV	V
Total Shortages	37	32	60	52	39	32	24	16
Quantitative Shortages	6	6	5	9	8	6	5	3
Qualitative Shortages	31	26	55	43	31	26	19	12

Table 4 highlights averages of the region but this shortage differs significantly from one region to another. Rojas and Medellin (2011) suggested that since each country in the region has different socio economic and geopolitical structures, the shortage should be tackled differently. Figure 11 shows the percent of households in Latin America and Caribbean region (Bouillon, 2012, p. 28). The shortage is most profound in Bolivia (75%) and is lowest in Costa Rica (18%). Since the trade relations of most of these countries with the United States are amicable and supportive (Baack, Harris, & Baack, 2013), the manufacturers and suppliers of houses in the U.S. can explore the region as a potential market opportunity.

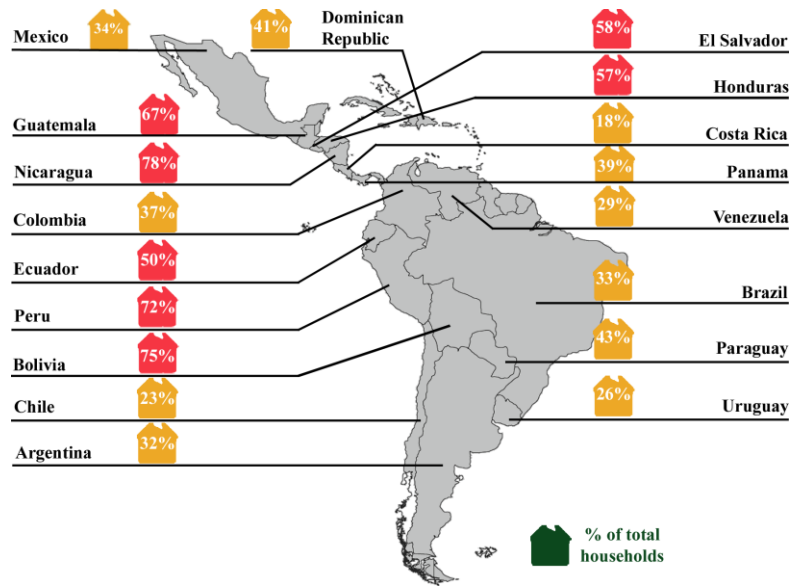


Figure 11 Housing Deficit by Countries, 2009 (Percent of Households) (Bouillon, 2012)

As a part of this research, Peru, Ecuador and Colombia were selected as candidate countries for assessment of potential implementation of U.S. manufactured system built wooden homes. These countries were selected because of the existing housing deficit in the region (Figure 11). These countries thus can provide a considerable market segment where the U.S. manufacturers can export. These countries also have amiable trade relation with the United States through different trade agreements easing business transactions. Cultural difference is a major barrier to exports. All three of these countries have some similarities with the United States in socio-economic culture that would further support business endeavors and product acceptance (Baack, Harris, & Baack, 2013). The political structure of these countries is fairly stable to safeguard and support any business transactions. With an attempt to be environmental friendly, these countries are eagerly attempting to shift to decrease their dependence on non-renewable resources. Thus it was important to study the government policies regulating social housing projects in the region, existing use of wood in construction and identify different

stakeholders involved in social housing value chain. The following sections discuss the social residential housing markets of these three countries in detail.

2.5.2 Peru

Peru is one of the most rapidly urbanizing nations in the region. On the contrary, it is the third in term of housing deficit in the region (Figure 11). This rapid urbanization since mid-1950s essentially led to the current urban skewed Peruvian cities. The government was not involved in assuring housing supply leaving formal development of the cities to the real estate markets (Cockburn & Quispe, 2013). Moreover the indulgent and lenient national policies led to massive and informal settlements on the periphery. These stimuli produced “the center-periphery urban structure in which central districts are surrounded by large extensions of substandard housing area” (Maldonado, 2014). The situation is considerably alarming as the data from 2007 census reported by Maldonado (2014) shows that national quantitative deficit decreased slightly from 397,756 units in 1993 to 389,745 units in 2007, the qualitative deficit in the same period increased by 135 per cent from 624,427 units to 1,470,947 units. This highlights prominence of autoconstruction (also called self-construction or incremental housing) in the region where two out of three new homes are built through incremental housing schemes. These areas dominated by informal autoconstruction, on an undeveloped land are called *Barriadas*. (Cockburn & Quispe, 2013; Ferguson & Navarrete, 2003; Maldonado, 2014). Peruvian authorities have been providing technical support in the settlements on *barriadas* in urban peripheries since mid-1950s (UN Habitat, 2011).

Peruvian government have established a state owned funding scheme called Fondo MIVIVIENDA S.A. which aims at the promotion and financing of the acquisition, improvement and construction of homes, especially those of social interest, promotion of activities to invest into the home lending market, participation in the secondary market for mortgage loans, and contributing to the development of the Peruvian capital market. (CAPECO, 2011). Mortgage loans comprises of the following three components:

1. Subsidy channeled by funds from Peruvian government. (Transferred directly to the seller-builder, developer or the respective technical unit)
2. Household savings
3. Complimentary financing by Intermediary Financial Institutions, when necessary.

Following schemes are available to support social housing in Peru in form of subsidies (Ministerio Vivienda, 2015)

- Bono Familiar Habitacional (BFH): This grant is issued to eligible households to incentivize and supplement their savings to build a house on their own site. It is a one-time grant only. It can also be used for home improvements. The households are selected on the basis of their monthly incomes and savings. The funds are issued directly to the beneficiary household.
- Techo Propio Program- Management of the household housing bonus (BFH):- This program aims at promoting “Own roof” government scheme which works for assuring dwellings for all sections of the society. This scheme also promote and encourage private participation in massive social housing construction projects. The eligible households are selected on the basis of their monthly household income. Households with monthly income less than

S/.1860 (560 USD) were eligible for the scheme in 2015. Under this program, subsidies are granted under three modes:

1. Acquisition of new home. [alias Adquisición de vivienda Nueva (AVN)]: The value of homes that can be funded through this scheme ranges from 5.5 UIT to 20 UIT. UIT (Unidad Impositiva Tributaria) is the national tax unit and its value for 2016 was S/. 3,950 (SUNAT, 2016). The eligible households can get a bonus of either 4 UIT if the value of home varies between 12 UIT to 20UIT or 5UIT if the value of home varies from 5.5 UIT to 12 UIT. Table 5 summarizes the details of AVN scheme.

Table 5 AVN Scheme

Value of the house	Value of BFH bonus	Household savings to access BFH bonus
12 UIT (S/.47,400) (15,000 USD) to 20 UIT (S/. 79000) (23,500 USD)	4 UIT (S/.15,800) (4730 USD)	A minimum of 3% of the house value
5.5 UIT (S/. 21,725) (6,500 USD) to 12 UIT (S/.47,400) (14,200 USD)	5 UIT (S/.19,750) (5900 USD)	

UIT: Unidad Impositiva Tributaria (National tax unit)

1 UIT= 3,950 S/. (Peruvian Sol) in 2016

2. Construction on an owned land. [alias Construcción en Sitio Propio (CSP)]: This mode of own roof program aims at helping families who have their own land and want to build home. Again the value of such homes to be funded can vary between 4.9 UIT to 20 UIT. The eligible households can get a bonus of either 4 UIT if the value of home varies between 12 UIT to 20UIT or 5UIT if the value of home varies from 5.5 UIT to 12 UIT. Table 6 summarizes the details of CSP scheme.

Table 6 CSP Scheme

Value of the house	Value of BFH bonus	Household savings to access BFH bonus
4.9 UIT (S/.19,355) (5,800 USD) to 9 UIT (S/. 35,550) (10,650 USD)	4.7 UIT (S/.18,565) (5560 USD)	0.2 UIT (S/. 790) (237 USD)
9 UIT (S/. 35,550) (106,50 USD) to 20 UIT (S/.79,000) (23,660 USD)	3.5 UIT (S/.13,825) (4140 USD)	A minimum of 3% of the house value

UIT: Unidad Impositiva Tributaria (National tax unit)

1 UIT= 3,950 S/. (Peruvian Sol) in 2016

- House Renovations. [alias mejoramiento de Vivienda (MV)]: The eligible households can get a bonus of 2.3 UIT if the value of improvement is 2.5 UIT and the household has a saving of 0.2 UIT as summarized in Table 7.

Table 7 MV Scheme

Value of the improvement	Value of BFH bonus	Household savings to access BFH bonus
More than 2.5 UIT (S/.9,875) (2960 USD)	2.3 UIT (S/.9,085) (2,720 USD)	0.2 UIT (S/. 790) (237 USD)

UIT: Unidad Impositiva Tributaria (National tax unit)

1 UIT= 3,950 S/. (Peruvian Sol) in 2016

- MIVIVIENDA Fund (Mortgage fund for housing promotion): The fund give resources to those financial institutions that are participants in the Peruvian financial system to grant financial loans to eligible households.

MIVIVIENDA Program includes the following products:

- Nuevo Crédito MIVIVIENDA: This program provide home loans for homes valued from 14 UIT (S/.55,300) (16560 USD) to 70 UIT (S/.276,500) (82809 USD) for a period of 10 to 20 years. The value of loan varies from 14 UIT (S/.55,300) (16560 USD) to 50 UIT (S/.197,500)

(59150 USD). It can be used to buy a new home or for building a new home on personal land.

- Crédito MICONSTRUCCIÓN: This program provides mortgage for building new or expanding existing buildings.
- Crédito MISMATERIALS: This program supports the purchase of materials. The approved loan varies from S/. 11,100 to S/. 37,000 with a payment period of 5 years.
- Crédito MICASA MÁS: This program credits the households who already have their own home and willing to sell it to change to one that fits their current financial and family situation. The loan varies from S/. 45,000 to S/. 185,000 with a payment period of 10-20 years.

2.5.3 Colombia

Like every other developing country in Latin America, Colombia too suffers from a huge housing problem. This is evident from the fact that 3.8 million households, which is 36 percent of the families, did not have sufficient housing in 2010 (Pinto, 2010). Two thirds of this housing need is qualitative deficit where the housing quality is really poor, lacks services, built of inferior materials or having too little space. Rest one-third of the families of this 3.8 million did not have their own home. Low income and poverty is the predominant reason for this shortage with around 24 percent of the families in the country earning under four times the minimum salaries per month that live in substandard housing (Gilbert A. , 2014).

Colombian cities that led public and private lands to be used to construct houses for poor households have considerably higher rates of home ownership as compared to the ones that

don't. But the national average is still low. In 2011, on 51 percent of the Colombian families owned, formally or informally, or were willing to buy a home (DANE, 2012). The poor households in the country tend to rent or share the accommodation as the cost owning even an un-serviced plot is considerably high. As an example, 46 % of families in the capital city of Bogota rent. A lot of these households in turn live in areas of consolidated self-help housing (Gilbert A. , 1999).

Latin America, in general, has a well-developed mortgage system financing private formal housing. But these schemes fail to reach the most low income households. As a result, half of the population lives in self-help housing where the household constructs the complete house with auto-construction (Florian A. , 2011). Colombia follows the similar practice as with most of countries in the Latin American region to improve social housing. It started with state banks offering mortgages to middle income groups, social housing for low income groups through state agencies and introduce rent control legislations and promote self-help shelter. These programs matured into encouraging private home ownership, adopted a supply –side capital subsidy programmed or the poor (Brednoord, Lindert, & Smets, 2014). The first effort of making housing available to the poorest in the country started in 1939 by establishment of the *Instituto de Credito Territorial* (ICT). It built and financed around 700,000 units in its 50 years of operations. These efforts were concentrated in large cities (Torres, 1996). However, these attempts became increasingly expensive for the poor. In response, the efforts were instead concentrated on sites and services, and mutual help solutions from 1958 (Laun, 1997). But in just few years, this change was widely criticized by the construction industry due to widespread increase in cost of capital and building materials, poor management of self-help options leading

to overall financial difficulties. This led the agency to return to building finished houses and employing different cost reduction and management strategies. Various financial measures easing the credit availability to poor households were employed to increase housing ownership in the segment. But the subsidizing model did not work and the agency, ICT, was declared bankrupt in 1991 and shut down (Giraldo, 1997).

This was followed by neoliberal approach for drafting social housing policy aiming at suppressing central housing banks. It strengthened the local municipalities, moving to demand based subsidy system from traditional direct construction and targeting the spending to on the poorest section of the society (Giraldo, 1997). This encouraged the private investments in social housing sector by supporting the poor buyers and obliging the financial system to increase investment in low-cost housing. The state in turn would take the role of a facilitator to encourage the private sector to enter the social housing field and not built itself. This financial policy was based on three elements of savings (ahorro), subsidy (bono) and credit (credito), known as ABC policy (DNP, 2011). Bankrupt ICT was replaced by *Instituto Nacional de Vivienda de Interes Social y Reforma Urbana* (INURBE). The new agency followed demand led approach by offering subsidies to the poor instead of the supply-side model traditionally used by ICT. The same approach stayed but INURBE was replaced by *Fondo Nacional de Vivienda* (FONVIVIENDA) and *Cajas de Compensacion Familiar* (CCFs) (Gilbert A. , 2014).

Government schemes to support social housing in Colombia have heavily dependent on mix of policies and tools to address problem of housing deficit in the country. Social Interest Housing (Vivienda de Interes Social) VIS is the primary upfront subsidy program aiming to help low income households to improve/buy new house. This credit does not cover total costs of the

home but is expected to be complemented by credit or household savings. But the problem surfaced when most of the families needing such support failed to get their credit approved. Thus the new program, Priority Interest Housing (Vivienda de Interes Prioritario) VIP was created for comparatively smaller and cheaper houses. These units were designed for people with informal jobs and the subsidies cover majority of the house cost. The government works to attract private developers to social housing projects by Macroproyectos initiatives. The land and infrastructure development parts are co-financed by the government. In return, plots are subdivided in partnership for mixed income housing developments. Through cross-subsidies, the benefits from income housing lots cover the losses incurred from those of low income.

2.5.4 Ecuador

Ecuador has always been seen as an oil-rich but small Andean country. The country underwent long spells of political instability, economic crisis, prolonged poverty and social inequality in the late 2000s (Jokisch & Pribilsky, 2002; Whitten, 2003). This has led to a considerable housing shortage of almost 2 million units (Klaufus & Perez, 2014). This deficit has reduced from 75.5 per cent in 2005 (INEC, 2006) to 52 per cent in 2010 (SNI, 2011). This includes both quantitative (that needs to be replaced) and qualitative (that needs to be improved) shortage. National housing deficit reported in 2010 included 33.1 percent qualitative and 18.9 percent quantitative.

Government support for social housing in Ecuador started in 1960 with the founding of Ecuadorian Housing Bank (BEV) and an executive body named Junta Nacional de la Vivienda (JNV). This policy aimed at tackling social housing shortage by producing standardized 36 square meter units. These units were financed by the state but built by private firms. This

method did not work for long as many flaws were stood out of the approach. The system was inefficient due to high costs, high level of abuse of state finances and geographical preference to the metropolitan areas of Quito and Guayaquil (Klaufus & Perez, 2014). Inspired by success of Chilean approach of market based incentives, the Ecuadorian government integrated JNV into the new Ministry of Urban Development and Housing (MIDUVI) (Whitten, 2003). The role of BEV also changed from a direct financier to a second –tier bank supporting the housing value chain. These events led to the creation of Housing Incentives System (SIV) in 1998 that was financially supported by Inter-American Development Bank (Hall, 2010). This system is based on the ABC formula of *ahorro* (savings), *bono* (grant) and *credito* (loan) where the low income households can apply for a subsidy, use their personal savings in the bank and apply for a loan from the same bank. This approach helped Ecuador in reducing its housing deficit and also in promoting residential construction sector and developing local financial market (Klaufus C. , 2010). This approach has been fairly progressive and adaptive with each subsequent Ecuadorian governments keep housing as one of their priorities. One of the major reform happened in 2007 with the aim to develop local solutions, improving local-level governance and tackling housing and land problems closer to home (Neira, 2011). A dedicated department for habitat and human settlements was also created along with the Housing Department under MIDUVI to support policies for housing, urban spatial planning and upgrading. The role of Habitat Department is to “develop urban planning and land management policies” along with “offering technical assistance to the municipalities”. The Housing Department on the other hand is specifically responsible to implement Housing Incentives System (SIV) (Klaufus & Perez, 2014).

Self-help housing is still a major approach employed by the low-income households living in urban periphery and rural areas of the country. The family builds and expands the unit over time mainly using the resources available to them. These families provides free labor, employ progressive construction by expanding the unit vertical or horizontal over time depending upon availability of resources and need. Ecuadorian government did try to formalize this sector but failed to keep it cheap. Now MIDUVI offers assistance to self-help housing by selling 'technical assistance services, laboratories for the production of concrete, soil studies, design and planning of the housing projects to public and private sector' (MIDUVI, 2016). Despite this effort from the government to improve the quality of new and existing self-help houses through different programs, the preference is still on developing new social housing solutions. Urban poor are unable to access sufficient housing solutions as the real estate developers in the region build either centrally located apartment buildings or suburban single-family houses (Klaufus & Perez, 2014).

2.5.5 Low Income Housing: Developing For Bottom of the Pyramid (BOP)

While it is often perceived to be public sector's responsibility to develop affordable housing, the government alone is not capable of fulfilling this need. As highlighted by Inter-American Development Bank's initiative "Opportunities for Majority" (OMJ), the private sector can stimulate profitable business opportunities in delivering valuable goods and services to BOP segment of the market. This fraction has enough buying power as it still invests \$56.7 billion annually on housing solutions in Latin America and Caribbean region (Stickney, 2014).

As demonstrated in Western Europe and America, support of public housing programs can significantly promote private housing industry in reducing the overall deficit (Chen, Stephens, & Man, 2013). Rojas and Medellin (2011) suggested that since each country in the region has different socio economic and geopolitical structure, the shortage must be tackled differently. Improvement of current construction practices, use of better materials, use of new techniques, and government policies to support these changes are the few to start with (IDB, 2012). Stickney (2014) demonstrated the need of private financing institutes for housing portfolio in Latin America and Caribbean region, and an opportunity for low-cost housing developers, suppliers of construction materials, and NGOs in developing a complete solution.

Fundamental to the affordable nature of system-built construction is its ability to inherently reduce construction lead-time, on-site labor hours, and construction waste (HUD, 2000). Comparative price analyses of site-built, modular, and manufactured homes revealed distinct savings obtained through system-built home construction (HUD, 1998; Apgar, Calder, Collins, & Duda, 2002).

The greatest opportunity for cost savings when constructing a new home is in the structure itself (HUD, 2007). System built homes are constructed almost completely in a factory setting and provide increased efficiencies, quality, and durability when compared to site-built homes (HUD, 1998, 2001). On site-built construction face major cost constraints with labor, climate, construction waste and the potential for vandalism (HUD, 1998; Atilas & Vanderford, 2006; Newman & Fleming, 2006). Advanced techniques used in the construction of system-built homes maximize efficiencies and minimize waste in labor, materials and resources (HUD, 2007).

Cost-reduction within the manufacturing process greatly reduces operating expenditures for the producer and is then passed on to the consumer (HUD, 1998, 2000).

Clear understanding of various export parameters is necessary to assure success of export oriented forest products industry (Parhizkar, Miller, & Smith, 2010). Based on this analysis and reported market potential, the companies in the United States can develop products for social housing projects with promising market access. But there is a lack of knowledge specifically related to policy, current construction practices, and social perception of wood construction in foreign markets. This study aims to gather information and highlight the potential of an export based business model. This would also provide an opportunity for the U.S. manufacturers to expand to new market and improve business performance.

2.6 Summary of the literature review

The most important ideas from the literature review can be summarized as follows:

- The system built wood construction industry is classified as prefabricated, panelized and modular systems. These techniques vary in the degree of the construction in controlled environments.
- Overall, the industry has performed well over the period, even as it has slightly lagged behind conventional housing construction. The housing market has rebounded strongly over the past five years as the economy has recovered, but low prices for traditional homes in many areas encouraged consumers to substitute away from industry products.
- The system built wood construction industry's revenue is expected to increase an annualized 5.2 percent to reach \$8.1 billion by 2022, including a projected 2.5 percent

increase in 2017. In comparison, however, the total value of residential construction is expected to grow at an annualized 7.0 percent over the same period, highlighting that the industry continues to lag behind the traditional housing market.

- The industry is highly consolidated with 3 companies together controlling more than 45 percent of the market share in 2015. These three companies are Berkshire Hathaway Inc., Champion Enterprise Inc. and Cavco Industries Inc. The level of consolidation in the industry has increased after recession. In 2017, share of these three companies is expected to rise to 56.6 percent.
- Despite some recovering after the 2008 economic downturn, the growth of System Built housing industry has been declining over the past decade. Several factors have contributed to this decline, most notably consumers' perceived value of manufactured homes. Traditional homes are typically viewed as superior to manufactured homes, decreasing the appeal of industry products in general.
- Despite the common believe, the sector has low capital intensity (6 percent) in manufacturing processes. The change in technology has also been fairly medium with standardized techniques and no major changes. The sector exhibits low level of revenue volatility owing to changes in price and demand.
- Exports of U.S. forest products have grown over 80 percent in the period of 5 years from 2009-14 with majority of increase due to volume as prices stayed uniform. But the share of factory built homes in the total export revenue is very low. In 2015, the industry had \$226.8 million worth of exports while the forest products industry reported the total export of \$9.62 billion.

- Performance measurement, both in domestic and international markets, is one of the important tools for measuring a company's success. With fast expansion of international business activities, exporting play a key role in many organization's survival and growth. Export performance is the relative success or failure of the efforts of a firm or nation to sell domestically produced goods and services in other nations. It has been widely studied as a key indicator of firm's ability to successfully leverage its resources and capabilities in international context. Studies highlight the complex and multidimensional nature of export performance measurement.
- Resource Based View (RBV), Contingency theory, Institutional-Based View (IBV), and Organizational Learning Theory (OLT) are the most commonly used underlying theories in developing export performance measurement framework.
- Export performance depends upon at least 4 elements: internal factors, external factors, control variables and moderating variables. Internal factors relate to firm specific characteristics like experience, marketing strategy and management characteristics. External factors associate with environment surrounding the firm in domestic and international market. Control and moderating variables may be either or external are the ones that can impact the export performance and needs to be identified and controlled by the firm.
- Latin America (including the Caribbean) is among the highly urbanized regions of the world. But housing affordability have become a critical issue in the region due to this increasing gap in the society, lack of flexible financing options and high costs of key inputs to housing.

It is extremely important for the people to have sufficient and sustainable housing at affordable prices.

- Peru (72%), Colombia (37%) and Ecuador (50%) housing deficit can prove to be a considerable market segment for U.S. house manufacturing industry. Making it important to study the government policies regulating social housing projects in the region, existing use of wood in construction and identify different stakeholders involved in social housing value chain.
- Latin America, in general, has a well-developed mortgage system financing private formal housing. But these schemes fail to reach the most low-income households. As a result, half of the population lives in self-help housing where the household constructs the complete house with auto-construction. Most of the government schemes and financial policies supporting housing for low-income people in the region are based on three elements of savings (ahorro), subsidy (bono) and credit (credito), known as the ABC policy.
- Fundamental to the affordable nature of system-built construction is its ability to inherently reduce construction lead-time, on-site labor hours, and construction waste. The private sector can stimulate profitable business opportunities in delivering valuable goods and services to bottom of the pyramid (BOP) segment of the market. This fraction has enough buying power as it still invests \$56.7 billion annually on housing solutions in Latin America and Caribbean region.

2.7 Research question

Since its introduction, the concepts of system built construction have diversified to various forms and scale. Emerging segments of system-built housing industry helped producers to

diversify to alternative products such as modular, panelized, and pre-cut houses within the same industry (Hart, Rhodes, & Morgan, 2002). Market share of system built wood home manufacturing industry in the United States indicates that the industry is in its declining phase of its life cycle. Current value added is lower than that compared to other industries in the wood products sector. In order to rejuvenate and sustain in the market, the companies in this industrial sector need to expand to new markets and diversify their products. These alternative products provide opportunity, in the case of a declining product life cycle curve, to shift to related products to maintain and gain further market share within the industry. Developing countries with high population and problem of quality housing can prove to be an appropriate untouched market for such an expansion of factory built wood construction. This would also create new employment opportunities across the entire supply chain associated with the manufacturing in the United States. But there is a lack of extensive analysis of such a proposal and a viable business plan. Identification of key processes and associated stakeholders for such an extensive export value chain would be helpful to managers in selecting appropriate market segments and evaluate their performance. It is also necessary to identify key supporting factors and barriers to exporting wood housing units manufactured in the U.S. System built wood construction can also act as an affordable and sustainable alternative to the traditional construction for the low-income urban households in the region. The research question developed for this study:

What are the key features of international social housing market impacting development and adaptation of system built wood housing units built in the United States and does this industry have the capability to fulfill this demand overseas?

2.8 Goals and objectives

This research aims at identifying potential expansion opportunities for system built wood house manufacturing companies in the Latin American countries. The existing production chain will be evaluated to identify factors supporting or hindering the possible business expansion to the urban social housing markets in Peru, Colombia and Ecuador. Such an alternative can act as a sustainable (economic and environmental) alternative for low-income households living in these countries. This would benefit both the manufacturing companies in the U.S. and deficit market in target countries. Following are the three objectives of this study:

1. Identify incentives and barriers for successful implementation of exporting system built wood homes to developing countries.
2. Identify factors differentiating exporting firms from non-exporting firms and barriers of exporting system built wood construction.
3. Establish and validate export assessment model using resources availability, capability and export venture strategy in system built wood construction industry.
4. Develop a marketing training manual for the system built wood housing manufacturers in the United States to export to selected countries.

3. Methodology

This research is based on using case studies and surveys as qualitative and quantitative methods respectively with the aim to do an exploratory and descriptive analysis to assess export markets for the system built wood housing manufacturing industry in the United States.

A qualitative approach aims to explore and understand the sense assigned by different stakeholders to an issue (Creswell, 2009). Exploratory approach offers a detailed understanding of perception in the research object and descriptive approach highlights the attributes of objects, people or organizations (Zikmund, Babin, Carr, & Griffin, 2010). This method is essentially useful when the aim is to understand the problem based on the information given by the participants (Creswell, 2009). This also gives an opportunity to study the subject in its natural settings. The Following section gives detail of how each objective was implemented in this research

3.1.1 Objective 1: Identify incentives and barriers for successful implementation of exporting prefabricated wood homes to developing countries.

This objective aims at understanding the potential opportunities for using system built wood homes manufactured in the U.S. as an alternative to traditional construction in the target countries. Different factors control the possible acceptance in the market. Thus stakeholders involved in the residential construction sector were interviewed to evaluate their views and understanding of wood construction. Interviews were conducted with government agencies regulating residential construction, builders, suppliers, and construction project managers. Interviews were drafted to cover essential features of social housing projects in target

countries. The size of the potential market segment that can shift to wooden houses, if introduced through social housing projects, was accessed through different stakeholders. Stakeholders were also asked about their awareness of the use of wood in construction. The questions were made from the factors identified through the literature review. Potential opportunities and drawbacks associated with the residential construction market were also recorded. Short surveys to access awareness about prefabricated wood construction among the four major stakeholders in social housing value chain from the target countries were also conducted. These were government agencies, construction companies/builders, project developers and raw material suppliers. Questionnaires can be found in the Appendix section of the report.

Activities: For accessing the urban social housing markets in developing countries of South America with a housing deficit, Peru, Colombia and Ecuador were selected. The selection was based on high qualitative and quantitative deficit in these countries (IDB, 2012) and ease of getting access to the stakeholders. Stakeholders in urban social housing projects were identified and contacted to understand the nature of the target market. The information would be used to evaluate opportunities for U.S. manufactured wood homes in this market segment. Interviews were conducted in person and any relevant data/information was recorded. Social housing project sites were also visited.

Methods used: Case studies, used for objective 1, are empirical forms of inquiry with a systematic approach of information gathering. This approach goes beyond than pure data gathering by including different approaches of information collection. In-depth interviews designed to gather information about but not limited to the research problem. This generally

involves recording life experiences and histories, related documents and participant's perception. This gives an opportunity to bring out the potential discrepancies or fall outs related to the research topics which might be missed by other approaches. Therefore, case studies can be attributed to be an efficient way of detailed and in-depth data collection method (Berg, 2004).

The U.S. commercial service offers "The Gold Key Matching service" where they help U.S. agencies in finding potential links to gain knowledge and access to overseas markets. This is done by arranging interviews in advance with preselected stakeholders (International Trade Administration, 2016). Structured interviews were conducted to collect information and document data. Representatives from government agencies were questioned on the policy regulating construction projects and use of wood as structural component. They were also asked social housing programs supported by the government, policies determining foreign involvement, and future strategies in housing construction market. The next group was the construction companies. This group was vital to understand the nature of native construction. They provided information on current social housing markets, consumer trends, scale and timeline of the projects and cultural aspects specifically relevant to certain segments of the market. They can also act as a medium for the U.S. firms to enter into the markets of target nations in future. Other groups that were interviewed included regulatory agencies, non-for-profit organizations, financing agencies were helpful in learning about the project allotment, and management procedures. The interviewees were also given an opportunity to add their own personal opinion on the topic at the end of the interview. These interviews were done in person by visiting the countries. The interviewees were asked open-ended questions in order to

record their perspective of social housing projects and possibility of using factory build wood housing system in future projects. Information about the policies regulating housing for low-income households was also collected. Existing housing projects were visited to understand the typical features, social aspects and scale of such projects. Figure 12 summarize the approach used in the study for objective 1.

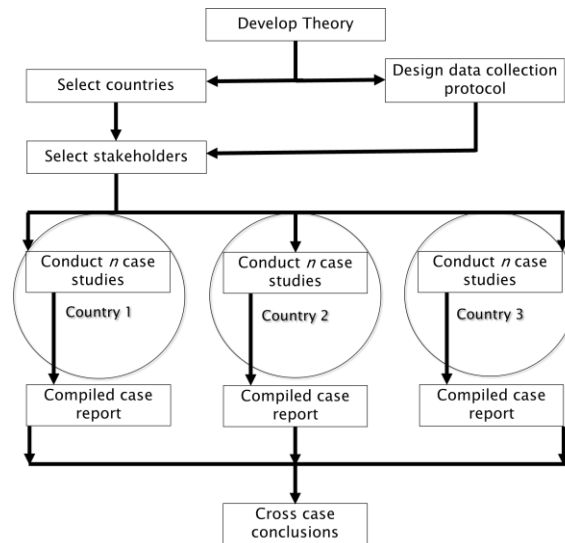


Figure 12 Market Assessment Methodology used for Objective 1

Means of assessment: Since the interviews had overlapping questions, the information was cross validated between different stakeholders. These interviews were documented, revised and validated through secondary sources as well. A detailed summary of all the interviews was prepared that would act as a guide for the U.S. manufacturing companies attempting to access social housing market in the selected countries.

Limitations: The data collected was country specific and cannot be used for other countries in the region. Some of the information collected was limited to selected stakeholder's

perspective. Also, details of project parameters (design, cost, timeline, scale etc.) would vary from one city to the other even within a country.

Expected outputs: Through this objective, an understanding of the nature and scale of prevalent construction projects used social housing in selected countries was expected to be gathered. This would be used to characterize the market and evaluate possible expansions in this market segment.

3.1.2 Objective 2: Identify factors differentiating exporting firms from non-exporting firms and barriers of exporting system built wood construction.

This objective aimed at identifying the differentiating firm level characteristics among exporting and non-exporting system built wood house manufacturing companies in the United States. The population of interest for this research was the manufacturers of system built wood construction systems in the United States classified under NAICS 32199201, 32199202, 32199205 and 32199206. A sample of 1021 firms was selected randomly stratified by each state. The collected data was analyzed using Mann-Whitney tests of independence to see if there is any statistically significant difference between the exporting and non-exporting firms in the United States. The data collected from the exporting firms was also analyzed to identify barriers to export.

Activities: The first step in this objective was to design the questionnaire. It involves conceptualizing questions that will in turn be used to measure the relationship between variables and effects based on the theoretical framework (Dillman, Smyth, & Christian, 2009). The designed questionnaire was then sent to the sample of 1021 firms selected from the

population as described in section 4.2.3. The collected responses were used to access difference between exporting and non-exporting firms. Export status of the firm was assumed to be independent categories and the hypotheses were designed to test different dependent variables. Since the data collected was ordinal in nature, a Mann-Whitney test was used to study the potential relationship and the test the hypotheses. Table 8 summarize hypotheses corresponding to each category addressed in the survey. Details of variables can be found through variable names from Table 21.

Table 8 List of Hypotheses for Objective 2

Category	Null Hypothesis	Variable	
		ID	Name
Number of Employees	H1: There is no difference between the average number of employees working for exporting firms and the employees working for non-exporting firms.	VAR4	Employees
Total Sales	H2: The sales level of exporting firms and the sales level of non-exporting firms are the same.	VAR5	Sales
Age of Firm	H3a: The average age of exporting firms and that of non-exporting firms is the same.	VAR9	Experience
Value of Firm	H4a: The average value of exporting firms and of non-exporting firms is the same.	VAR6	Value
Sales growth	H5a: The annual growth rate of exporting firms and of non-exporting firms is the same	VAR10	Growth
Business success factors	H6a: Importance of product quality to exporting firms is same as that to non-exporting firms.	VAR16.1	Prod_qual
	H6b: Importance of product availability to exporting firms is same as that to non-exporting firms.	VAR16.2	Prod_avail
	H6c: Importance of product pricing to exporting firms is same as that to non-exporting firms.	VAR16.3	Prod_pricing
	H6d: Influence of raw material's cost in final product cost for exporting firms is same as that	VAR16.4	Raw_mat_cost

	to non-exporting firms.		
	H6e: Influence of transportation cost in final product cost for exporting firms is same as that to non-exporting firms.	VAR16.5	Trans_cost
	H6f: Importance of good sales team to exporting firms is same as that to non-exporting firms.	VAR16.6	Sales_team
	H6g: Importance of customer relations for exporting firms is same as that to non-exporting firms.	VAR16.7	Cust_rel
	H6h: Importance of timely delivery for exporting firms is same as that to non-exporting firms.	VAR16.8	Time_del
	H6i: Importance of selecting agents/distributors for exporting firms is same as that to non-exporting firms.	VAR16.9	Sel_agent
	H6j: Importance of market expansion for exporting firms is same as that to non-exporting firms.	VAR16.10	Mark_expan
	H6k: Importance of marketing and promotions for exporting firms is same as that to non-exporting firms.	VAR16.11	Mark_promo
	H6l: Importance of after sales services for exporting firms is same as that to non-exporting firms.	VAR16.12	Aftr_sale_serv
	H6m: Importance of on-site support for exporting firms is same as that to non-exporting firms.	VAR16.13	On_site_support
	H6o: Importance of product modification for exporting firms is same as that to non-exporting firms.	VAR16.14	Prod_magn
	H6p: Importance of custom design for exporting firms is same as that to non-exporting firms.	VAR16.15	Custom_design
	H6q: Commitment to expand markets for exporting firms is same as that to non-exporting firms.	VAR16.16	Expansion_commit
	H6r: View on exports as long term sustenance for exporting firms is same as that to non-exporting firms.	VAR16.17	Commit_Export
	H6s: Importance of participation in trade shows for exporting firms is same as that to non-exporting firms.	VAR16.18	Trade_shows

The objective also aims to identify the major barriers faced by the system built wood housing manufacturers in the United States. So the respondents were asked to rate the barriers on a scale of 1 to 5 anchored at not important to extremely important. Table 9 lists the barriers experienced by an export venture.

Table 9 Barriers to Exporting System Built Wood Houses from the U.S.

Barriers	Variable	
	ID	Name
My product is not easily exportable	VAR25.1	Prod_exportibility
Don't know much about the exports and not sure where to start	VAR25.2	Export_know
I'd worry about getting paid	VAR25.3	Payment_prob
Regulatory complexity	VAR25.4	Reg_complexity
Unaware how to use foreign trade agreements	VAR25.5	Foreign_trade_agreem
Difficulty to get financing for foreign customers	VAR25.6	Financing
It would take time from my regular domestic sales	VAR25.7	Effect_domestic_sales
Insufficient protection of intellectual property rights.	VAR25.8	IPR_protection
Too costly	VAR25.9	Costly
Finding on site work force in foreign markets	VAR25.10	Site_Support
Difficulty in finding customers	VAR25.11	Finding_customer
Difficulty on forming partnership or joint ventures with local businesses	VAR25.12	Partnership_difficulty
After sales and maintenance services	VAR25.13	Partnership_difficulty

Methods to be used: The responses were collected through a mail survey implemented from March till April, 2017. There were three waves of responses. The first wave of respondents that filled the questionnaire after they received their first copy and mailed it back within 2 weeks. The second wave of the respondents were those who responded after receiving the reminder

post card. The third wave of responses were those who sent the questionnaires sent to them after 4th week. They received a different cover letter urging them to response to the survey.

Means of assessment: The first step before using the survey data was to conduct non-response bias and check if the respondents from all the three waves represent the same population. Non-response bias can be assessed in different ways. Ratio of exporting and non-exporting firms and classification of the respondents on the bases of number of employees. Once it was determined that the pattern of respondents in all the waves are not different from each other, it is safe to assume that they are coming from a same population and can be used as a representative sample.

The responses to all the variables in used for hypothesis testing in Table 8 have an ordinal scale. So Mann-Whitney test used to determine independence between two groups and test the hypothesis. Mann-Whitney being a non-parametric test works by merging two independent samples together for the purpose of ranking. This numbers are then ranked in an ascending order and sum of ranks for each group is calculated. Just as any comparison test, the statistical significance levels are determined at certain Type I and Type II represented by the σ and P-value respectively. The p-values indicates the association between exporting and non-exporting categories for each factor. In statistical hypothesis testing, a type I error is the incorrect rejection of a true null hypothesis (a "false positive"), while a type II error is incorrectly retaining a false null hypothesis (a "false negative").The comparisons would be useful to identify key factors that differentiate the exporting firms from non-exporting firms.

Descriptive analysis was used to analyze responses on barriers to exports. The perception of the exporting firms on the factors impeding export operations would in turn be useful in developing strategies for purposed expansion to low income social housing in this study.

Limitations: Based on the number of responses, the respondents from the sample may not represent the actual population. Low response rate can reduce applicability of statistical tests and reliability of results. Thus in such cases, the results cannot be extended and generalized to represent the entire industry.

Expected outputs: Through this objective, an understanding of key differentiating factors between the exporting firms and non-exporting firms in the system built wood manufacturing industry in the United States will be developed. Analysis of barriers to exporting would be useful to identify key problems being faced by the industry. This information can be used by the companies to selectively identify and invest in important factors while planning any business expansion through exporting.

3.1.3 Objective 3: Establish and validate export assessment model using resources availability, capability and export venture strategy in system built wood construction industry.

Export performance measurement is important to benchmark and measure performance of exporting firms. This objective measures the export performance of exporting firms recorded through the survey and use the information to validate the theoretical model to measure performance developed through the literature review.

Activities: The sample surveyed in objective 2 were also asked about their current export status. Those companies who were exporting or have exported system built wood homes in the

past were asked additional questions. The measurement items and constructs used to assess the export performance derived from the literature are listed in Appendix D.

Methods to be used:

For objective 2 and 3, survey methodology was used to assess the system built wood construction industry in the United States. Survey research is an observational study approach where inferences are drawn about the population by collecting information from a sample using a questionnaire designed based on a predefined problem (Babbie, 2010). This study approach needs definition of theories underlying the problem phenomenon. With the background knowledge from previous work and developed theories, hypothesis for the problem that are testable aspects of theories. From these hypothesis, research questions are developed which are in turn used to form theoretical framework to guide the design the survey. There is a difference between a list of questions and survey questionnaire (Dillman, Smyth, & Christian, 2009). These questions can also be in form of statements upon which respondents are asked whether they agree or disagree. Indexes and scales can be used to measure the degree of approval, importance, and frequency. The questions can be designed using two different approaches: open or close ended questions. Open-ended questions allow respondents to provide their own opinion as an answer but close-ended ask respondent to pick from the provided alternatives only. Thus while former are ideal to gather in-depth information, the later are ideal when the researcher knows and cares only for response from specific, preselected options. In terms of analyzing the collected response quantitatively, the responses to open-ended questions would need to be coded. Responses to close-ended questions can be directly accessed quantitatively using it as numerical data. Both categories can be single or multiple

responses (Babbie, 2010). This approach of surveying is again an observational not experimental approach where the study subjects are observed without influencing them, same as case studies discussed before. This is an effective way to collect data as it can be self-administered removing the need of researchers to travel. This quantitative method is also a beneficial when the inferences can be drawn about the population from a small representative sample selected without any bias. Surveys can be used to conduct exploratory, descriptive, and explanatory or even a combinations of these depending upon the goal of studies (Blanco, 2014). Exploratory research is useful when the aim is to increase understanding of the relevance of a topic for the population or to assess the feasibility to conduct a larger study. Descriptive approach is used to describe characteristics and/or behaviors of the population. Explanatory surveys are conducted to understand the reason things happen (Vaske, 2008).

Survey design

The structure of the mail questionnaire focused on five key business dimensions impacting export performance of U.S. system built wood housing industry. These dimensions were extrapolated from extensive literature review focused on industry demographics, internal resources available to the firm, external factors impacting the firm, export venture strategy and export venture performance. These dimensions were addressed through different group of questions. These questions were grouped under demographic information, business success factors, transportation and delivery factors and barriers to exports. The questionnaire was divided into two segments differentiating the respondents into exporting and no-exporting firms. Only exporting firms were asked to respond to the latter two groups, i.e. transportation and delivery factors and barriers to exports, along with additional demographic information for

exporting firms. Two types of questions, namely categorical and five-point interval scale, were used to assess the five dimensions of questionnaire. The questionnaire also had an open-ended question to gather respondent's opinion/remarks on exporting system built wood buildings. Each questionnaire also included an introductory section with details of the study and researcher's contact details to support cover letter mailed along the questionnaire.

The survey consisted of 26 questions grouped into 5 different sections: namely "General information", "General Characteristics of the company", "Business success factors", "Transport and delivery" and "Barriers to export". The first question of the survey, from General information section, asked if the companies did manufacture system built wood homes to filter respondents from manufacturers to non-manufacturers. Only respondents that manufacture were asked to continue with the survey. General characteristics of the company had 19 questions about the company 5 out of which were specifically for the exporting firms. Business success factors section had 18 sub-questions that all respondents were requested to answer. Sections on transport and delivery section and barriers to export with 13 sub questions each were directed specifically for the companies that export or have exported in the past. The last question of the survey gave respondents an opportunity to add their additional comments/recommendations for researchers. Figure 13 shows the survey design and implementation strategy used in the study. The questionnaire and description of variables can be found in the Appendix C.

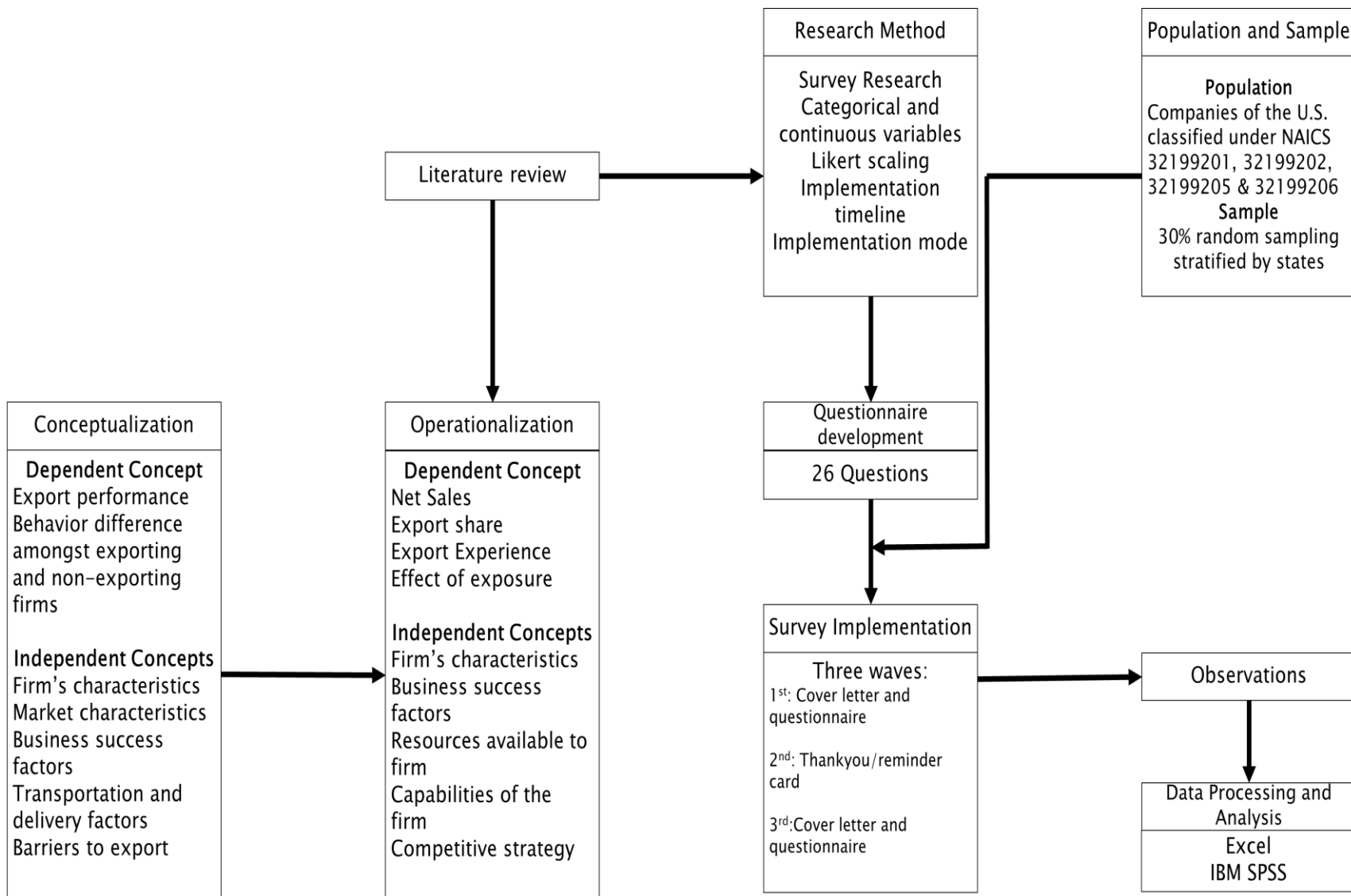


Figure 13 Survey Design Methodology

Population

The population under study was U.S. system built wood housing industry. A complete contact list of 3166 firms classified under NAICS 32199201, 32199202, 32199205 and 32199206 was purchased from an industry directory (SICCODE.com, 2016). The classification 321992 under NAICS covers Prefabricated Wood Building manufacturing and the list had all the companies collected by the vendor up till December 2016. Table 20 in appendix B lists the number of firms per state and was population for part of this study.

Sample selection and survey implementation

Sample group mailing list was derived from the population list by randomly selecting one-third of the companies from the population list for each state making it a stratified random sampling. This led to a sample size of 1021 companies selected from the population list for the survey. The survey was implemented on March 21, 2017 through first class mail to assess difference between exporting and non-exporting firms and export venture performance of exporting firms. Implementation of survey is not just sending out the questionnaire, but should also look into tactics to motivate the respondents to participate and see the potential value of the research (Dillman, Smyth, & Christian, 2009). This involves multiple aspects of visual design of the instrument, solicitation techniques and developing a proper communication strategy during the process to engage the subjects of the study (Blanco, 2014). Dillman recommends a five steps process for conducting mail surveys and obtain higher response. It involves a) a pre-notice letter, b) questionnaire mailing (with cover letter), c) thank you post card, d) replacement questionnaire (with cover letter) and e) a final contact notice. A similar strategy was employed for this research. Each of the recipient received a cover letter (Appendix D), questionnaire

(Appendix E) with a unique tracking number and return envelope through traditional mail or “snail mail”. The return envelope had first class pre-paid postage to encourage responses. Unique identification number linked to each questionnaire helps in expediting the envelope packing process, aid response monitoring and provides a method for follow-up actions on non-respondents (Biemer & Lyberg, 2003; Rea & Parker, 2005). A communication timeline was established according to the guidelines of Dilman (2000) for traditional mail contacts. The correspondence consisted of three written forms of communications at a two weeks difference. The first correspondence was the questionnaire with cover letter introducing the study and a pre-paid return envelope. A two week reminder/thanking postcard (Appendix D) was sent to all the sample. It thanked the recipients who have already responded to the survey and requested the non-respondents to participate as well. After elapse of another two weeks, all the non-respondents were sent another mail with same questionnaire (Appendix E), pre-paid return envelope but a different cover letter reminding importance of response. Table 10 shows the correspondence timeline in the implementation of the mail survey used in this study.

Table 10 Correspondence Timeline for Implementation of Survey

Correspondence	Date	Time Mark
Cover letter with questionnaire (1021 in total)	March 21 st , 2017	Day 0
Postcard (Thank you/reminder) (1021 in total)	April 4 th , 2017	2 weeks
Reminder letter to non-respondents (Different cover letter with same questionnaire) (977 in total)	April 18 th , 2017	4 weeks

Means of assessment: First part of this objective involved measuring the reliability of the variables measuring factors affecting export venture performance to be used for modeling process. Reliability of the constructs can be checked by various methods. This study used

Cronbach's alpha coefficients (Cronbach & Meehl, 1955). Second part of the analysis consisted of evaluating relationship between the dependent variables measuring export venture performance and explanatory variables as defined in the research design and Appendix G. The independence between these sets of variables were tested with Fisher's exact test (Agresti, 2002). This was followed by performing simple linear regression between all the explanatory variables altogether and each one of the response variables. Contingency analysis to test categorical data (Agresti, 2002) were conducted to explore the behavior of each individual variable and the potential relationships among them to assess association between the responses and factors developed from the theoretical model.

Limitations: Power of a statistical test is the probability that a test will reject the null hypothesis when the null hypothesis is false. The two major factors affecting the power of a study are the sample size and the effect size. Thus insufficient sample availability highly restricts application of statistical tests. Applicability of these statistical tests can further be confirmed by their conformity tests. For example reliability of regression analysis depends upon the regression coefficient. High regression coefficient (closer to 1) indicate stronger empirical relation between the dependent and estimating variables and vice versa. Low regression coefficients obtained would indicate inability of the model to predict meaningful relation.

Expected outputs: Export venture performance model developed through this objective can be used to measure the export performance on four financial and non-financial indicators using resources, capabilities and strategies of the venture as estimators.

3.1.4 Objective 4: Develop a marketing training manual for the system built wood housing manufacturers in the United States to export to selected countries.

This objective aims to develop a summarized introductory and guidance manual based on findings of this study to be used by system built wood building manufacturers in the United States. This manual can be used by manufacturers along with government and non-profit organizations aiming to support and expand the business of US manufacturers to the markets of South America. This report is structured to briefly introduce the features of system built wood construction in the United States. Key segments of this report to include residential construction market in the U.S. followed by benefits of using wood in construction. Classification and discussion of system built wood construction in residential market of the country is another important factor to be included in the report for information of all the stakeholders. Current international operations by the business should also be analyzed since this study also aims at assessing foreign operations and exports of system built construction. The report would also be used to share the findings of this study of market assessment of urban social housing in developing market with stakeholders in system built wood construction industry. Key conclusions can be drawn from these findings to identify need and key opportunities for the sector to grow in international market. Approach used in this study would also be included to in this report so that the stakeholders can utilize to build a viable business plan based on this research.

3.2 Means of assessing the results

As mentioned in the previous section, two main data collection techniques were used in this research. Interviews (both standardized and non-standardized) were used for objective 1 and

standardized questionnaire implemented through a mail survey for objective 2 and 3. A standardized approach is considered appropriate for gathering quantitative and factual data, and non-standardized is better for qualitative and causal data (Healey & Rawlinson, 1994). Data collected through these interviews was documented and verified for any missing information. Since different stakeholders were interviewed, each responder had an independent, but related perspective on the similar topic. This helped in cross checking and validating responses gathered from different interviews on a same topic. Available published literature and data about the target country was also be referred for validation. Contact information of the interviewees was recorded for follow-ups if needed in future.

Regression analysis can help to elucidate how well changes in an independent variable can explain the behavior of dependent variable. Regression models can be used for different purposes, namely: (1) description and explanation, (2) estimate parameters, (3) prediction, and (4) control (Montgomery, Peck, & Vining, 2001; Ott & Longnecker, 2001). Regression in the context of this study was utilized to describe how export performance of venture changes with the change in underlying factors as described in the theoretical model. Significance tests were also calculated to determine whether the linear regression equations were significant at $\sigma=0.05$ indicating whether the slopes calculated were significantly different from zero. P-value in test indicates the probability of the relationship emerging randomly. A p-value of 0.05 means that there is a 95 percent chance that the relationship is real.

4. Results

4.1 Objective 1

This section summarizes the findings of the study from market analysis conducted in Peru, Colombia and Ecuador. Being the first of its kind in the region specifically for analyzing market opportunities for U.S. built prefabricated panelized wood housing systems, the focus was to gather macro information from the major capital cities of the target countries. Table 11 shows detail of the visits to each of the three countries and number of interviews conducted categorized according to the nature of organization.

Table 11 Details of Visits

	Lima, Peru	Bogota, Colombia	Quito, Ecuador	Total
Visit Dates	October 13-17 th , 2015	March 12-16 th , 2016	September 6-9 th , 2016	
Fair attended	Expo M&M Tradeshow 2016	13 th Technological and Industrial fair on Forestry, Wood and Furniture	FERIA- International Construction Trade Fair	
Number of organizations				
• Construction Companies	3	2	3	8
• Governmental organizations	2	4	2	8
• Financing Institutes	1	1	1	3
• Educational Institutes	0	1	2	3
• Non- for profits	0	1	1	2
• Trade firms/ certification agencies	1	4	2	7
• Wood users / suppliers	2	10	2	14
Housing projects visited	1	1	1	3
Total	10	24	14	48

Key highlights of policies and schemes associated with the social residential housing are discussed first followed by current solutions in the market by major construction companies. The findings also include highlights of major financial and supervising institutions supporting/monitoring such projects.

4.1.1 Lima, Peru

With the construction industry being one of the engines of economic growth, current housing deficiency is a major concern of the Peruvian government. There is additional pressure on the government as the cities expand and the households migrate to urban areas in search of better jobs. This also leads to increase in land prices indirectly affecting the construction costs. Most of these migrating households are low to medium income families that move to illegal constructions on the periphery of the major cities instead. Figure 14 shows the types houses currently available to low income households in the periphery of Metropolitan Lima, Peru.



Figure 14 Current Housing Solutions for Low income Households in Metropolitan Lima

Policy: Techo Propio/ Adquisición de Vivienda Nueva (AVN) [Own Roof/New Housing Acquisition] is an umbrella policy in place to support social housing projects. This program has been implemented since 2002 with the aim to create a subsidized housing market for low-

income households. The policy attempts to resolve the problem of high and increasing cost of land and construction, informality and social inclusion.

Current status of residential construction: Brick and concrete are the most commonly used material in construction. Prefabrication, both in wood and concrete, is not commonly used in residential construction. Despite different support programs, there are only few builders in Lima, Peru working exclusively in social housing projects due to lack of profitability using current construction methods. Progressive housing is a common feature of low and middle income households in the country where they start with a very basic structure and empty lot. The family built floors and expand the house over time. Despite that, there weren't any specific cultural/regional design/architectural requirement reported, the durability and maintenance of wooden buildings as compared to concrete buildings in the humid climate of Lima can be a deciding factor. According to CAPECO (Chamber of Construction, Metropolitan Lima), metropolitan Lima alone had an expected demand of 443,544 units in 2014. But there were only 27,952 (6.3% of the demand) homes built. Fifty percent of the unfulfilled demand was for the units below the sale price of 40,000 USD (ownership cost including land and construction).

Use of wood as a construction material: The use of wood is limited to non-structural applications only. There are few high cost projects that used wood for structural applications but the market share is very limited. The policy has a major role to play in regulating the use of wood. According to existing guidelines, only the indigenous species can be used as structural component in government projects. There is a provision to include foreign wood species after going through the testing procedures. Grades of materials and guidelines approved by the United State agencies could be accepted by the Peruvian regulatory agencies and can help in

speeding up the process. The interviewed stakeholders widely acknowledged the benefits of wooden construction in form of better seismic resistance, lower construction time, and low cost, environmental friendly over concrete construction. Wood construction can also be used as emergency shelters in the remote regions of the country. Ease and speed of building a prefabricated house can have an extra edge over concrete construction.

4.1.2 Bogota, Colombia

The Colombian housing market varies from luxurious homes to temporary shacks with bare minimum infrastructure. While there is a well-developed mortgage system to finance housing, the low income households still fail to get houses from formal market. As a result, this section of the market resorts to informal construction. In Bogota alone, 54 percent of the homes built between 1993 and 2005 were built informally (Florian A. , 2011) which in itself varies in quality and concentration across different parts of the city.

Policy: The state does not build homes under any schemes, but encourages and supports private sector. Proposals for projects are invited once a need is determined by the government. The proposals are examined and projects regulated by Findeter, a third party mediator and a developmental bank. Findeter is financial management institution for social housing and is also involved in budget planning each year. The proposal does not specify any material or design usage. Project designs have to be approved by the government entity, “Curaduria Urbana” before they are implemented. These homes should be durable and hard to break in. Despite high government interest, only a few construction companies participate in social housing projects. Returns from the projects were reported to be highly dependent on scale of projects.

As of March, 2016, the housing policy in Colombia had four different schemes to support social housing needs of low income households.

- **Mi Casa YA (My House Now):** This is a short term policy to support eligible households with income between 2 to 4 times the current legal minimum wage (689,455 Colombian Peso or 230 USD/month, 2016) to buy houses costing from 70 to 135 times the legal minimum monthly wage. The scheme designed to benefit 130,000 households from 2015-2018. These houses can range from 16,100 – 31,050 USD.
- **VIS (Affordable Social Housing):** This program aims to build houses under the value of 135 legal minimum monthly salaries. Currently, a demand of 77,000 houses is estimated in this program. This policy covers houses under the cost of 31,050 USD without any restrictions on selection of beneficiary households.
- **VIPA (Priority Interest housing):** The maximum value of houses built in this program cannot exceed 70 legal minimum monthly salaries i.e. a total cost under 16,100 USD. This type of housing targets population in extreme poverty, the network “red unidos”, displaced rural population by guerrillas, and displaced citizens by natural disasters. Average size of these homes is 48 m². The program aims to cover more than 100,000 households in different zones (4, 5 or 6) of urban areas.
- **Fondo de Estabilizacion de la Cartera Hipotecaria (FRECH):** FRECH is a public hedge facility supporting social housing. The benefit provides reduced interest rates to eligible households and act as a stabilization buffer to counter inflation.

This limiting cost also includes the lot cost (< 53 m²) which goes up to 10 percent of the total cost of the single family unit. The allotted project may include availability of a fully developed site with installed utility lines or it may also include site development as builder's responsibility.

Current status of residential construction: The building code is designed specifically to withstand high seismic activity. The projects also need to demonstrate effective performance with energy and water consumption efficiency, a focused area in current national Sustainable Energy law. A total of 19,758,964 m² in area licenses were issued in the year 2015 for residential house construction out of which 25 percent (4,971,147 m²) of the land was dedicated to VIS projects. The majority of the households that fail to get support from any of these schemes; prefers progressive housing as a solution through self-help process. This incremental self-construction is major feature of low-income housing market in Bogota as well. Concrete in combination with steel is the most prevalent construction material in the nation. Share of other materials, including bricks is approximately 11 percent. Every new material to be used in construction requires an approval from Colombian Society of Engineers.

Use of wood as a construction material: The majority of the interviews reported lack of expertise for building with wood. Current use of wood in construction is predominantly limited to non-structural applications. This is also due to unavailability of graded, rated lumber and the negative impression of wood construction. The wood is considered either for expensive construction projects or very low cost temporary housing. Three types of projects involving wooden construction in Colombia were recorded. TECHO, nonprofit international firm, has built 1500 units (6X3 meters) in Valle Aurra region of the country. These units were reported to be imported from Chile. Programa "Aldeas" (Program "Village") is one of the flagship initiative for

social housing by EPM, group of companies located in Central America, Chile, Mexico, United States, Spain and Colombia, with headquarters in Medellin, Colombia. Wood from their private plantation was used to develop the project. The project aims to deliver 1400 homes in 3 phases. Along with poor families, they are also covering households relocated due to hydrothermal projects in 6 districts of the region.

A foreign company can participate in bidding process by demonstrating a construction experience of up to 5 years or by partnering up with local companies. Current social housing projects for low income households range from 100 to 2000 dwelling units per project. With current practices, at least 400 units are necessary to make a project profitable for the builder. Big companies already tend to subcontract construction processes if deemed feasible. The builders prefer vertical construction to reduce costs but the people like horizontal construction more.

4.1.3 Quito, Ecuador

The deficiency in the housing in Ecuador is spread across both the rural and the urban parts of the nation. Housing conditions vary considerably from city to city, but unfortunately there is very little data to compare cities in Ecuador, either among themselves or with cities outside Ecuador.

Policy: The constitution of Ecuador guarantees the right to housing which implies that the state is responsible for ensuring that all its citizens are properly housed. But it's not state's primordial function to produce the necessary assets and services, but the state will guarantee that society will have the required mechanisms for accessing these assets and services. Its basic role will be

to motivate, to channel, to facilitate, to regulate, to set norms, and to coordinate the agents engaged in urban development. The government has taken an enabling role where instead of being directly responsible for producing the houses, it oversees and corrects the housing sector as a whole. In other words, the government enacts and enforces laws and regulations, corrects market failures, and provides institutional, technical, and financial support to the stakeholders, while relinquishing control over the building, lending for, buying or selling, owning or renting, managing or maintaining houses and apartments. This enables the key stakeholders in the housing sector dwellers and communities, builders, lenders and local governments to work efficiently and equitably towards meeting housing needs.

Current status of residential construction: Evaluating the housing markets, despite the slow economic growth, it is fairly easy for the buyer to secure credits and get a home. Progressive housing is again one of the major features defining residential construction in low and medium cost construction. The household expands the building both vertically and horizontally on the same lot over time. This cultural aspect is used by the builders as well. Selling a unit with basic minimum required construction reduces the cost. It also gives the household an option to make a custom designed unit that best suits their needs. One of the companies interviewed during the visit very efficiently incorporated modular design to allow future expansion and delivering units with different levels of finish to keep the costs down.

The social housing policy requires the unit cost to be under \$40,000 USD 15-20 percent of which is usually the land cost and rest is allocated to the site development and construction. Many companies develop projects with units of mixed costs ranging from medium to low in order to assure the overall viability of the project. These builders also prefer vertical

construction to save on land costs. But the consumer still prefers detached homes or horizontal homes. Since the current use of wood is limited with little wood working knowledge, there is a need to develop marketing and promotion plans educating the stakeholders of the benefits of wood in construction.

Use of wood as a construction material: The use of wood is majorly restricted to non-structural applications. Limited knowledge about the application, poor perception and availability of wood were found to be the major reasons for low utilization of this resource in residential construction. Despite low current use, the market size and push to find alternating materials capable of better sustaining the earthquakes gives an opportunity to promote the use of wood as structural component in residential construction. This was evident from the increasing use of Bamboo in residential construction of earthquake prone coastal regions. The perception to use it as structural component among the low-income consumers changed substantially after recent devastating earthquake of April 2016 in south-eastern region of the country. But lack of performance standards for building with Bamboo or any other alternate material was a major concern among the builders and designers. There are no reported restrictions on the use of wood in construction. There are agencies that can assist the companies in planning projects and drafting proposals for the social housing projects. There is no restriction on participation of foreign companies provided the project is approved. The awareness of benefits of using wood and education and perception of using it can be major hurdle in the Ecuadorian market. But the push to find renewable materials and architectural abilities when supported with correct programs can help break this taboo. This would help opening new markets for the wood

construction in general and prefabricated wood building manufacturers in the United States can take a lead in this market.

4.2 Objective 2

4.2.1 Overview of survey responses

A total of 108 responses were received from the surveyed sample. This represented 10.6 percent of the sample. Out of this response, only 25 of the respondents answered positive to the first question and continued the survey questionnaire. Only these were the respondents that reported to be manufacturing system built prefabricated wood building systems. The rest of the respondents returned the survey questionnaire without answering any other questions. Thus only these valid responses could be used in analysis. Moreover these responses represent only 0.8 percent of the total population of 3166 companies considered in this study. Low response rate restricted the extrapolation of results and conclusions from the sample to the population. This limitation of nonresponse restricts the use of results only as a case study within the industry instead of an overall representation.

4.2.2 General characteristics of the companies

Once the respondents responded yes to the first question, the next item asked respondents what is the major product manufactured by their company. The questions ask for the share different varieties of wood construction system for the responding company. The types include panelized systems, modular systems, precut systems, log Cabins and any other type that the respondent can add to the list. One manufacture can offer more than one type of construction systems. The total share for all the categories selected should be 100 percent. Log Cabin Homes

and Buildings were found to be most widely manufactured product line among the respondents. Fifty two percent of the respondents reported it to be one of their products. This was followed by Modular Systems with 28 percent respondents manufacturing the system. Precut and others category which included Mobile HUD homes and stick built construction were both reported by 24 percent of the respondents as one of their products. Only 16 percent of the respondents reported to manufacture Panelized Systems. Table 12 summarize responses of the survey across different product categories.

Table 12 Response Summary on Different Construction Methods

Construction System	Number of respondents in each category	Manufactured by (Fraction of respondents)	Mean level (S.D.)	Median level	Range
Panelized System	4	16%	65% (43.56%)	75%	10% - 100%
Modular System	7	28%	70 % (28.28%)	50%	40% - 100%
Precut System	6	24%	48.33 % (29.94%)	50%	10% - 100%
Log Cabins homes and buildings	13	52%	83.08 % (21.36%)	100%	50% - 100%
Others (Stick built and Mobile homes)	6	24%	63.33 % (31.41%)	55%	20% - 100%

* The sum of total respondents across 5 categories will not be 100% as each respondent can be manufacturing more than one product.

For the responding firms, 81 percent of these construction systems were built for residential market and remaining 19 percent for commercial sector on average. Majority, with 24 percent, of the responding companies had 1-4 full time employees working for them. The median category of the number of employees among surveyed companies was 10-19. There were only two respondent companies that had more than 250 full time employees and only one of them

had more than 500. Figure 15 shows distribution of number of employees among the respondents.

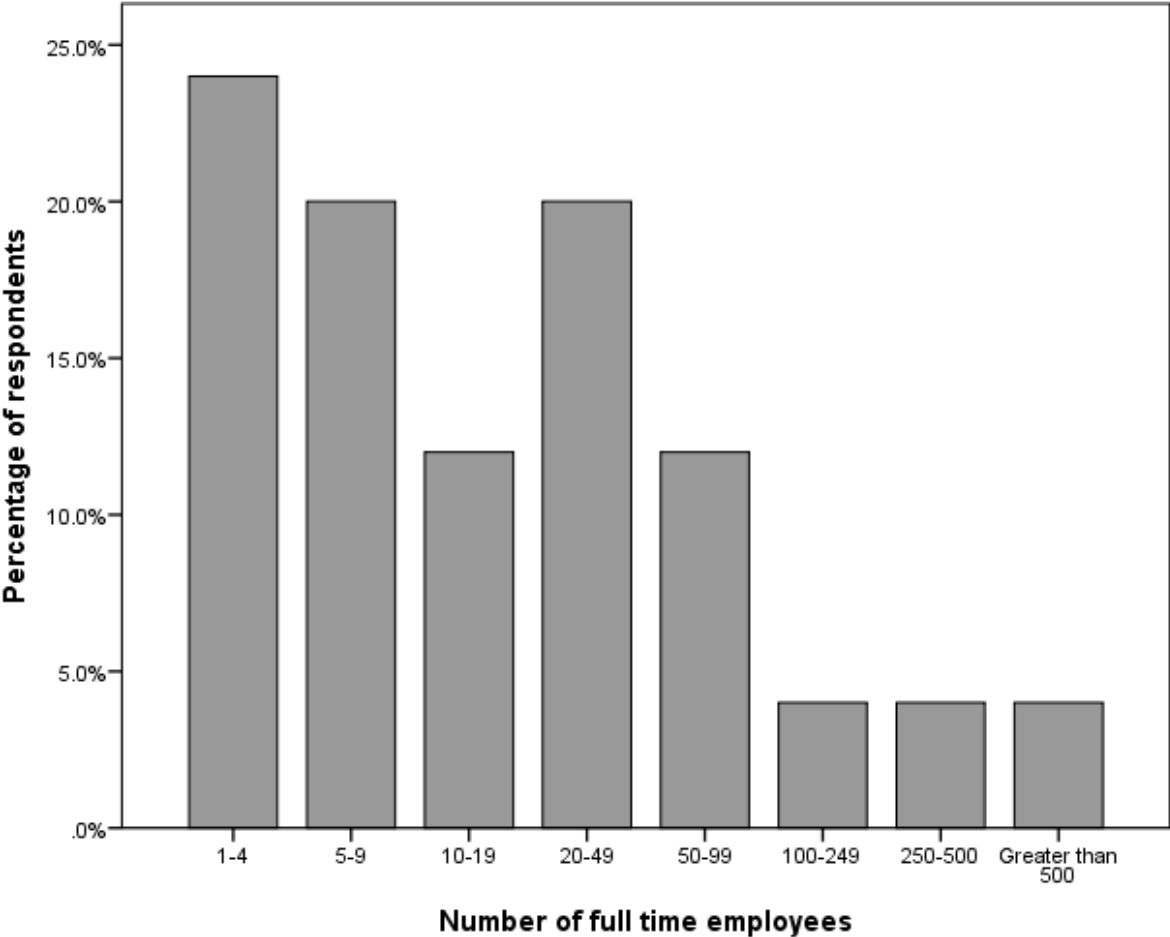


Figure 15 Distribution of Respondents by Number of Employees

Sales and value of a company plays an important role in improving business performance. Both of them were distributed with \$1-2.5 Million as median value. Figure 16 shows value of the respondent companies by their most recent annual sales.

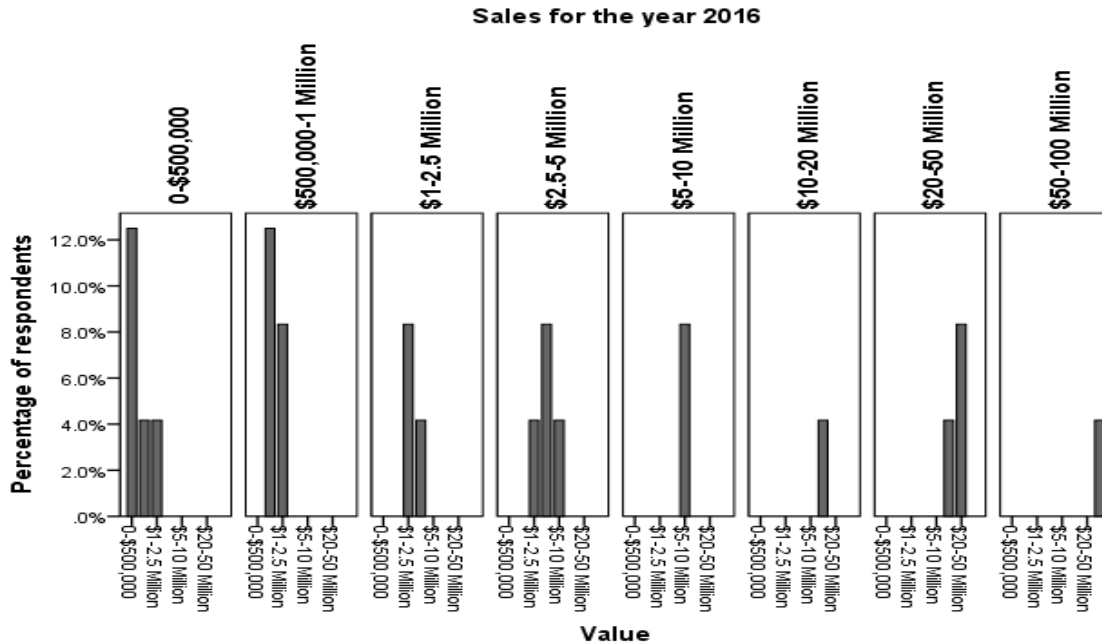


Figure 16 Distribution of Respondents by Sales and Value of the Company as Reported in Survey

On average, the respondents reported to be manufacturing 74 units of houses each year with an outlier company that reported to be manufacturing 4000 units alone. Average size of units being manufactured by the respondents was 2240 sq. ft. ranging from 1400 ft² to 6000 ft² in area. Manufacturing firms in this industry are fairly old and experienced. Eighty three percent of the respondent companies reported to be in business for more than 20 years. Only 4 percent of the companies that responded were younger than 5 years. In term of growth, 45.5 percent of the responding companies reported to experience less than 5 percent annual sales growth per year over past five years. The median sales growth for the respondents was still 6 to 10 percent. Median delivery distance for the respondents ranges from 200-300 miles and the average transportation cost incurred by the companies that responded was 6.3 percent. Contractual trucking is most common delivery mode used by the responding companies. Ninety six of the

respondents used it to deliver on average 71 percent of their products. Forty four percent of the responding companies used company trucking to deliver on average 27 percent of the customer orders. Customer trucking, rail and others (via sea) were not widely used means of transport among the respondents. Less than 10 percent of the respondents reported to have used them. Interestingly, only 24 percent of the respondents were ever involved in developing products and participating in low income housing market and all of these efforts were dedicated to domestic markets.

Only thirty six percent of the responding companies reported to have conducted any export at any point of their business operations. When asked about interest to get into exporting to those that are not currently exporting, 56 percent responded positively and wanted to learn more about international business expansion. For the companies that did report exports, the share is quite small. Approximately 90 percent of the exporting respondents reported to have less than 10 percent of their total sales coming from exports. The regions of the world that are currently serviced by the United States system built wood construction sector were also inquired. Northern Asia and Pacific Rim reported highest share of exports from this industry. Table 13 summarizes the share of exports to regions of the world. The sum total of the share here will not be 100 percent as a company can export to more than one region.

In terms of experience, the majority (55.6 percent) of the responding exporters have been in international business for over 20 years. Close to twenty two percent of these exporting respondents reported to have been involved in the export business for less than 5 years. Wholesalers/distributor was reported to be most commonly used by the U.S. companies. Close to 67 percent of the companies used this medium. No respondent reported to have sales team

in foreign market for direct selling. One respondent reported to have sold directly to the foreign builder. Interestingly, none of the exporting respondents increased their employees or manufacturing capacity specifically to support export activities.

Table 13 Export Share for Each Region

Region	Share of exporting respondents (Count)	Region	Share of exporting respondents (Count)
North America	44.4% (4)	Western Europe	22.2% (2)
South Africa	11.1% (1)	Eastern Europe	22.2% (2)
South America	33.3 % (3)	Middle East	0%
Central America	44.4% (4)	Southern Asia (India/Indonesia/Malaysia)	22.2% (2)
Northern Asia and Pacific Rim (China/Japan/Taiwan)	77.8% (7)	Other	11.1% (1)

This objective of the study also attempts to identify business success factors differentiating exporting firms from non-exporting firms. The research attempts to identify common barriers of exporting system built wood construction based on the responses from the survey. The first subpart of this objective analyzes how the export status of a respondents impact their perception on different business success factors. Which it means that if there is a difference between the respondent companies that do not export and respondent companies that reported exports in the survey. Respondent’s opinion on importance of different success factors varies from one factor to the other (Figure 17). This includes both the exporting and non-exporting respondents from the survey.

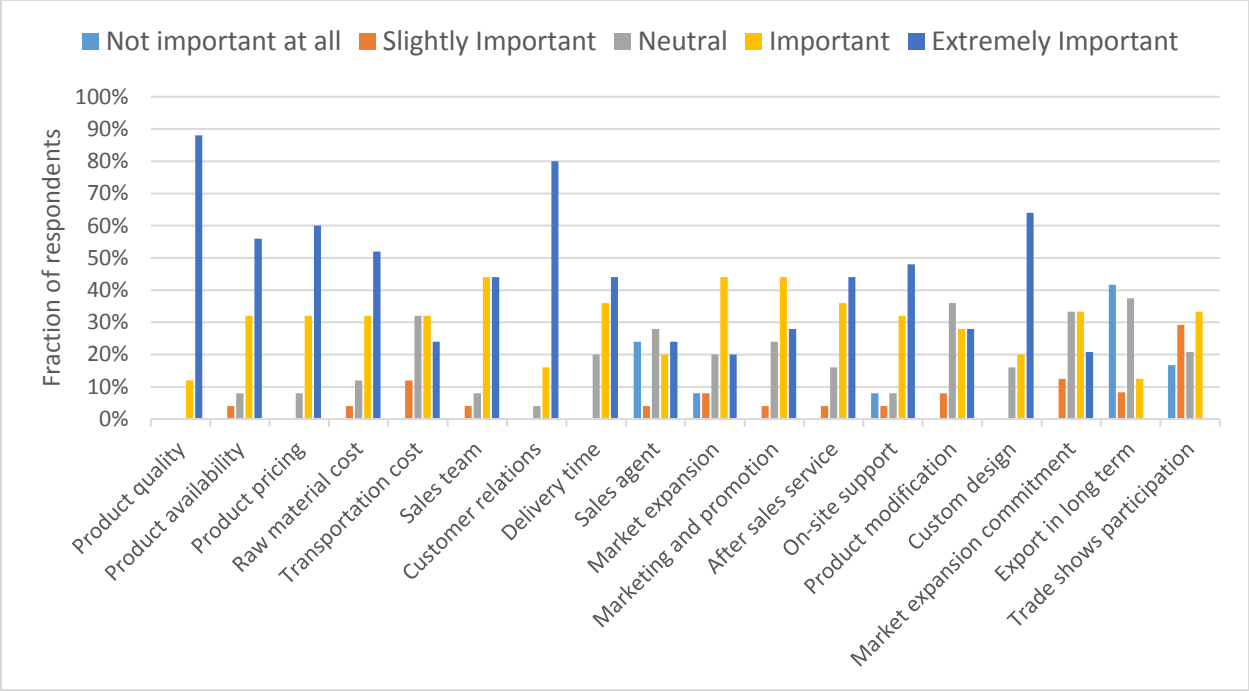


Figure 17 Survey Responses to Business Success Factors

Results indicate that product quality, customer relations and custom design are considered to be important business success factor across majority of the respondents. Product availability, product pricing, raw material cost, sales team, delivery time, after sales service, on-site support and product modification enjoyed medium importance. The respondents reported less importance on sales agents, product modification, commitment to market expansion, attending trade shows and export operations.

The respondents that reported have exported were also asked to rate the importance of each various barriers to export impacting the global operations. Figure 18 lists the percent of responses on a five point Likert scale rating anchored at not important at all and extremely important.

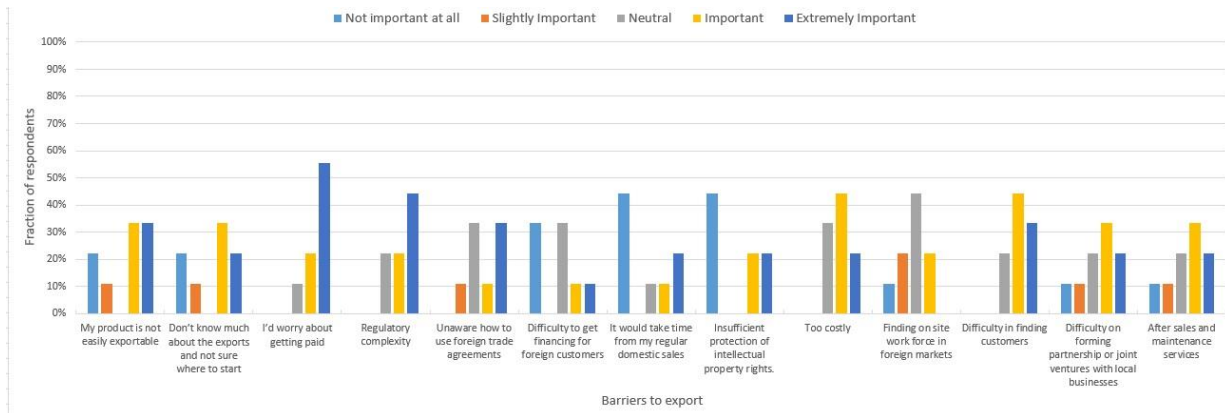


Figure 18 Survey Responses to Barriers to Export

Difficulty in getting paid, inability to use foreign trade agreements and regulatory complexity were the keys barriers identified by the respondents. Difficulty on forming partnership and providing after sales service were two factors with most diverse responses with rated as important. Majority of the respondents disagreed on exports taking time off their domestic sales and if there is a risk to their intellectual property by exporting their products.

As mentioned in the methodology section (section 4.3.2), the goal of this research was to assess behavior of participants based on the export status of the company. In this objective, the aim was to determine if the exporting and non-exporting firms actually represent two different populations. The data was determined to be ordinal. Thus examination was determined requiring median responses only. Contingency tables were then examined to test the hypothesis and shown in Table 14.

The analysis indicate that the two groups, exporting and non-exporting respondent companies statistically differentiate in the level of sales. With p-value of 0.078, Fisher's Exact test of independence indicates difference between the two groups based on their responses. The

findings also indicate a statistically significant difference (p-value 0.033) on the importance of looking at exports for long term sustenance of the business among non-exporting and exporting respondents. Based on this survey data, no other significant difference were found among the two categories of respondents using either Chi-square or Fisher's exact test.

Table 14 Hypothesis Testing using Chi-Squared and Fisher's Test

Hypothesis	Variable	Test statistic significant level	
		Pearson Chi-Square Asymp. Sig. (2-sided)	Fisher's Exact test Exact Sig. (2-sided)
H1	Employees	0.372 ^a	0.442 ^b
H2	Sales	0.096 ^a	0.078 ^{b**}
H3	Experience	0.173 ^a	0.204 ^b
H4	Value	0.203 ^a	0.203 ^b
H5	Growth	0.94 ^a	0.93 ^{b**}
H6a	Prod_qual	0.166 ^a	0.280
H6b	Prod_avail	0.5 ^a	0.726 ^b
H6c	Prod_pricing	0.492 ^a	0.455 ^b
H6d	Raw_mat_cost	0.397 ^a	0.482 ^b
H6e	Trans_cost	0.77 ^a	0.836 ^b
H6f	Sales_team	0.549 ^a	0.889 ^b
H6g	Cust_rel	0.634 ^a	0.758 ^b
H6h	Time_del	0.969 ^a	1 ^b
H6j	Sel_agent	0.762 ^a	0.918 ^b
H6k	Mark_expan	0.85 ^a	1 ^b
H6l	Mark_promo	0.552 ^a	0.744 ^b
H6m	Aftr_sale_serv	0.672 ^a	0.769 ^b
H6n	On_site_support	0.631 ^a	0.721 ^b
H6o	Prod_magn	0.567 ^a	0.64 ^b
H6p	Custom_design	0.634 ^a	0.712 ^b
H6q	Expansion_commit	0.998 ^a	1 ^b
H6r	Commit_Export	0.05 ^a	0.033 ^{b*}
H6s	Trade_shows	0.236 ^a	0.286 ^b

^a There were cells in crosstab with count less than 5. Thus Chisquare test should not be used.
^b Calculated using Monte Carlo simulation based on 10000 sampled tables
* Significant at 0.05 level
** Significant at 0.1 level

4.3 Objective 3

Nine respondents exported the system built wood houses. This represents less than 1 percent of the total population of this study. Thus the analysis and associated conclusions are intended to describe the interactions and behavior of factors determining the export venture's performance within the sample itself. The results can serve as a case study within the off-site residential wood construction industry in the U.S.

As mentioned in section 3.3.3, the first task in assessing the export venture performance for this objective was to measure the reliability. For each of the three constructs cited before, Cronbach's alpha coefficients were calculated and depicted in Table 15. Each of the constructs in turn consists of individual parameters being measured at Likert scaling through the survey. Factor 1, Resources available to the export venture, consist of 13 different parameters. Factor 2, Capabilities available to the export venture, also consist of 13 different parameters. Factor 3, Export venture competitive strategy, is being measured by 18 different parameters. In order to combine individual parameters to obtain single score of the construct, the responses on Likert scaling were added together for all the parameters within that construct. Table 22 in appendix F lists details of each construct and the parameters being used to measure that construct. Converting parameters within a construct to a single construct score was done in order to convert variables to a continuous measurement scale that in turn can be used for regression analysis. Since the coefficient for all the three constructs is above 0.7, these factors can be considered to be reliable (Carmines & Zeller, 1979). This also means that variables included in each of these factors yield coherent results throughout the sample using the Likert scaling system, and may be considered for future research.

Table 15 Cronbach's Alpha Coefficients

Construct	Cronbach's alpha coefficient
Resources available to the export venture	0.91
Capabilities available to the export venture	0.96
Export venture competitive strategy	0.94

With reliability of the constructs verified, the next step is to conduct regression analysis to determine relationship between these three factors on export venture performance. This task was performed using SAS JMP software. As mentioned earlier, the export venture performance was being measured by 4 different variables, two of which were categorized as financial and two as non-financial. Equation below summarize the regression model used to assess export venture performance.

$$EVP = R.A. + C.A. + C.S. + Constant + error$$

where, EVP = Export Venture Performance

R.A. = Resources available to the export venture

C.A. = Capabilities available to the export venture

C.S. = Export venture competitive strategy

Table 16 details the regression models developed using the data collected through the survey. Constructs developed through the theoretical model were used as independent variables (factors) and export venture performance evaluated through all the 4 response categories were used as dependent variables. Model statistics as described in Table 16 for export venture performance considering all 4 recorded variables was statistically insignificant with the p-value of 0.914. Moreover with R² of 0.091, the model could only explain 9.1 percent of the variability in export venture performance.

Table 16 Regression Models and Associated Coefficients for Each Independent Variable

Factors	Responses	
	Export venture performance (All Factors)	Export venture performance (Sales & Export Experience)
Resources available to the export venture	- 0.012	0.016
Capabilities available to the export venture	- 0.053	- 0.105
Export venture competitive strategy	- 0.029	- 0.021
Intercept	14.929	12.66
R ²	0.091	0.122
p-value	0.914	0.872

Table 16 also lists a second regression model for dependent variable export venture performance evaluated by just using just 2 parameters, sales and export experience. Remaining 2 parameters evaluating effect of exporting on venture were dropped as they both were a categorical in nature with yes/no responses. The model this obtained had an improved R² of 0.122 indicating it was capable of explaining 12.2 percent of variance in new export venture performance variable. But with the p-value of 0.872, the model was still not significant. It is also important to note here that none of the three independent factors reported a statistically significant relation with export venture performance in any of the two models.

4.4 Objective 4

While the system built wood construction industry in the U.S. strives to increase its market share, social housing market in developing countries offers a considerable opportunities. But in order to exploit this opportunity, the companies interested in entering this market need to understand not only just the consumer requirements but requisites from the perspectives of all the stakeholders involved in the housing value chain in target markets. The study of qualitative

and quantitative housing deficits in South America discussed in earlier sections of this report indicates a potential market opportunity for the U.S. system built wood construction industry to expand and internationalize but companies would need a guideline to what to strategize. The information collected in the first three objectives was compiled and summarized in the way that the system built wood housing manufacturers in the United States along with state and federal agencies assisting business expansion. This report can be used as a guideline to identify key factors that the stakeholders should look into when attempting to expand business by exporting to South America. Using the examples of urban social housing market in Peru, Columbia and Ecuador discussed in the report, the stakeholders can develop and initiate their own expansion plans by exporting the wood housing units built in the United States. The report introduces system built wood construction and current status of this industry in the United States. This is followed with the housing demand in the developing countries and focus on the buying potential of this market. The findings from this study covering urban social housing in Peru, Colombia and Ecuador are highlighted next. The observations put in spotlight the potential market opportunities for the developing affordable housing solutions for low-income households in developing countries. Appendix H covers the complete report.

5. Discussion

5.1 Exporting system built wooden houses

Pre-manufacturing of houses in a controlled environment and shipping them to the construction site is not a new idea. The United States being one of the largest producers and consumers of wood fiber is perfectly poised to lead the global market. But this industrialized wood construction sector has been losing ground over the past decade even in the domestic market to on-site construction. Considering this background, these companies could expand to niche international markets by developing specific products. The experience of manufacturing for domestic markets, efficient building guidelines, availability of efficient delivery networks, and favorable international trade treaties places the US manufacturers in a favorable position to export this type of housing solutions.

Economic problems for the construction market have become a global trend. However, even as the United States continues to grow at slow but steady rate, opportunities are emerging for international contractors in developing countries, particularly those rich in resources. At the same time, the rise of construction activity in developing countries has caused an increase in competition in global market. Due to the instability of the global economy, the international construction market has been continuously marginally shrinking in recent years. Engineering News Report (ENR)'s Top 225 International Contractors list indicates the global shift in the international construction market. The Top 225 as a group generated \$383.66 billion in 2010 contracting revenue from projects outside their home countries, which is slightly lower than 2008's figure of \$390 billion (Reina & Tulacz, 2011). Top 225's regional revenue breakdowns

also indicate that contractors are shifting their focus to new and emerging markets. International revenue fell 6.6% to \$94.18 billion in Europe. It also fell 6.6% in the Middle East to \$72.43 billion and 6.5% to \$32.61 billion in the U.S. By contrast, international contracting revenue rose 25.6% to \$34.05 billion in Latin America and in the Caribbean, 6.7% to \$60.59 billion in Africa and 4.7% to \$76.64 billion in Asia and Australia. This shift in focus is leading to upheaval for major international contractors (Reina & Tulacz, 2010). The shift could be caused by the growth of mining sectors and the associated infrastructure required in these countries. As a traditional developed country, United States plays an important role in the world. Many industrial sectors of the United States lead the world economy. Construction is one of these sectors. With the development of internationalization and globalization, the construction industry in developing world has become more involved in the international market. This is even more important for residential construction where suitable housing not just a requirement but a necessity for living a quality life. System built wood housing manufacturers are strategically poised to take advantage of this huge market share.

Entering new and untouched markets is also beneficial for the sector as highlighted in the literature review. Internationalization and exports can prove to be strategically important for the U.S. manufacturing companies as it offers access to high and strategically consistent market shares without investing heavily in capacity improvement. The companies can keep using their existing facilities and manufacture for international markets. This would also increase the existing revenue share for the system built housing industry from exports (\$226.8 million in 2015). Getting into export would also expand the existing export base of U.S. forest products sector. Exporting clearly requires a long-term outlook from the company. The decision to enter

the export market requires the manufacturer to commit sufficient managerial, economic, and financial resources to the task. Table 17 highlights major activities associated with exporting.

Table 17 Major Activities Associated with Exporting (Evans, 1990)

STEP 1 Management Commitment	STEP 2 Analyze objectives, strengths, and weaknesses 1. Short- and long-term goals 2. Personnel 3. Resources 4. Production 5. Financing 6. Knowledge of export Marketing	STEP 3 Develop contacts and collect current market information in the United States 1. U.S. Government and State agencies 2. Banks with international departments 3. Freight forwarders 4. Marine insurance agents 5. U.S. port authorities	STEP 4 Conduct market analysis 1. U.S. export statistics 2. Foreign import statistics 3. Current market developments and trends 4. Import barriers 5. Other factors (political, economic, geographic, and cultural)
	STEP 5 Country/market selection 1. Demand potential/ trends 2. Product identification 3. Standards and specifications and trends 4. Language requirements 5. Distribution channels 6. Business practices 7. Tariff and nontariff barriers 8. Licensing/phytosanitary requirements 9. Legal considerations 10. Shipping costs	STEP 6 Develop marketing approach targeted to every countries 1. Organization of the firm 2. Determine production 3. Contact foreign importers 4. Schedule marketing/ sales trip to the country or market	STEP 7 Trade servicing 1. Product development/ modification in response to changes in demand 2. Attention to importer's needs/ commitment to the market 3. Periodic visits to the market to maintain good customer relations and develop new contacts 4. Refine marketing Approach

Thus each company must weigh the advantages and disadvantages of exporting to determine if projected profits, possible losses, and inherent risks justify management's commitment to exporting.

Assessment of system built wood housing manufacturing industry in the United States conducted in this study highlighted some important findings:

- Industry can be characterized as small to medium sized firms with annual sales of \$7.4 billion (2015) and a profit of \$161.8 million. Share of exports for the same year was \$226.8 million.
- Internationalization within the industry is relatively low; most manufacturers operate domestically and sell within a relatively limited geographic scope. Transportation costs can go as high as 10% of total cost of the product.
- As mentioned before, international trade for industry products is negligible. Industry's performance in international trade is also impacted by the level of internationalization in upstream industries as they affect the availability and price of wood materials for system built home manufacturers.
- Findings show that firms acknowledge that exports offer growth opportunities. However, there exist various legal, economic and political risks associated with dealing in foreign countries.
- Product quality, customer relations and custom design are considered to be the most important business success factors.

- The companies that are currently exporting reported no negative impact of internationalization on their domestic sales. But the share of exports as compared to domestic sales is very limited.
- Majority of export currently done to Northern Asia and Pacific Rim region of the world.
- Companies that are not exporting currently also want to know more and export their product.

5.2 Market assessment

This study introduced the possibility of using prefabricated wood construction system developed in the United States to develop affordable alternatives to current construction practices in urban social housing. Table 18 summarizes findings across all the three countries. As highlighted before in the report, pre-fabrication in building helps in optimizing construction by reducing time, environmental effects, health and safety risks, building defects and its life cycle cost. The technique also increases net productivity, whole life performance and net profitability. The housing market deficit of the studied countries summarized in Table 4 shows an opportunity for innovative techniques to fulfil the gap. Wood pre-fabricated housing systems can be one of the possible alternatives. This generates an opportunity for such system manufacturers in the U.S. These manufacturers can take advantage by developing custom products for each housing market segment.

Due to urgent need and large scale of projects, social housing segment can prove to be a favorable segment. Existing trade channels and policies between the U.S. and these three countries would further support such expansion. The mode of entry depends upon the levels of

corporate control, internationalization cost and associated risk the company is willing to maintain. U.S. pre-fabricated system manufacturers can go international by exporting straight to the local builders with or without using intermediaries. Direct exporting would mean least investment risk and costs but lacks the control over supply chain.

Table 18 Summary of the findings

	Peru	Colombia	Ecuador
Identified housing deficit (fraction of total households)	72%	37%	50%
Government's concern to tackle social housing	Yes	Yes	Yes
Traditional construction method	Block and concrete	Block and concrete	Block and concrete
Preferred building type	Detached	Apartment buildings (Up to 5 floors)	Both detached and apartment homes
Average floor area of social housing (m ²)	20-25 m ²	20-30 m ²	45-60 m ²
Selling price of single family homes (USD)	\$25,000-\$45,000	\$16,000-\$32,000	< \$40,000 (social housing) \$40,000-\$70,000 (public housing)
Profitability of social housing projects	Average	Below average	Average
Use of wood in construction	Non-structural	Non-structural	Non-structural
Building code for wood	Absent	Present	Present
Restriction on using imported wood species	Yes	No	No
Awareness of use of wood in construction	Limited	Limited	Limited
Social perception of wood construction	Poor	Poor	Poor
Other probable markets	Mining displacement camps and housing in hilly regions	Projects with less than 250 units	Coastal and high seismic prone regions

Manufacturers from the U.S. can also make long term partnerships with local agencies to form joint ventures with certain level of ownership. Local partners can be responsible for providing access to residential construction market, site selection and development while the U.S. manufacturers could be responsible for developing and manufacturing the wood housing systems. This entry mode would involve higher costs of internationalization as compared to exports. The risk of failure now would be shared between both the partners. Joint venture involves formation of a separate legal entity. If any of the partner is not willing to do that, there is an option of formulating strategic alliance. It is very similar to joint ventures but does not involve formation of new organization. Another major entry mode that the companies in the U.S. can take is by establishing a wholly owned subsidiary. But this would require the U.S. companies to comply with local rules, adjust to local culture and language, accommodate to local economic conditions and expect support from local infrastructure.

5.3 Assessment of wood house manufacturers

The analysis of data collected by surveying the system built wood construction industry in the United States supports the key findings cited in the literature review. The respondents consisted of all the major sub-categories, namely, panelized, modular, log homes and mobile homes, of the system built wood construction industry. The industry is concentrated with small scale of operations. Though majority of the respondents have been in the business for long times (more than 10 years), investment in assets and manpower is limited. Average number of houses manufactured among the respondents each year was 74 units. Current level of exports among the respondents was low as well. Thirty six percent of the responding companies reported to have conducted any export at any point. Share of sales from exports was reported

to be low as well. Approximately 90 percent of the exporting respondents reported to have less than 10 percent of their total sales coming from exports. Majority of this export is done to Northern Asia and Pacific Rim region of the world. When asked about interest to get into exporting to those that are not currently exporting, 56 percent responded positively and wanted to learn more about international business expansion.

The survey findings also highlighted the perceived importance of various business success factors by the companies in this industry. Product quality, customer relations and custom design are considered to be the most important business success factor across majority of the respondents. Product availability, product pricing, raw material cost, sales team, delivery time, after sales service, on-site support and product modification enjoyed medium importance. The respondents reported less importance on sales agents, product modification, commitment to market expansion, attending trade shows and export operations. When analyzed the difference between exporting and non-exporting firms, level of sales and opinion on using exports as long-term business strategy were the only two factors that were found to be significantly different.

The survey also attempted to identify key barriers to export experienced by the companies in the industry. Difficulty in getting paid, inability to use foreign trade agreements and regulatory complexity were the keys barriers identified by the respondents. Difficulty on forming partnership and providing after sales service were two factors with most diverse responses with rated as important. Majority of the respondents disagreed on exports taking time off their domestic sales and if there is a risk to their intellectual property by exporting their products.

As discussed during the review of literature, the export performance measurement is influenced greatly by the nature of market studied and the way ventures are analyzed. A firm's performance, domestic or international depends upon its own characteristics and resources and the capabilities offered by the external factors. The means of using this information and developing an optimal business strategy also influences venture's performance. This study attempted to comprehend, not one, but multiple dimensions of the export performance problem. Individual factors determining each of these three factors were then combined together to form estimator constructs used to develop empirical relationship on the basis of the theoretical model. Construct's reliability determined beforehand assured the logic behind grouping the variables together in factors. These three independent factors were thus to be used for regression analysis to develop estimation models for each of the four indicators of export performance of a venture. Various approaches were used to improve the response rate. Few companies in the sample whose emails could be found by the research team were contacted again after the final sendoffs of questionnaire. Representatives of those companies were also contacted through other platforms like LinkedIn to participate in the study. The collected data was used to develop simple linear regression models assess relationship according to theoretical export venture assessment model between dependent and independent variables. Export venture performance as dependent variable was measured using 4 different parameters. With low response rate, individual regression analysis for all the factors was found to be statistically non-converging. Thus these 4 categories were in turn combined by adding the responses together. The results of first model reported in Table 16 are using export venture performance as a combined response variable. Second model reported in the same

table is using export venture performance as a combined response variable using only two parameters. One of these is financial (sales) and one non- financial (export experience). Findings showed that the ability of model to explain variance in response variable (i.e. Export Venture Performance) increased by almost 3 percent but both the model still failed to report a statistically significant relation at a p-value of less than 0.1.

One of the reasons regression results failed to report significant relationship could be because of low response rate for firms that are exporting. This is actually similar to the findings from literature review on current status of exports of system built wood construction systems from the United States. With reported revenue of under 3 percent, the level of internationalization is very low. Similar ratio was observed among the exporting and non-exporting respondents of the survey of the industry.

There are few other limitations to approach of this study. The findings reported are country specific and may not be used for other markets in the Latin American region. Some of the information collected could also be limited to selected stakeholder's perspective. Also, details of project parameters (design, cost, timeline, scale etc.) would vary from one city to the other even within the same country. Only the capital cities of each country were visited and taken as a representative of the low-income urban social housing market. Though country wide policy regulating and controlling the social housing sector would stay essentially the same, the market dynamics may change from region to region.

6. Conclusions

Strategic export planning in the world market can provide new jobs, greater income, and increased profitability for U.S. wood producers. A stronger forest products industry will lead to new investment in forest management, thus assuring a continuous supply of wood and fiber for the United States and its customers overseas. The identification and understanding of factors impacting exports of system built wood systems in the US is essential for the industry to shape successful marketing strategies supporting current and future exports. The advantages of exporting wood products include new marketing and financial opportunities, diversification of risk, and increased financial leverage and credit. In addition, revenue derived from export sales permits spreading fixed costs over a greater number of production units. Wider margins may be realized on higher valued products.

The purpose of this research was to identify opportunities to increase the market share of system built wood construction industry. Latin America offers a large undeveloped market for wood products. Due to preference and a general lack of knowledge about the use of wood in construction, this region is inclined to build with concrete and masonry materials. Historically, most markets hold a bias against wood and timber frame construction because of the effects of inferior perception, experience of using, weathering and termites on untreated softwood lumber. Use of system built wood construction for providing residential solutions can offer shorter construction cycles (compared to that for concrete and masonry), high insulation values, promotion of construction materials produced from renewable resources, and superior performance under adverse weather conditions. Such attributes should fit well into these

markets. In addition to these advantages, expansion of wood based construction encourages the potential for diversifying employment opportunities in both the markets.

A broader understanding of the urban social housing market of South America developed through this study can be used to characterize the market, develop strategies and identify problems that the U.S. manufacturers must confront in order to compete effectively in target markets. Using an exploratory approach, the research shed light on the key factors characterizing the urban social housing markets in the Peru, Colombia and Ecuador. Current policies governing economics, scale and the type of construction in the urban residential sector in these countries were recorded. Personal interviews with building and projects management companies along with the site visits were helpful for insight on the current construction practices in the region. This helped to identify key cultural features defining the residential construction and can be used to develop an export plan as shown in Table 17. Key findings from this study are:

- There exists a high, unmet demand for low cost houses in the urban regions of Peru, Colombia and Ecuador.
- There is a little interest to specifically develop for low-income markets among the local builders due to low profitability further expanding the deficit gap.
- Current trade policies, rising cost of construction and economic development of the region makes it a favorable market for expansion.
- The region lacks knowledge to use wood and its associated benefits as a construction material. Wood is labeled as cheap construction material with service and performance issues.

The companies decide their optimal entry mode based on the trade between ownership and associated risk. There is a need to educate about the benefits prior to entering the market to assure acceptance. This can be done by forming collaborations with government, builders, NGOs and project developers in the foreign market. Developing a hybrid design of traditional construction and wood prefabricated system may prove to be the most favorable blend. This would mean the manufacturers would need to work closely with the local builders. This would be largely depends upon the selection of entry mode by the company. Other markets segments such as disaster relief, or emergency relocation shelters in the regions can also be looked at by the U.S. manufacturers as possible market segments. The social housing market is further divided into variety of market segments each requiring tailored products and approaches.

Key areas identified in this study at which the system built industry in the United States should concentrate on as moving forward.

- **Increase the market share**

The system built wood construction industry in the United States needs to communicate the value in better way to residential consumers. Current market share highlights this need. Without this added value proposition, the industry will eventually lose ground to traditional on-site construction. Product quality, customer relations and custom design were the three most important success factors for the industry in this research. The companies should built on these performance measures while improving their market share.

- **Industry collaboration and integration**

One of the key barriers hindering the progress of this industry identified in this research was lack of sufficient collaborative efforts. It is particular not to just the system built sector but all of

the residential construction industry. This was further supported by this work that identified knowledge and information related factors preventing foreign trade. The majority of the companies surveyed in this research lack required knowledge for using foreign trade agreements and associated regulatory complexity. Difficulty on forming partnership and providing after sales service were other two important barriers to exports. The companies can come together and work on these issues collaboratively with a comprehensive focus of improving long term acceptance both in domestic and international market.

- **New markets and market segment**

Findings from the research indicate that the sector needs to increase its market share in residential construction market as compared to the other developing countries in Europe and North America. It is clear that more research and development needs to be conducted both to develop product and market. This would help the industry to gain confidence of stakeholders and move to a widely appreciated technique. Some of the current requirements include further improving design and manufacturing capabilities to develop custom products both for domestic and international markets. The companies also need to invest in researching new and innovative ways to convey the benefits of off-site wood construction and hence convince more customer to use it.

- **Need for better guidance and communication**

The industry should work on developing a best practices guide that includes all the information regarding performance, quality, materials to be used, dictating construction codes and benefits of projects preventing confusions of owners, professionals and associated jurisdiction authorities. It is also important to have consensus of all the stakeholders and use regular

communication during marketing, development and promotion of system built wood construction projects.

Specific Recommendations

- Develop extensive programs and marketing strategies to introduce system built wood construction manufactured in the United States targeted for specific markets. Such programs should be directed at informing and educating all stakeholders associated to social housing market. This should include but not limited to builders, consumers, suppliers, government official and policy makers as key stakeholders who would need to be informed of the benefits of using off-site construction. This might include project demonstrations, information on performance of such systems, educational activities and developing partnerships.
- Use existing manufacturing and export of wood housing systems all over the world to develop benchmarks and identify best business practices.
- Analyze social perceptions, current construction practices used in new markets or specific market segments and use the information for developing custom design and production systems.
- Demonstrate risks and returns of system built wood construction solutions compared to traditional construction.
- Develop easy to use custom guidelines both for domestic and international markets for the stakeholders to use and make informed decisions on incorporating system built wood construction solutions into projects. It should include design principles, performance

guidelines, building strategies, project timelines to be used as tools to support strategies and associated decisions.

- Provide overview of manufacturing and supply capabilities of the industry in United States to be used by associations and trade groups in foreign markets. This also includes developing long term associations.

Develop long term plans for internationalization of U.S. manufacturing. Identify partners, develop associations and develop investment roadmap aiming to make a successful export business model.

Specific strategies that can be implemented in studied market of urban social housing in Peru, Ecuador and Colombia

- Develop awareness programs by partnering with stakeholders in target markets with an aim to educate on benefits of wood construction. These programs should be designed and implemented specifically for each of the stakeholders in social housing value chain to the foreign market. Programs developed for government should aim at assisting policy and regulatory framework for using wood construction. Programs for construction companies and builders should intend to introduce principles of wood construction and associated design parameters used in residential construction in the United States. There should also be programs for the final consumers to help improve the perception of use of wood in construction. This can include but not limited to different demonstration projects, development of education materials in local language highlighting risks and returns associated with prefabrication of wood construction.

- Based on the inputs from stakeholders, develop a roadmap with key indicators impacting decisions to use wood prefabrication from beginning to the end. This should include development of custom design parameters depending upon the local environmental conditions and selection of appropriate materials. There should also be tools in place incorporate efficient certification systems in place assure uniformity and replicability in future projects. This can be done by using construction code in the U.S. and that of the target market.
- The companies in the United States interested in exporting to these markets should also work closely to understand local building criteria, bidding strategies, project economics and critical stakeholders in the complete value chain.
- Develop product performance parameters acceptable in foreign market. These product performance standards for structural testing, serviceability, consumer perception, durability and protection, social acceptability, energy and environmental performance, fire and seismic performance, acoustic performance and onsite installation and after sales performance.
- Since a single manufacturer in the U.S. might not be able to be able to invest in all of the above mentioned recommendations, formation of a consortium or an association of the companies dedicated to working closely with the stakeholders in foreign markets in mapping out and identifying key actors. The findings from interviews conducted in this study according to agendas attached along can act as a guideline in drafting the initial planning.

- The association of manufacturers in the United States should also work on developing an overview of existing manufacturing capabilities and identify major companies that have the capacity to export.

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Appendix A: Housing starts in the United States

Table 19 Type of Construction Method of New Single-Family Houses Completed in the United States

Year	Number of houses (in thousands)				Percent distribution			
	Total	Site-built	Modular	Other (Panelized and precut)	Total	Site-built	Modular	Other (Panelized and precut)
1992	964	903	33	28	100%	94%	3%	3%
1993	1,039	978	32	29	100%	94%	3%	3%
1994	1,160	1,093	38	30	100%	94%	4%	3%
1995	1,066	1,001	35	29	100%	93%	4%	3%
1996	1,129	1,059	37	32	100%	94%	3%	3%
1997	1,116	1,046	40	30	100%	94%	3%	3%
1998	1,160	1,082	44	34	100%	94%	3%	2%
1999	1,270	1,197	40	34	100%	94%	3%	3%
2000	1,242	1,163	40	39	100%	95%	3%	2%
2001	1,256	1,184	42	30	100%	95%	3%	2%
2002	1,325	1,246	46	33	100%	96%	3%	2%
2003	1,386	1,313	41	33	100%	95%	2%	2%
2004	1,532	1,454	42	36	100%	96%	3%	2%
2005	1,636	1,565	44	26	100%	95%	3%	2%
2006	1,654	1,579	40	35	100%	96%	2%	2%
2007	1,218	1,166	31	22	100%	95%	2%	2%
2008	819	779	23	17	100%	96%	2%	2%
2009	520	497	11	12	100%	96%	2%	2%
2010	496	473	12	12	100%	96%	2%	2%
2011	447	427	10	10	100%	97%	2%	1%
2012	483	465	8	9	100%	94%	3%	3%
2013	569	548	11	10	100%	94%	3%	3%
2014	620	601	10	8	100%	94%	4%	3%

Components may not add to totals because of rounding. Percent computed from unrounded figures (U.S. Census Bureau, 2016).

Appendix B: System built wood housing assessment survey

Table 20 Survey Population and Sample Description

<u>State</u>	<u>Population</u>	<u>Sample</u>	<u>State</u>	<u>Population</u>	<u>Sample</u>	<u>State</u>	<u>Population</u>	<u>Sample</u>
Alaska	23	7	Massachusetts	15	4	Ohio	111	36
Alabama	49	16	Maryland	53	17	Oklahoma	31	10
Arkansas	28	9	Maine	26	8	Oregon	80	26
Arizona	64	21	Michigan	153	50	Pennsylvania	159	52
California	283	93	Minnesota	71	23	Rhode Island	1	1
Colorado	116	38	Missouri	54	17	South Carolina	75	24
Connecticut	7	2	Mississippi	32	10	South Dakota	11	3
Delaware	21	6	Montana	82	27	Tennessee	91	30
Florida	213	70	North Carolina	97	32	Texas	211	69
Georgia	63	20	North Dakota	10	3	Utah	30	9
Iowa	31	10	Nebraska	21	6	Virginia	89	29
Idaho	36	11	New Hampshire	29	9	Vermont	17	5
Illinois	81	26	New Jersey	29	9	Washington	83	27
Indiana	109	35	New Mexico	19	6	Wisconsin	106	34
Kansas	16	5	Nevada	20	6	West Virginia	25	8
Kentucky	51	16	New York	94	31	Wyoming	21	6
Louisiana	29	9						

Appendix C: Survey Instruments: Phase 1

Social Housing: "Social housing is an umbrella term referring to rental housing which may be owned and managed by the state, by non-profit organizations, or by a combination of the two, usually with the aim of providing affordable housing". (Wikipedia)

Builders/ Construction companies:

1. Does your company participate in Social Housing projects?

- Yes
 No

1.1 If yes, which scheme(s) funded the project? _____

2. Specifications of the most recent social housing project undertaken:

	Type 1	Type 2	Type 3
2.1 Number of houses			
2.2 Floor to Area ratio			
2.3 Time taken to complete the project (in years)			
2.4 Cost of each house (in Peruvian Nuevo Sol)			

Details:

	Floor area (in m ²)	Number of bed rooms	Other specifications if any
Type 1:	_____	_____	_____
Type 2:	_____	_____	_____
Type 3:	_____	_____	_____

3. What are the shares of each activities in the total cost of an average house (in percentage)?

Please note that the total should be 100%

Land Cost	Material Cost	Construction Cost	Financing Cost	Other cost	Total
_____	_____	_____	_____	_____	100
					%

4. How do you rate use of wood as structural component of residential houses?

- Strongly favor
 Favor
 Neutral
 Oppose
 Strongly oppose

5. Do you know about prefabricated panelized wooden houses?

- Yes
 No

Respondent Information:

Name: _____

Company: _____

Designation: _____

Email address: _____

Social Housing: "Social housing is an umbrella term referring to rental housing which may be owned and managed by the state, by non-profit organizations, or by a combination of the two, usually with the aim of providing affordable housing". (Wikipedia)

Construction material suppliers:

1. Do you provide raw material for social housing projects?
 Yes
 No
If yes, how much of your annual share of sales comes from social housing?
_____ (in Percent)

2. Do you get adequate logistics and manpower support to supply?
 Yes
 No

3. What are the top three construction materials you supply?
a) _____
b) _____
c) _____

4. How do you rate use of wood as structural component of residential houses?
 Strongly favor
 Favor
 Neutral
 Oppose
 Strongly oppose

5. Do you know about prefabricated panelized wooden houses?
 Yes
 No

Respondent Information:

Name: _____

Company: _____

Designation: _____

Email address: _____

Social Housing: "Social housing is an umbrella term referring to rental housing which may be owned and managed by the state, by non-profit organizations, or by a combination of the two, usually with the aim of providing affordable housing". (Wikipedia)

Government agencies

1. What are the existing programs to support Social Housing projects for low income people?
 - a) _____
 - b) _____
 - c) _____
 - d) _____

2. How do you rate current practices in achieving the target of reducing housing deficit?
 Very efficient
 Efficient
 Neutral
 Inefficient
 Very inefficient

3. How do you rate current policies in support of foreign investment in affordable housing?
 Strongly favor
 Favor
 Neutral
 Oppose
 Strongly oppose

4. Do you think an alternate construction method different from traditional practices can be used to generate an affordable housing option for low income people?
 Yes
 No

5. Do you know about prefabricated panelized wooden houses?
 Yes
 No

Respondent Information:

Name: _____

Department: _____

Designation: _____

Email address: _____

Social Housing: "Social housing is an umbrella term referring to rental housing which may be owned and managed by the state, by non-profit organizations, or by a combination of the two, usually with the aim of providing affordable housing". (Wikipedia)

Project Developers/Investors

1. Do you deal with foreign suppliers for housing projects?
 Yes
 No

2. How do you rate investment returns from social housing projects as compared to other residential construction projects? (Select one)
Good _____ Neutral _____ Bad _____

3. Are social housing projects profitable?
 Yes
 No

4. Rate the problems associated with social housing projects in order of their extent. (1 to 4 ; 1 being most affecting, 4 being least affecting)
 Land Availability and cost
 Lack of incentives and financing mechanisms
 High construction costs
 Long project durations

5. Do you know about prefabricated panelized wooden houses?
 Yes
 No

Respondent Information:

Name: _____

Company: _____

Designation: _____

Email address: _____

Appendix D: Survey supporting documents: Phase 2



Sustainable Biomaterials
Brooks Center (0503), 1650 Research Tech Drive
Blacksburg, Virginia 24061
540/231-0978 Fax: 540/231-8868
E-mail: quesada@vt.edu
www.sblo.vt.edu

March 21st, 2017

Dear Participant,

My name is Gaurav Kakkar, a graduate research assistant and MS candidate at the Department of Sustainable Biomaterials, CNRE, Virginia Tech. I am writing to ask your help in a study aimed at assessing and improving exports of prefabricated wood building systems. You are requested to participate by completing the attached questionnaire.

Your company was selected because it is considered as prefabricated wood building manufacturer according to NAICS classification. The selection was made randomly from all the companies in the United States with same classification.

Results from the survey will be useful to estimate the export capabilities of the manufacturers in the United States. They will also be useful in identifying barriers and drivers to export of wood construction systems. The information will be helpful for the industry to understand the performance of its current export business and in developing new export corridors. The results will be disseminated through workshops, journal articles, newsletters etcetera.

Your answers are completely confidential and only aggregated data will be used for reporting purposes. When you return your completed questionnaire, your name will be deleted from the mailing list and will never be connected to your answers. The participation in this survey is voluntary. The survey questionnaire have been reviewed by Institutional Review Board (IRB) at Virginia Tech.

If you have any questions or comments about this study, please contact Gaurav Kakkar by email at kakkarg@vt.edu, by phone at +1-540-808-7183 or at the address on the letterhead.

Thank you very much for helping with this important study.

Sincerely,

Gaurav Kakkar
Graduate Research Assistant
Department of Sustainable Biomaterials
Virginia Tech
Phone: (540) 808-7183
Email: kakkarg@vt.edu

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

Figure 19 Cover Letter for 1st Wave of Surveys

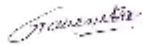
Two weeks ago you were mailed a questionnaire seeking your experience of selling prefabricated wood construction systems in domestic and foreign markets. Your company was randomly selected from a list of Prefabricated Wood Building Manufacturing companies in the United States.

If you have already completed and returned, please accept my sincere thanks. If not, please do at your earliest convenience. I am especially grateful for your help because it's the information from your experience that would make this study a success and in turn help the industry.

If you did not receive a questionnaire, or if it was misplaced, please contact me and I'll mail another copy to you.

Thanks.

Sincerely,



Gaurav Kakkar
Graduate Research Assistant
Department of Sustainable Biomaterials
Virginia Tech
Phone: (540) 808-7183
Email: kakkarg@vt.edu

Figure 20 Reminder/ Thanking Postcard



VirginiaTech
College of Natural Resources and
Environment

Sustainable Biomaterials
Brooks Center (0503), 1650 Research Tech Drive
Blacksburg, Virginia 24061
540/231-0978 Fax: 540/231-8868
E-mail: quesada@vt.edu
www.sblo.vt.edu

April 18th, 2017

Dear Participant,

My name is Gaurav Kakkar, a graduate research assistant and MS candidate at the Department of Sustainable Biomaterials, CNRE, Virginia Tech. About 4 weeks ago, I sent you a questionnaire that asked about your experience of prefabricated wood building systems trade. To the best of my knowledge, it's not been returned yet.

The responses that I have received so far have identified multiple factors affecting exports. The companies who are already exporting and the companies who are not have described their experiences in both domestic and international markets. I think the findings would be very useful for the industry.

I am writing again because of the importance that your response has for helping to get accurate results. Although I sent these questionnaires to companies in every state of the US, it's only by hearing from nearly everyone in the sample that we can be sure that the results are truly representative. In case you don't have the previous questionnaire, please use the attached questionnaire instead to respond.

A comment on the survey procedure. Your answers are completely confidential and only aggregated data will be used for reporting purposes. When you return your completed questionnaire, your name will be deleted from the mailing list and will never be connected to your answers. The participation in this survey is voluntary. The survey questionnaire have been reviewed by Institutional Review Board (IRB) at Virginia Tech.

I hope that you fill out and return the survey questionnaire soon, but if for any reason you prefer not to answer it, please let me know by returning a note on the blank questionnaire in the provided enclosed envelope.

If you have any questions or comments about this study, please contact Gaurav Kakkar by email at kakkarg@vt.edu, by phone at +1-540-808-7183 or at the address on the letterhead.

Sincerely,

Gaurav Kakkar
Graduate Research Assistant
Department of Sustainable Biomaterials
Virginia Tech
Phone: (540) 808-7183
Email: kakkarg@vt.edu

Invent the Future

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Figure 21 Cover letter for 2nd Wave of Surveys.

Appendix E: Survey Instrument and variable description: Phase 2



Questionnaire

Social housing in Latin America: Opportunities for US prefabricated wooden building manufacturers

In an effort to assess and improve export markets of prefabricated wood construction, Virginia Tech's Department of Sustainable Biomaterials needs your help to complete the enclosed questionnaire.

The purpose of this survey is to identify export activities of prefabricated wood building manufacturers in the United States.

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

The participation in this survey is voluntary. Yours and your firm's identity will not be disclosed in any communications from this study. The survey instrument have been reviewed by Institutional Review Board (IRB) at Virginia Tech.

This research is being conducted by Gaurav Kakkar, Graduate Research Assistant and MS student in Department of Sustainable Biomaterials at Virginia Tech, Blacksburg, VA.

If you have any questions/comments about this study, please contact Gaurav Kakkar by email at kakkarg@vt.edu or by phone at +1-540-808-7183

1. Do you manufacture prefabricated wood building systems?

- Yes (Continue to next question)
- No (End of survey, please return)

2. What percentage of the following systems do you manufacture?

- Panelized systems _____%
- Modular systems _____%
- Precut Systems _____%
- Log Cabins homes and buildings _____%
- Other: _____%

(The total should equal to 100%)

3. What percentage of your company's products correspond to following sectors?

- Residential _____%
- Commercial _____%
- Other: _____%

(The total should equal to 100%)

4. How many full time employees are currently employed by your business?

- | | |
|--------------------------------|---|
| <input type="checkbox"/> 1-4 | <input type="checkbox"/> 50-99 |
| <input type="checkbox"/> 5-9 | <input type="checkbox"/> 100-249 |
| <input type="checkbox"/> 10-19 | <input type="checkbox"/> 250-500 |
| <input type="checkbox"/> 20-49 | <input type="checkbox"/> Greater than 500 |

5. What were your gross sales or revenues for your most recent fiscal year (2016)?

- | | |
|--|---|
| <input type="checkbox"/> 0-\$500,000 | <input type="checkbox"/> \$10-20 Million |
| <input type="checkbox"/> \$500,000-1 Million | <input type="checkbox"/> \$20-50 Million |
| <input type="checkbox"/> \$1-2.5 Million | <input type="checkbox"/> \$50-100 Million |
| <input type="checkbox"/> \$2.5-5 Million | <input type="checkbox"/> Greater than \$100 Million |
| <input type="checkbox"/> \$5-10 Million | |

6. What is the estimate of the total value of your company (including assets)?

- | | |
|--|---|
| <input type="checkbox"/> 0-\$500,000 | <input type="checkbox"/> \$10-20 Million |
| <input type="checkbox"/> \$500,000-1 Million | <input type="checkbox"/> \$20-50 Million |
| <input type="checkbox"/> \$1-2.5 Million | <input type="checkbox"/> \$50-100 Million |
| <input type="checkbox"/> \$2.5-5 Million | <input type="checkbox"/> Greater than \$100 Million |
| <input type="checkbox"/> \$5-10 Million | |

7. How many homes did your company manufacture in a year on average?

Number: _____

8. What is the average size of homes produced by your company in sq. ft.?

_____ sq. ft.

9. How many years has your company been in business?

- | | |
|--|---|
| <input type="checkbox"/> 5 years or less | <input type="checkbox"/> 11-20 years |
| <input type="checkbox"/> 6-10 years | <input type="checkbox"/> More than 20 years |

10. What has been your average sales growth per year for past 5 years?

- | | |
|---------------------------------------|---|
| <input type="checkbox"/> Less than 1% | <input type="checkbox"/> 11-15% |
| <input type="checkbox"/> 1-5% | <input type="checkbox"/> 16-20% |
| <input type="checkbox"/> 6-10% | <input type="checkbox"/> Greater than 20% |

11. What is the average distance of your domestic deliveries?

- | | |
|--|--|
| <input type="checkbox"/> 0-100 Miles | <input type="checkbox"/> 300-400 Miles |
| <input type="checkbox"/> 100-200 Miles | <input type="checkbox"/> 400-500 Miles |
| <input type="checkbox"/> 200-300 Miles | <input type="checkbox"/> More than 500 miles |

12. What is the share of average expense for delivering the product in final product cost?

_____ (In percent)

13. What are the frequently used mode of transportation by your company?

- Contract trucking _____%
- Company owned trucking _____%
- Customer Trucking _____%
- Rail _____%
- Other: _____%

(Select all that apply and give percentage of share)

14. Have you focused any of your manufacturing efforts in developing low income housing products?

- Yes
- No

15. If yes, which markets were they for?

- Foreign
- Domestic

16. Please rate the importance of the following factors for your business success (Select one)

Business success factors	Not important at all	Slightly Important	Neutral	Important	Extremely Important
a. Product Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Product availability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Product Pricing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Raw Material costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Transportation costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Sales team	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Customer relations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Timely delivery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Selecting agents/distributors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Market expansion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. Marketing and promotions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. After sales services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
m. On-site support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
n. Product modification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
o. Custom designs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
p. Commitment to expand markets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
q. Exports in long term sustenance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
r. Participation in trade shows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17. Do you export to foreign markets?

- Yes
- No

18. If not exporting, would you be interested in selling your product to a foreign customer in future?

- Yes
- No

The following section involves those firms that export. If you do not export, please submit your questionnaire now. Thank you.

19. What percentage of your business sales is from exporting?

- Less than 10%
- 10-25%
- 25-50%
- 50-75%
- More than 75%

20. Which regions have you ever exported? (Select all that apply)

- North America
- South Africa
- South America
- Central America
- Northern Asia and Pacific Rim
(China/Japan/Taiwan)
- Western Europe
- Eastern Europe
- Middle East
- Southern Asia (India/Indonesia/Malaysia)
- Other: _____

21. How many years have you been exporting prefabricated wood building systems?

- Less than 5 years
- 6-10 years
- 11-20 years
- More than 20 years

22. Have you increased your number of employees and/or manufacturing capacity because of exporting?

- Yes
- No

23. What is primary distribution channel you use to sell prefabricated wood houses?

- Direct (through Internet)
- Direct (Through sales team)
- Direct (Catalogue)
- Wholesaler/Distributor
- Dealer
- Other: _____

24. Please rate the importance of the following factors impacting transport and delivery (Select one)

Transportation and delivery factors	Not important at all	Slightly Important	Neutral	Important	Extremely Important
a. Transportation medium selection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Having a good freight forwarder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Use of personal agent in foreign market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Having good customs broker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Point of entry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. United States government regulations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Foreign nation's government regulations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Documentation process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Knowledge of exporting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Transportation cost	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. Product security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. Product Labeling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
m. Delays in delivery to foreign markets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

25. Please rate following barriers to selling your product to foreign markets.

Barriers to export	Not important at all	Slightly Important	Neutral	Important	Extremely Important
a. My product is not easily exportable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Don't know much about the exports and not sure where to start	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. I'd worry about getting paid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Regulatory complexity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Unaware how to use foreign trade agreements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Difficulty to get financing for foreign customers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. It would take time from my regular domestic sales	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Insufficient protection of intellectual property rights.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Barriers to export	Not important at all	Slightly Important	Neutral	Important	Extremely Important
i. Too costly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Finding on site work force in foreign markets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. Difficulty in finding customers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. Difficulty on forming partnership or joint ventures with local businesses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
m. After sales and maintenance services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

26. Any other experiences related to the exporting of prefabricated wood buildings that you are willing to share.

*****Thank you for taking the time to participate in this survey. 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.

Sincerely,
 Gaurav Kakkar
 Graduate Research Assistant
 Department of Sustainable Biomaterials
 Virginia Tech
 Phone: (540) 808-7183
 Email: kakkarg@vt.edu

Request for Information

Please send a copy of the study results to the address listed below.

Name _____
 Address _____

Table 21 Variable Description for the Questionnaire

Question	Survey Section	Factor	Variable Label	Variable ID	Description	Response	Type
01	General Information	-	Manufacturer	VAR1	Groups respondents in system built housing manufacturers and non-manufacturers	Yes/No	Categorical
02	General Characteristics of the company	-	Panelized_sys	VAR2.1	Manufacturing share of panelized systems in firm's total share	Percent	Continuous
02	General Characteristics of the company	-	Modular_sys	VAR2.2	Manufacturing share of modular systems in firm's total share	Percent	Continuous
02	General Characteristics of the company	-	Precut_sys	VAR2.3	Manufacturing share of Precut systems in firm's total share	Percent	Continuous
02	General Characteristics of the company	-	Log_sys	VAR2.4	Manufacturing share of Log systems in firm's total share	Percent	Continuous
02	General Characteristics of the company	-	Others_sys	VAR2.5	Manufacturing share of other systems in firm's total share that have not been listed before	Percent	Continuous
03	General Characteristics of the company	-	Residential_sys	VAR3.1	Residential market share catered by the company	Percent	Continuous
03	General Characteristics of the company	-	Commercial_sys	VAR3.2	Commercial market share catered by the company	Percent	Continuous
04	General Characteristics of the company	-	Employees	VAR4	Full time employees in the company	Selection	Ordinal
05	General Characteristics of the company	-	Sales	VAR5	Gross sales or revenue in the company	Selection	Ordinal

06	General Characteristics of the company	-	Value	VAR6	Total value of the company	Selection	Ordinal
07	General Characteristics of the company	-	Number_homes	VAR7	Average number of homes manufactured by the company in a year.	Number	Continuous
08	General Characteristics of the company	-	Size_home	VAR8	Average size of homes manufactured by the company in sq. ft.	Number	Continuous
09	General Characteristics of the company	-	Experience	VAR9	Years for which the company have been in operation	Selection	Ordinal
10	General Characteristics of the company	E.V.P	Growth	VAR10	Average Annual sales growth rate for past 5 years	Selection	Ordinal
11	General Characteristics of the company	-	Distance_del	VAR11	average distance of your domestic deliveries	Selection	Ordinal
12	General Characteristics of the company	-	Trans_cost	VAR12	Share of transportation cost in final product cost	Percent	Continuous
13	General Characteristics of the company	-	Contract_truc	VAR13.1	Share of contractual trucking from the total transportation	Percent	Continuous
13	General Characteristics of the company	-	Comp_truc	VAR13.2	Share of company owned trucking from the total transportation	Percent	Continuous
13	General Characteristics of the company	-	Customer_truc	VAR13.3	Share of customer trucking from the total transportation	Percent	Continuous
13	General Characteristics of the company	-	Rail	VAR13.4	Share of rail cars from the total transportation	Percent	Continuous
13	General	-	other	VAR13.5	Share of other modes of	Percent	Continuous

	Characteristics of the company				transportation from the total transportation		
14	General Characteristics of the company	-	Low_inc_hous	VAR14	Manufacturing efforts of housing for low income housing	Yes/No	Categorical
15	General Characteristics of the company	-	Foreign/domes	VAR15	If yes, low income housing whether for foreign or domestic markets	selection	Categorical
16.a	Business success factors	C.S.	Prod_qual	VAR16.1	Perceived importance of Product Quality	Selection	Ordinal
16.b	Business success factors	C.S.	Prod_avail	VAR16.2	Perceived importance of Product availability	Selection	Ordinal
16.c	Business success factors	C.S.	Prod_pricing	VAR16.3	Perceived importance of Product Pricing	Selection	Ordinal
16.d	Business success factors	C.S.	Raw_mat_cost	VAR16.4	Perceived importance of Raw Material costs	Selection	Ordinal
16.e	Business success factors	C.S.	Trans_cost2	VAR16.5	Perceived importance of Transportation costs	Selection	Ordinal
16.f	Business success factors	C.S.	Sales_team	VAR16.6	Perceived importance of Sales team	Selection	Ordinal
16.g	Business success factors	C.S.	Cust_rel	VAR16.7	Perceived importance of Customer relations	Selection	Ordinal
16.h	Business success factors	C.S.	Time_del	VAR16.8	Perceived importance of Timely delivery	Selection	Ordinal
16.i	Business success factors	C.S.	Sel_agent	VAR16.9	Perceived importance of Selecting agents/distributors	Selection	Ordinal
16.j	Business success factors	C.S.	Mark_expan	VAR16.10	Perceived importance of Market expansion	Selection	Ordinal
16.k	Business success factors	C.S.	Mark_promo	VAR16.11	Perceived importance of Marketing and promotions	Selection	Ordinal
16.l	Business success factors	C.S.	Aftr_sale_serv	VAR16.12	Perceived importance of After sales services	Selection	Ordinal
16.m	Business success factors	C.S.	On_site_support	VAR16.13	Perceived importance of On-site support	Selection	Ordinal

16.n	Business success factors	C.S.	Prod_magn	VAR16.14	Perceived importance of Product modification	Selection	Ordinal
16.o	Business success factors	C.S.	Custom_design	VAR16.15	Perceived importance of Custom designs	Selection	Ordinal
16.p	Business success factors	C.S.	Expansion_commit	VAR16.16	Perceived importance of Commitment to expand markets	Selection	Ordinal
16.q	Business success factors	C.S.	Commit_Export	VAR16.17	Perceived importance of Exports in long term sustenance	Selection	Ordinal
16.r	Business success factors	C.S.	Trade_shows	VAR16.18	Perceived importance of Participation in trade shows	Selection	Ordinal
17	General Characteristics of the company	-	Export_status	VAR17	Current export status of the company	Yes/No	Categorical
18	General Characteristics of the company	-	Export_inter	VAR18	Interest on exporting in future	Yes/No	Categorical
19	General Characteristics of the company	E.V.P	Export_share	VAR19	Share of business sales from exporting	Selection	Ordinal
20	General Characteristics of the company	-	Export region_NAmerica	VAR20.1	Export to North American region	Selection	Categorical
20	General Characteristics of the company	-	Export region_Safrica	VAR20.2	Export to South Africa region	Selection	Categorical
20	General Characteristics of the company	-	Export region_Samerica	VAR20.3	Export to South American region	Selection	Categorical
20	General Characteristics of the company	-	Export region_CAmerica	VAR20.4	Export to Central American region	Selection	Categorical
20	General Characteristics of the company	-	Export region_Nasia	VAR20.5	Export to Northern Asia and Pacific Rim (China/Japan/Taiwan)	Selection	Categorical

20	General Characteristics of the company	-	Export region_Weurope	VAR20.6	Export to Western European region	Selection	Categorical
20	General Characteristics of the company	-	Export region_Eeurope	VAR20.7	Export to Eastern European region	Selection	Categorical
20	General Characteristics of the company	-	Export region_Meast	VAR20.8	Export to Middle Eastern region	Selection	Categorical
20	General Characteristics of the company	-	Export region_Sasia	VAR20.9	Export to South Asian region	Selection	Categorical
20	General Characteristics of the company	-	Export region_others	VAR20.10	Export to regions not listed above	Selection	Categorical
21	General Characteristics of the company	E.V.P	Export_exper	VAR21	Period for which the company have been exporting	Selection	Ordinal
22	General Characteristics of the company	E.V.P	Employ_increase	VAR22	Increase in number of employees due to export	Yes/No	Categorical
23	General Characteristics of the company	-	Distrib_channel	VAR23	Primary distribution channel used to export	Selection	Categorical
24.a	Transport and delivery	C.A	Trans_med_selection	VAR24.1	Perceived importance of transportation medium selection	Selection	Ordinal
24.b	Transport and delivery	C.A	Freight_forward	VAR24.2	Perceived importance of selecting a good freight forwarder	Selection	Ordinal
24.c	Transport and delivery	C.A	personal_agent	VAR24.3	Perceived importance of using personal agent in foreign market	Selection	Ordinal
24.d	Transport and delivery	C.A	Customs_broker	VAR24.4	Perceived importance of having a good customs broker	Selection	Ordinal
24.e	Transport and delivery	C.A	Point_of_entry	VAR24.5	Perceived importance point of entry	Selection	Ordinal

24.f	Transport and delivery	C.A	US_reg	VAR24.6	Perceived importance of United States government regulations	Selection	Ordinal
24.g	Transport and delivery	C.A	Foreign_reg	VAR24.7	Perceived importance of foreign nation's government regulations	Selection	Ordinal
24.h	Transport and delivery	C.A	Doc_process	VAR24.8	Perceived importance of documentation process	Selection	Ordinal
24.i	Transport and delivery	C.A	Know_export	VAR24.9	Perceived importance of knowledge of exporting	Selection	Ordinal
24.j	Transport and delivery	C.A	Trans_cost_export	VAR24.10	Perceived importance of transportation cost	Selection	Ordinal
24.k	Transport and delivery	C.A	Prod_security	VAR24.11	Perceived importance of product security	Selection	Ordinal
24.l	Transport and delivery	C.A	Prod_label	VAR24.12	Perceived importance of product labeling	Selection	Ordinal
24.m	Transport and delivery	C.A	Delivery_delay	VAR24.13	Perceived importance of delays in delivery	Selection	Ordinal
25.a	Barriers to export	R.A.	Prod_exportibility	VAR25.1	Perceived difficulty in exporting the product	Selection	Ordinal
25.b	Barriers to export	R.A.	Export_know	VAR25.2	Perceived importance of export knowledge	Selection	Ordinal
25.c	Barriers to export	R.A.	Payment_prob	VAR25.3	Perceived importance of getting paid	Selection	Ordinal
25.d	Barriers to export	R.A.	Reg_complexity	VAR25.4	Perceived regulatory complexity	Selection	Ordinal
25.e	Barriers to export	R.A.	Foreign_trade_agreem	VAR25.5	Perceived importance of trade agreement	Selection	Ordinal
25.f	Barriers to export	R.A.	Financing	VAR25.6	Perceived importance of getting finances	Selection	Ordinal
25.g	Barriers to export	R.A.	Effect_domestic_sales	VAR25.7	Perceived impact on domestic deliveries	Selection	Ordinal
25.h	Barriers to export	R.A.	IPR_protection	VAR25.8	Perceived risk of intellectual property	Selection	Ordinal
25.i	Barriers to export	R.A.	Costly	VAR25.9	Exporting is too costly	Selection	Ordinal
25.j	Barriers to export	R.A.	Site_Support	VAR25.10	Difficulty finding on-site support	Selection	Ordinal
25.k	Barriers to export	R.A.	Finding_customer	VAR25.11	Difficulty finding customers	Selection	Ordinal
25.l	Barriers to export	R.A.	Partnership_difficulty	VAR25.12	Difficulty forming long term	Selection	Ordinal

					partnership		
25.m	Barriers to export	R.A.	sales_support	VAR25.13	Difficulty in providing after sales support	Selection	Ordinal

R.A.: Resources available to the export venture

C.A.: Capabilities available to the export venture

C.S.: Export venture competitive strategy

E.V.P: Export Venture Performance

Appendix F: Export venture performance measurement

Table 22 Export Performance Measurement: Construct and Measurement Items

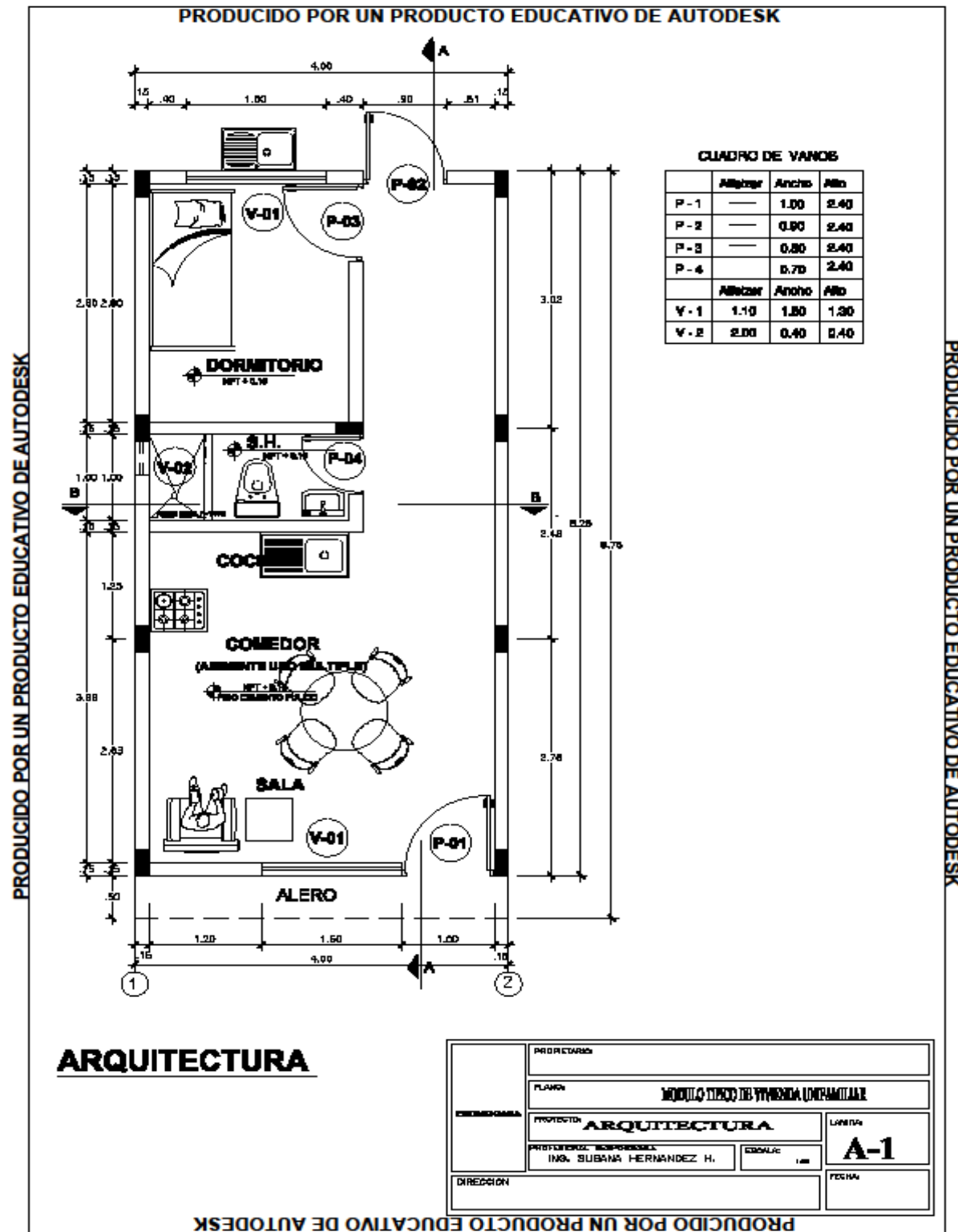
Resources available to Export Ventures	
A. Industry Level Characteristics	
VAR25.1:	Perceived difficulty in exporting the product
VAR25.2:	Perceived importance of export knowledge
VAR25.3:	Perceived importance of getting paid
VAR25.7:	Perceived impact on domestic deliveries
VAR25.9:	Exporting is too costly
B. Country Level Characteristics	
VAR25.4:	Perceived regulatory complexity
VAR25.5:	Perceived importance of trade agreement
VAR25.6:	Perceived importance of getting finances
VAR25.8:	Perceived risk of intellectual property
VAR25.9:	Exporting is too costly
VAR25.10:	Difficulty finding on-site support
VAR25.11:	Difficulty finding customers
VAR25.12:	Difficulty forming long term partnership
VAR25.13:	Difficulty in providing after sales support
Capabilities available to the export venture	
VAR24.1:	Perceived importance of transportation medium selection
VAR24.2:	Perceived importance of selecting a good freight forwarder
VAR24.3:	Perceived importance of using personal agent in foreign market
VAR24.4:	Perceived importance of having a good customs broker
VAR24.5:	Perceived importance point of entry
VAR24.6:	Perceived importance of United States government regulations
VAR24.7:	Perceived importance of foreign nation's government regulations
VAR24.8:	Perceived importance of documentation process
VAR24.9:	Perceived importance of knowledge of exporting
VAR24.10:	Perceived importance of transportation cost
VAR24.11:	Perceived importance of product security
VAR24.12:	Perceived importance of product labeling
VAR24.13:	Perceived importance of delays in delivery
Export venture competitive strategy	
VAR16.1:	Perceived importance of Product Quality
VAR16.2:	Perceived importance of Product availability
VAR16.3:	Perceived importance of Product Pricing
VAR16.4:	Perceived importance of Raw Material costs
VAR16.5:	Perceived importance of Transportation costs
VAR16.6:	Perceived importance of Sales team
VAR16.7:	Perceived importance of Customer relations
VAR16.8:	Perceived importance of Timely delivery

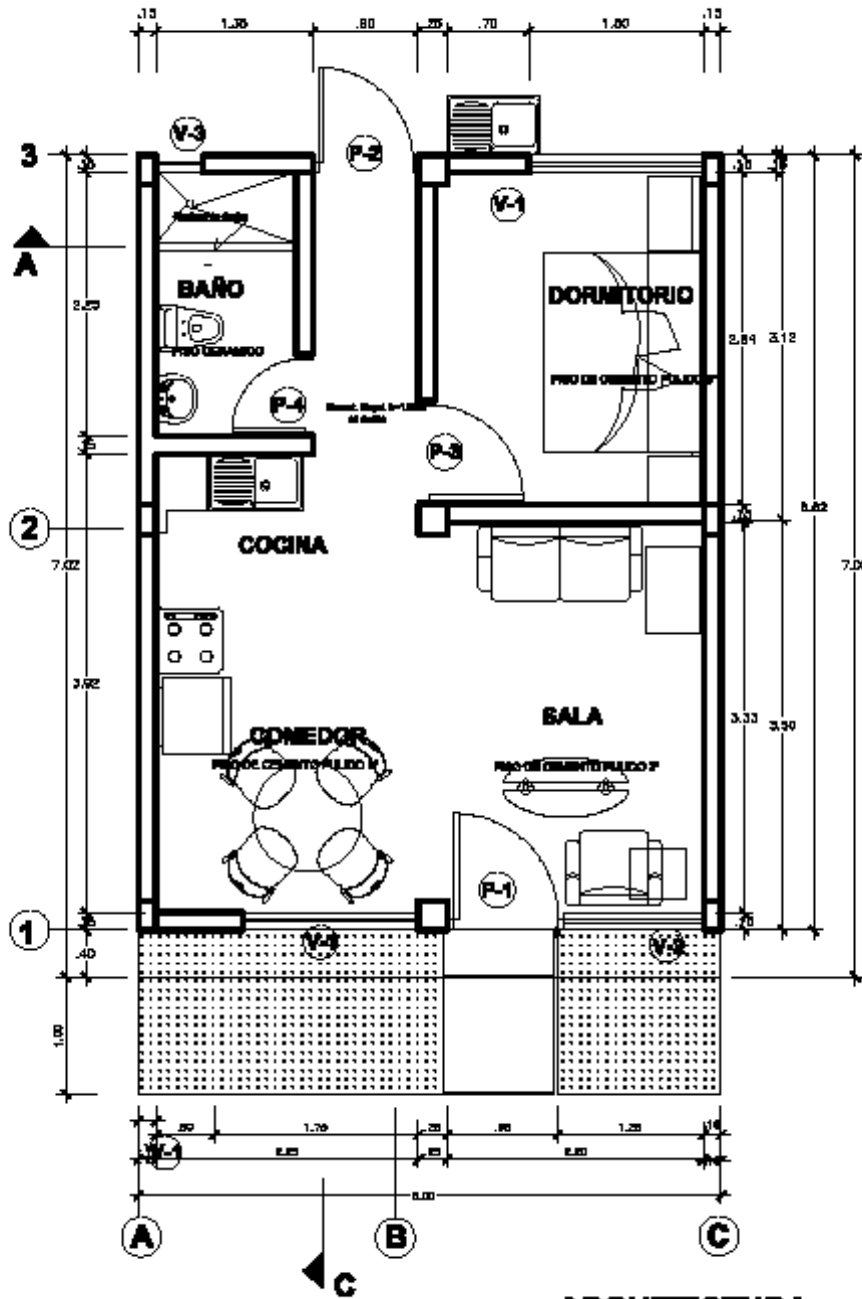
- | | |
|-----------|---|
| VAR16.9: | Perceived importance of Selecting agents/distributors |
| VAR16.10: | Perceived importance of Market expansion |
| VAR16.11: | Perceived importance of Marketing and promotions |
| VAR16.12: | Perceived importance of After sales services |
| VAR16.13: | Perceived importance of On-site support |
| VAR16.14: | Perceived importance of Product modification |
| VAR16.16: | Perceived importance of Commitment to expand markets |
| VAR16.17: | Perceived importance of Exports in long term sustenance |
| VAR16.18: | Perceived importance of Participation in trade shows |

Export Venture performance

- | | |
|--------|---|
| VAR10: | Average Annual sales growth rate for past 5 years |
| VAR19: | Share of business sales from exporting |
| VAR21: | Period for which the company have been exporting |
| VAR22: | Increase in number of employees due to export |

Appendix G: Floor plan layouts for low income housing in Peru





PRODUCIDO POR UN PRODUCTO EDUCATIVO DE AUTODESK

PRODUCIDO POR UN PRODUCTO EDUCATIVO DE AUTODESK

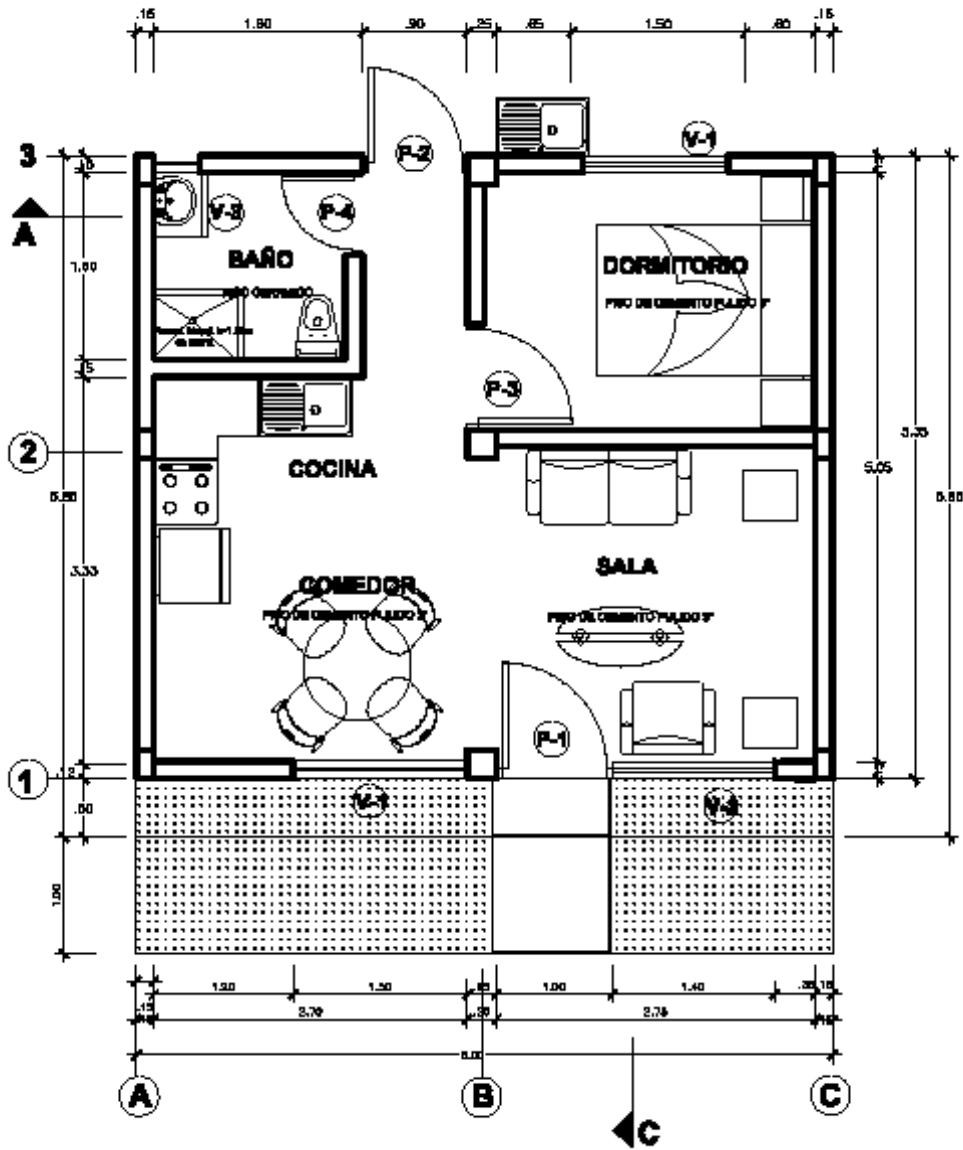
ARQUITECTURA

CUADRO DE VENTOS

TIPO	ALFEIZER	ANCHO	ALTO
P 1	—	1.00	2.00
P 2	—	0.80	2.00
P 3	—	0.70	2.00
P 4	—	0.80	2.00
V 1	1.20	1.00	1.30
V 2	1.20	1.20	1.30
V 3	2.20	0.70	0.30

PROYECTISTA	PROYECTOS		
	PLANO: MODELO TIPO DE VIVIENDA COMPARTILADA		
	PROYECTO: ARQUITECTURA	LAVADO: A-1	
	PROFESIONAL RESPONSABLE: ING. SILDANA HERNANDEZ H.	DEVALIA: <input type="checkbox"/>	FECHA: <input type="text"/>
DIRECCION			

PRODUCIDO POR UN PRODUCTO EDUCATIVO DE AUTODESK



PRODUCIDO POR UN PRODUCTO EDUCATIVO DE AUTODESK

PRODUCIDO POR UN PRODUCTO EDUCATIVO DE AUTODESK

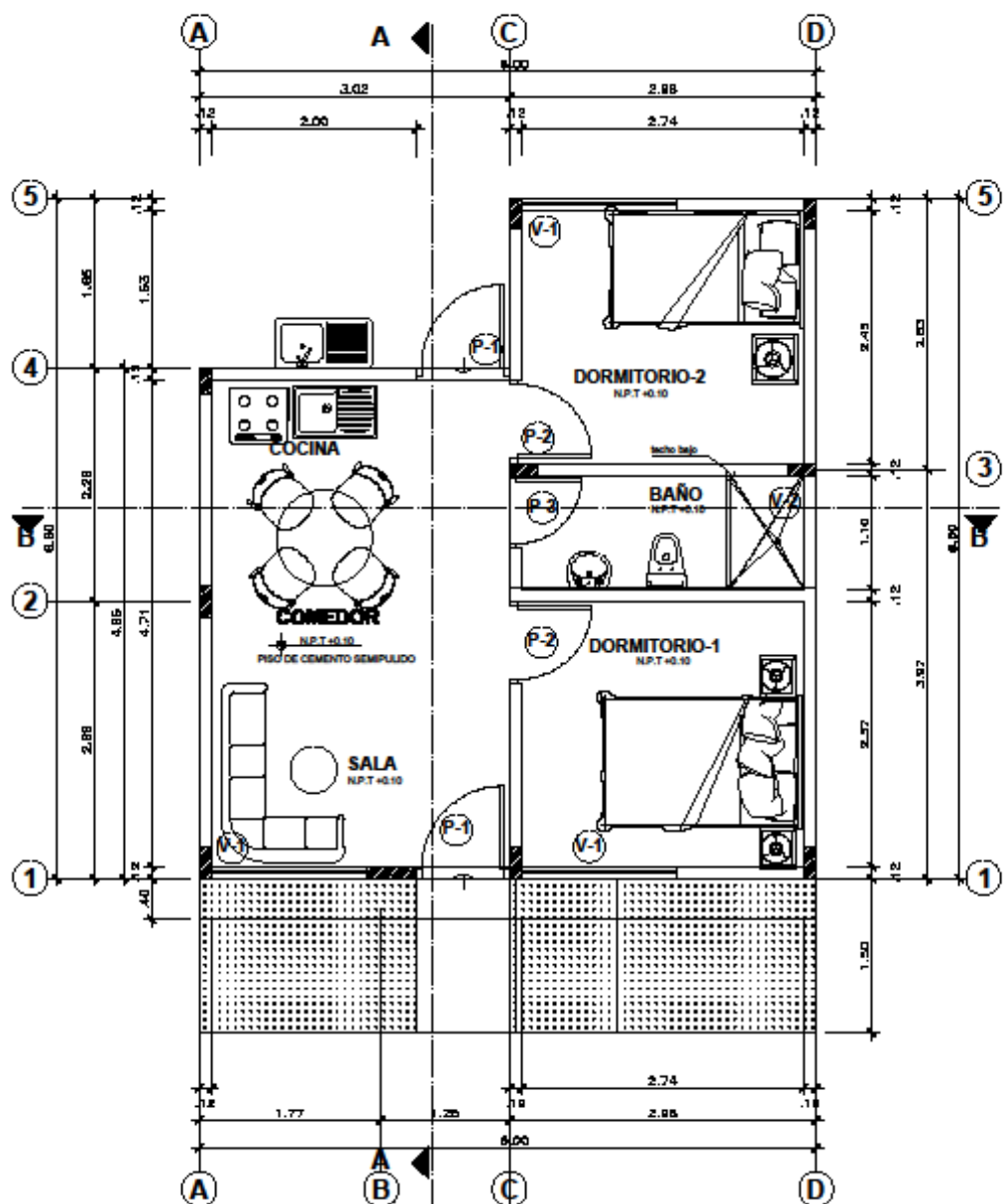
ARQUITECTURA

CUADRO DE VANOS

TIPO	ALFEIZER	ANCHO	ALTO
P 1	—	1.00	2.40
P 2	—	0.80	2.40
P 3	—	0.80	2.40
P 4	—	0.70	2.40
V 1	1.10	1.60	1.30
V 2	1.10	1.40	1.30
V 3	2.10	0.50	0.80

PROYECTISTA	PROYECTOS		
	PLANO: MÓDULO TIPO DE VIVIENDA URBANA 100		
	PROYECTO: ARQUITECTURA		LÁMINA: A-1
	PROFESIONAL RESPONSABLE: ING. SUSANA HERNANDEZ H.	ESCALA: 1:50	FOLIO: 1
DIRECCION			

PRODUCIDO POR UN PRODUCTO EDUCATIVO DE AUTODESK



PLANTA PRIMER PISO

ARQUITECTURA

ESC. 1:50

Area construida = 34.63 m²
 Area Techada = 37.00 m²

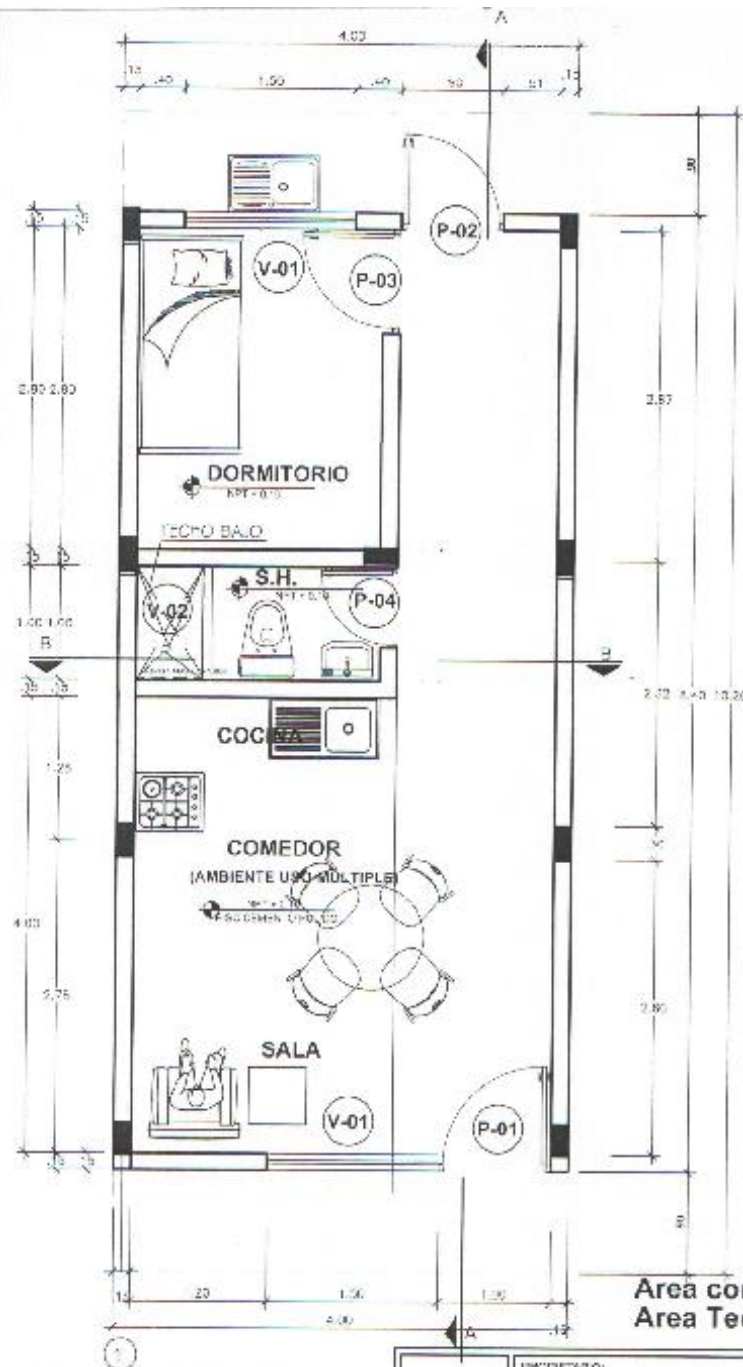
VENTANAS

TIPO	ANCHO	ALTO	ALFEIZER
V 1	1.50 m	1.40m	1.10 m
V2	0.60m	0.30m	2.30m

PUERTAS

TIPO	ANCHO	ALTO
P1	1.00 m	2.10 m
P2	0.90 m	2.10 m
P3	0.80 m	2.10 m
P4	0.70 m	2.10 m

PROPIETARIO			
PLANO: ARQUITECTURA-UBICACIÓN			
PROYECTOR	MÓDULO TIPO DE VIVIENDA UNIFAMILIAR		LIBRERA
PROFESIONAL RESPONSABLE	ESCALA:	1:50	A-01
DIRECCIÓN			FECHA
			JUNIO 2014



CUADRO DE VANOS

	Alteizer	Ancho	Alto
P - 1	---	1.00	2.40
P - 2	---	0.90	2.40
P - 3	---	0.80	2.40
P - 4	---	0.70	2.40
	Alteizer	Ancho	Alto
V - 1	1.10	1.30	1.30
V - 2	2.00	0.40	0.40

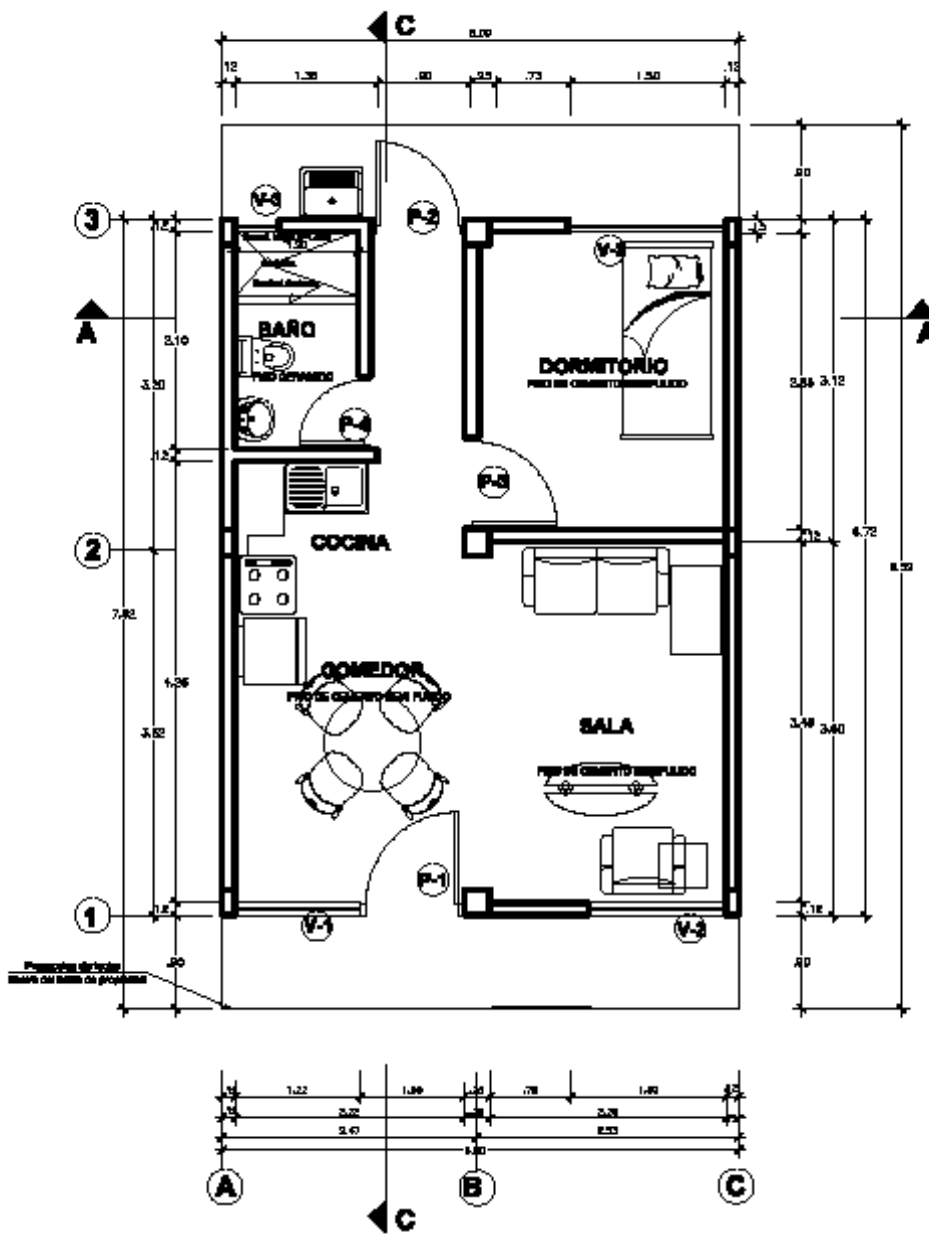
Area construida = 33.60 m2
 Area Techada = 40.80 m2

ARQUITECTURA

PROPIETARIO:	
PLANO: ARQUITECTURA-DISTRIBUCION	
PROYECTO: MODULO TIPO DE VIVIENDA UNIFAMILIAR	
PROFESIONAL RESPONSABLE	ESCALA: 1:50
FECHA: Julio 2014	

PROYECTO CASA: **A-01**

DIRECCION:



Propuesta de trabajo
basado en datos de programa

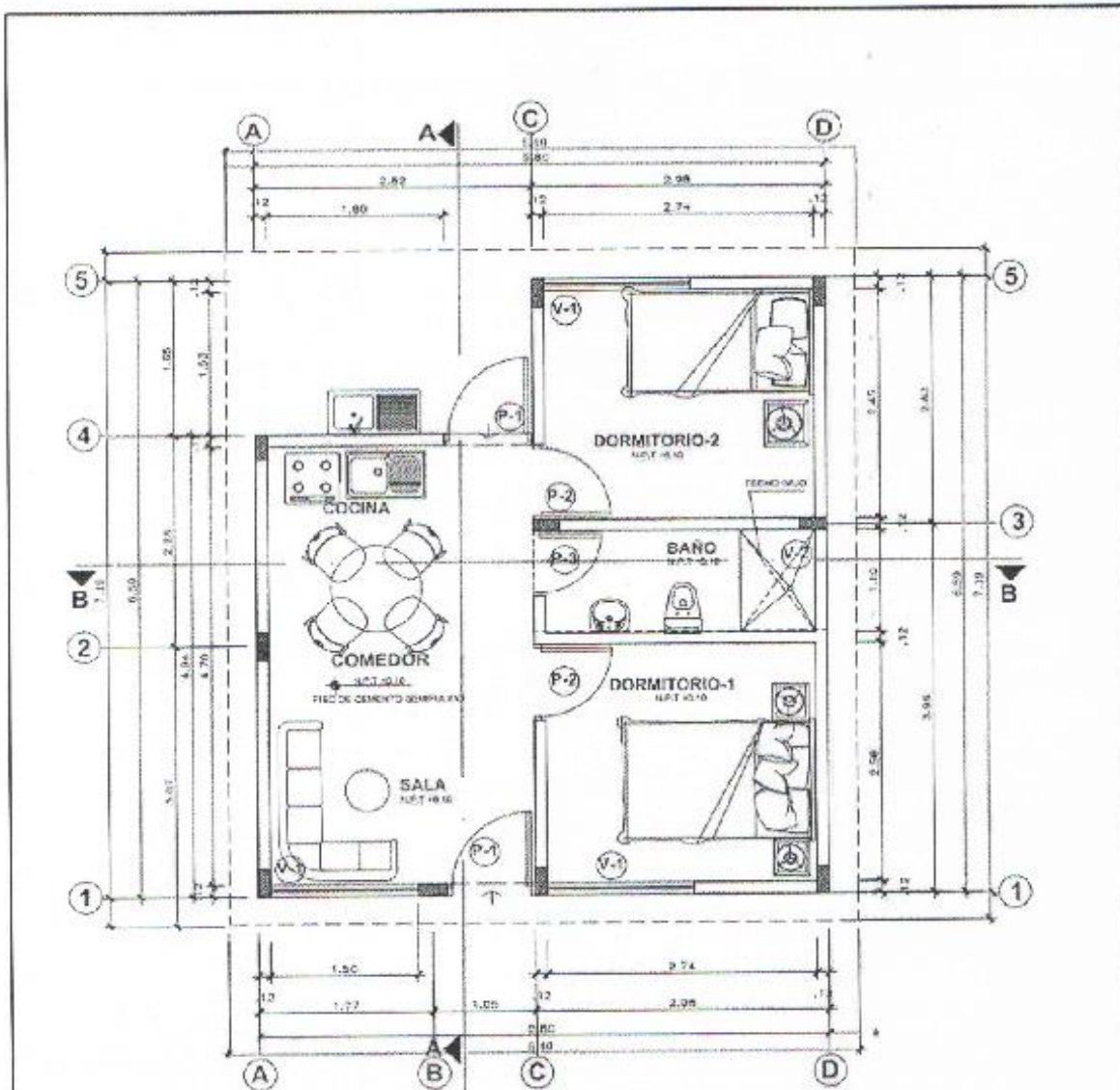
CUADRO DE VANOS

TIPO	ALFEZER	ANCHO	ALTO
P 1	—	1.00	2.60
P 2	—	0.90	2.60
P 3	—	0.70	2.60
P 4	—	0.80	2.60
V 1	1.22	1.60	1.80
V 2	1.60	1.80	1.50
V 3	2.60	0.80	0.30

ARQUITECTURA

Área construida = 33.60 m²
Área Techada = 42.60 m²

PROYECTO	PROYECTADO	
	PLANO: ARQUITECTURA-DISTRIBUCIÓN	
	PROYECTO: MODELO TIPO DE VIVIENDA FAMILIAR	
	PROFESIONAL RESPONSABLE	ESCALA: 1:80
FECHA:	LÁMINA: A-01	
	FECHA:	



PLANTA PRIMER PISO

ARQUITECTURA

IBC 150

Area construida = 33.60 m2
 Area Techada = 46.00 m2

VENTANAS

TIPO	ANCHO	ALTO	ALFEIZER
V 1	1.50 m	1.50m	1.10 m
V2	0.60m	0.30m	2.30m

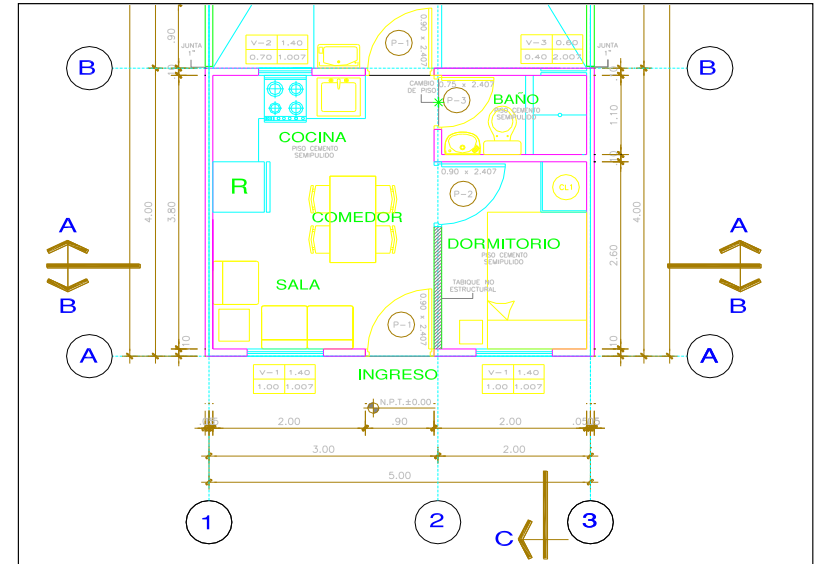
PUERTAS

TIPO	ANCHO	ALTO
P1	0.90 m	2.10 m
P2	0.80 m	2.10 m
P3	0.70 m	2.10 m

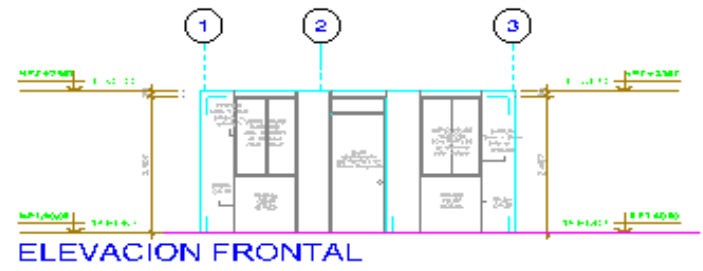
PROPIETARIO:			
PLANO:		ARQUITECTURA-DISTRIBUCION	
PROYECTO:		MÓDULO TÍPICO DE VIVIENDA LINEAL BAR	
PROFESIONAL RESPONSABLE:	ESCALA:	1:50	LÁMINA:
			A-01
FECHA:	OCTUBRE 2015		

TIPO DE CAMBIO: 3.25

PRESUPUESTO: MODULO TPDC - 20 M2					
ITEM	NOMBRE	UND	METRADO	C. UNITARIO	SUB TOTAL
1.00	Plataformado				
1.01	Concreto en plataformado $f'c = 175 \text{ Kg/cm}^2$	m3	2.70	\$86.15	\$232.62
1.02	Acero de refuerzo y mallas	kg	101.75	\$1.33	\$135.25
1.03	Encofrado y vaciado en plataforma	m2	20.40	\$3.83	\$78.15
2.00	Muros y losas Primer Piso				
2.01	Concreto en muros y losa primer piso $f'c = 175 \text{ Kg/cm}^2$	m3	6.40	\$92.31	\$590.77
2.02	Acero de refuerzo, mallas y dowels muros y losa primer piso	kg	291.82	\$1.33	\$387.90
2.03	Mano de obra encofrado en muros y losa primer piso	m2	102.65	\$3.83	\$393.23
2.04	Mano de obra concreto en muros y losa primer piso	m3	6.40	\$7.08	\$45.29
4.00	piso Lavanderia				
4.01	Concreto en piso $f'c = 140 \text{ Kg/cm}^2$	m3	0.20	\$70.77	\$14.15
4.02	Mano de obra encofrado y vaciado de concreto en piso $f'c = 140 \text{ Kg/cm}^2$	m2	1.51	\$3.83	\$5.78
4.03	Corte, compactación y eliminación	m2	1.51	\$3.69	\$5.58
5.00	Instalaciones Electricas				
5.01	A todo costo	Gbl	1.00	\$246.15	\$246.15
6.00	Instalaciones Sanitarias / Agua y Desague				
6.01	A todo costo	Gbl	1.00	\$230.77	\$230.77
7.00	Acabados				
7.01	Empastado y pintado en fachada	m2	5.78	\$2.31	\$13.34
7.02	Pintado en alfeizer	m2	2.02	\$3.08	\$6.20
7.03	Empastado en modulo	m2	74.85	\$1.85	\$138.18
7.04	Pintura gloss en baños	m2	5.67	\$3.38	\$19.19
7.05	Puertas + marco y chapa instaladas	Glb	1.00	\$246.15	\$246.15
7.06	Ventanas instaladas	Glb	1.00	\$209.23	\$209.23
7.07	Ducha de ceramico a todo costo	und	1.00	\$40.00	\$40.00
7.08	Semi pulido en cara exterior techo	m2	20.40	\$1.69	\$34.52
7.09	Curado de concreto	m2	267.63	\$0.31	\$82.35
7.10	instalacion de ladrillo pastelero	ml	5.10	\$3.38	\$17.26
7.11	Impermeabilizacion de losas	ml	20.40	\$3.69	\$75.32
8.00	Accesorios Sanitarios				
8.01	Aparatos y accesorios sanitarios	und	1.00	\$169.23	\$169.23
COSTO DIRECTO					\$ 3,416.62
GASTOS GENERALES (4.32%)					\$ 147.60
IGV 18%					\$ 614.99
COSTO TOTAL					\$ 4,179.21



PLANTA TIPICA MODULO DE 20 M2



Appendix H: Marketing Report for system built wood housing manufacturers in the United States.

Assessment of U.S. manufactured system built wooden homes as an affordable housing alternative for low income households in developing countries.

Executive summary:

Sustainable housing is one of the fundamental necessities for socio-economic development. Yet a considerable population of developing world is living in substandard houses. On the other hand, developed countries like United States have substantially improved residential construction sector by engineering new materials and developing efficient systems.

This study attempts to link this supply capacity of system built wood construction sector in the United States to urban low-income housing markets in Latin-American region. Expansion to new markets and diversification to new products can rejuvenate this industry in the U.S. Linking the manufacturer with potential buyers overseas would need efficient production, logistics and marketing systems. This research is focused on product development for bottom-of-the pyramid buyers to give them an affordable yet sustainable alternative to traditional system. Interviews and surveys tools were used to assess key aspects of housing deficits in target demographics of South American region. System built wood construction manufacturers in U.S. were assessed to identify barriers and incentives for internationalization and how they differ from exporting to non-exporting manufacturers within the same industry. Findings indicate developing products for social housing programs can provide access to potential untapped market. Lack of existing wood construction in market indicates possibility of resistance to

acceptance, but also assures no local competition. The findings can also contribute to opening of new markets for exports of prefabricated wooden buildings in other housing sectors.

Introduction

Almost everything that we buy and use is manufactured in a controlled environment. Why we cannot do the same to our wood home construction?

The construction industry in the United States is one of the major industries in the country. In 2014, the sector accounted for 3.8 percent of the annual Gross Domestic Product (Bureau of Economic Analysis, 2016). Over the past 15 years, the sector have experienced quite a fluctuations and endured a challenging time. Starting with a decent share of 4.5% in the year 2000, the construction sector experienced a frenzy growth with flourishing US economy till 2006. The sector was badly hit during the December 2007-June 2009 recession with a net employment decline of 19.8 percent (Hadi, 2011). The loss of 1.5 million employment was the largest decline among the non-farm industries. Residential construction was the most badly hit with effect starting almost a year before the start of the actual recession. The market and condition of this housing industry has improved ever since but this improvement is coming at a considerably slower pace (U.S. Census Bureau, 2016). As a result, the companies in this sector need to prepare themselves to face any similar market failure in future. Development of a robust business model with diverse market penetration could be one of the options to grow and prepare for any similar catastrophe (Baack, Harris, & Baack, 2013).

Based on the method of building, the wood residential construction sector in the U.S. is divided into two sectors namely the site-built and the factory built (also called system built) home

industries. There is a considerable difference in the share of market between these sectors. Site-built residential construction essentially dominates the market with controlling as high as 97% of the market share in 2014 (U.S. Census Bureau, 2016). Figure 1 shows the trend of new single family homes completed in the U.S. over a period of 12 years (1992-2014).

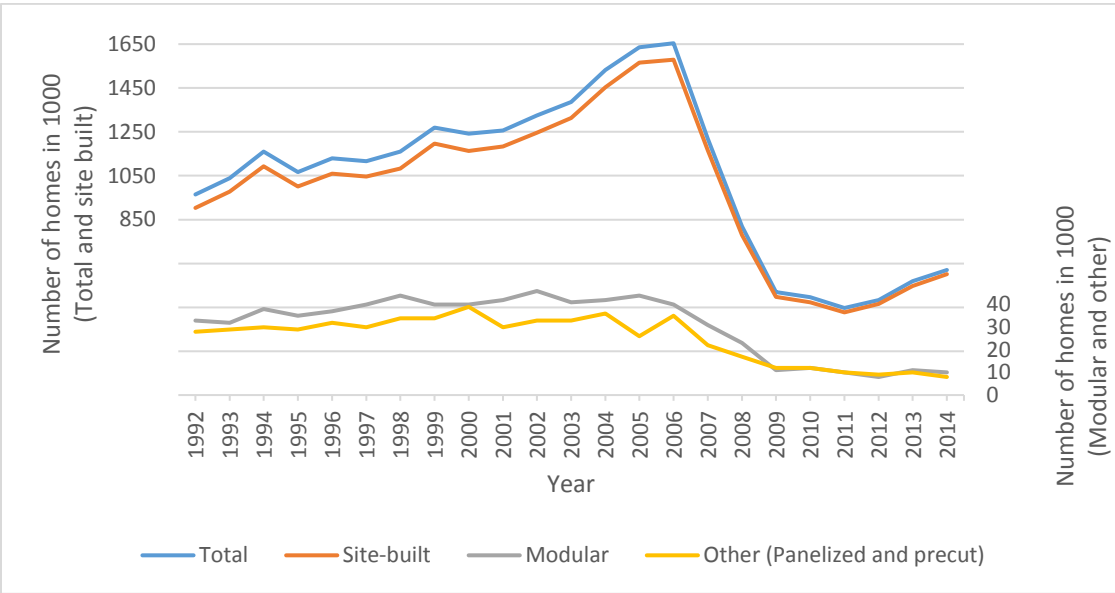


Figure 1 New Single Family Homes Completed in United States (1992-2014)

In order to better resolve the above graph, the axis are split into two groups. The axis on the left shows the number (in thousands) of the completed total and site-built houses. The axis on the right shows the number (in thousands) of the completed factory built (modular, panelized and precut) houses. Despite being mature technology, factory built sector is still to make its mark in the residential construction market as depicted in Figure 1. This indicates a need and possible opportunity for the factory built sector to grow and improve its contribution. Several studies (Apgar, Calder, Collins, & Duda, 2002; Bady, 1996; Wherry, 2009) suggested an inherent potential in factory built sector for increasing its market share.

Use of wood in construction

Sixty percent of the raw materials extracted from earth are used in construction (Bribian, Capilla, & Uson, 2011). From this volume, buildings represents 40 percent and the rest is infrastructure like roads, bridges etc. The sector alone contributes a substantial share in global resource consumption. But this also means that there is a possible opportunity to invent and improve this usage. Consumption of nonrenewable and non-replenishable resources can lead to devastating effects on the environment. Wood is extensively used as a construction material in many parts of the world because of its availability, cost, ease of working, renewable nature, attractive appearance, performance and serviceability if built and maintained properly. Consortium for Research on Renewable Industrial Materials (CORRIM) group showed using Life Cycle Assessment (LCA) of wood, steel and concrete frame housing that the net CO₂ emissions from wood construction was 55 metric tons while steel and concrete had higher carbon footprint with 185 and 167 metric tons of CO₂ emitted respectively (Consortium for Research on Renewable Industrial Materials (CORRIM, 2004)). With responsible forest management practices assuring a sustainable supply, wood have been proven to be a better choice of construction material (Smith, 2010). Certain concerns like fire, structural durability and moisture damage always put wood construction in an inferior spot. Bad heat conducting nature of wood and use of proper fire prevention structural and non-structural components in construction assures enough safety (Smith, 2010). Building design according to performance codes and timely maintenance can assure better structural performance and prevention from any moisture damage.

What is system built wood construction

Construction technology is an act or process of constructing, or building a product, commonly known as a structure, using different materials, methods and equipment (Carswell, 2012). Different structures can be constructed depending upon the type of material or method employed giving a variety to the industry. Over time, construction industry in the United States have grown and differentiated itself into different independent but functional categories. This transformation in construction industry has been relatively slower as compared to other areas of engineering and technology (Gianino, 2005). The central topic of analysis for this study is the system built wood buildings constructed majorly in the controlled environment of a facility. This is also known as off-site construction or factory built construction. Depending upon the extent of prefabrication, these off-site manufactured systems can vary from just pre-cut and prefabricated components to panelized leading up to fully advanced modular systems. Factory manufactured components in these systems replace some of the on-site labor built structures. The process is mainly feasible in repetitive components of house like, walls, floors, doors and windows etc. which when assembled easily on site can be very effective in saving time. Following section discuss different types of construction systems in this category.

Types of System built construction

This report introduces 3 different types of manufacturing techniques used in the United States for residential wood construction.

Prefabricated systems

This is the most basic type of off-site factory manufacturing of building components. This system evolved with the wide spread of lumber mills which started to supply processed

dimensional lumber to the builders. All of the cutting, drying and processing is done in a central location and then supplied to the builder on the construction site. The builder would then use these to make walls, floors or roof systems. This system further gained popularity with the development of engineered wood products like Structural Insulated Panels (SIP), trusses, I-joists (WoodWorks, 2014; WRAP, 2007) etc. which required mechanized manufacturing by skilled labor and cannot be done easily on the construction site.

Panelized systems

With further development in factory manufacturing of wood products, the wood products industry moved to assembling the prefabricated products into larger panels or complete assemblies. These panelized systems can be engineered according to construction design. Use of computer added design further helps the manufacturers to manufacture exact dimensions quite easily (WoodWorks, 2014; Chiang, Chan, & Lok, 2006). Using panelized systems, complete wall panels, floor and roof systems can be delivered to the site ready for assembly and installation. Some systems come even with plumbing and electric fittings so that factory built systems are not tampered.

Modular systems

This is the most advanced building system in which the entire house is divided into independent modules during the design. These modules are then built in a factory on a production line like any other manufacturing. Controlled environment, skilled labor and use of automation in construction make this off-site manufacturing very quick as compared to on-site construction. These modules are fitted with all the utility fittings and insulated properly before they leave the facility. Some modules might even come with interior finishing like carpeting, kitchen cabinets

and shelves etc. A complete module is transported to the job site where it would be connected and sealed with the rest of the structure to complete the building. This type of the building system has maximum amount of prefabrication ranging up to 95 percent of the total construction work done off-site. In order to assure sufficient safety and durability, the modules are inspected at factory during construction and on site at the time of installation as well. This method can complete a project in half the time as compared to traditional stick built on-site construction (WoodWorks, 2014; Blismas, Pasquire, & Gibb, 2006).

Current state of industry in the United States

Residential home construction industry in the United States is extremely scattered by nature (ProBuilder, 2016). Top 20 giant construction companies in residential sector accounted for only 17 percent of the market share. Bottom 100, companies from serial number 151 to 225, together accounted for only 2% of the market shares. Seventy percent of the market was operated by the non-giant small companies (Figure 4). This shows that majority of the market is being operated by small and medium companies.

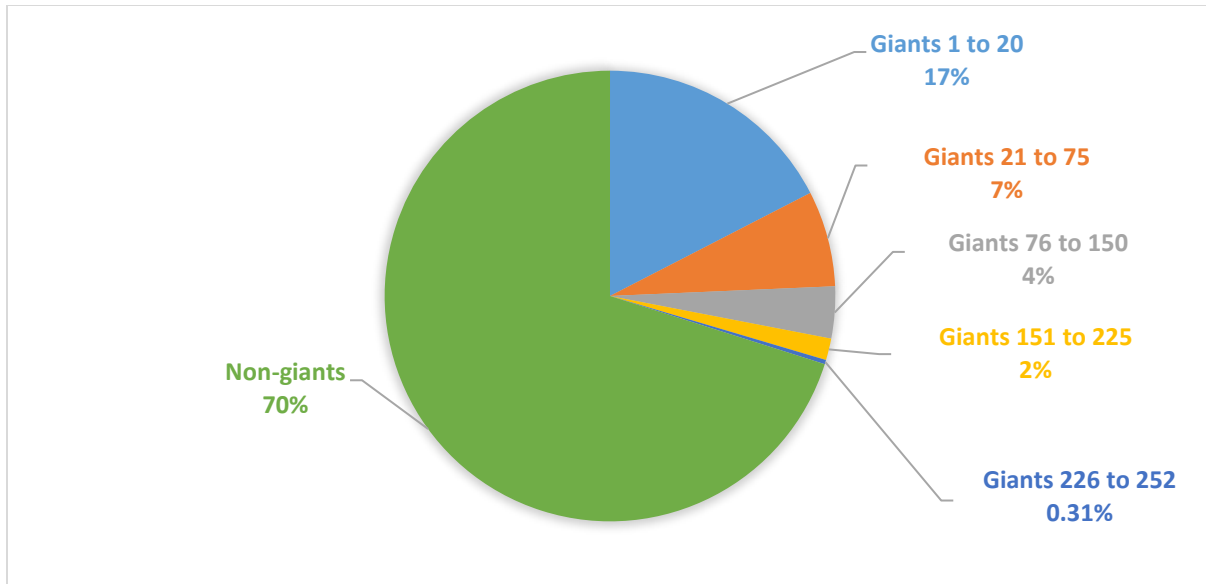


Figure 2 Housing Giants Market Share, 2016

ProBuilder (2016) also highlights major challenges and opportunities identified by the giant residential construction companies. Table 1 summarize their findings in each of the two categories along with the proportion of responses. Lack of skilled labor and increased competitions indicate that the construction companies need to diversify and mechanize their process in order to stay competitive. This also means that companies need to move to new market segments which is also seen as an opportunity by most of the major companies. The companies also feel that it is important to improve the operational efficiencies in their processes.

Table 1 Biggest Challenges and Opportunities Anticipated by Giant Companies in 2016

Challenges		Opportunities	
	Response Proportion		Response Proportion
Availability of land	51%	Operational efficiencies	56%
Scarcity of skilled labor	51%	Niche market opportunities	40%
Increased Competition	27%	Market expansion	39%
Rising Home Prices	19%	Economic recovery	28%
Government Regulations	15%	Better marketing	28%

Carter (2015) reported a detailed analysis of off-site construction industry in the United States. A total of 717 businesses together were estimated to generate a revenue of \$7.4 billion. \$226.8 million out of these revenues were expected from exports. The expected profits for the year were \$161.8 million. The industry showed a decent growth of 4.9 percent for the period of 2010-15 which is expected to reduce to 2.3 percent in the next 5 year period. It is alarming as the author mentions that “Despite slow sales growth, industry will lose ground to traditional housing”. Table 2 summarizes the current structure of off-site construction sector in the United States.

Table 2 Industry Structure: Off-site Construction in U.S. (2015) (Carter, 2015)

Factor	Status	Factor	Status
Life cycle Stage	Decline	Industry assistance	Low
Revenue Volatility	Medium	Capital Intensity	Low
Concentration Level	Medium	Regulation Level	Medium
Technology Change	Medium	Barriers to Entry	High
Industry Globalization	Low	Competition Level	High

Due to slow and decreasing growth rate, the sector is in declining stage of its life cycle. Owing to major acquisitions and mergers post 2008-09 economic downturn, the sector is fairly concentrated now with few companies contributing considerably to the overall revenues. This also makes it harder for new business to enter and compete at the top of the sector. Despite the usual belief, the industry is less capital intensive and more labor intensive because of higher share of customized orders instead. The industry has very low level of globalization with limited businesses across the globe. According to the Consumer Financial Protection Bureau, the median annual household income of manufactured homebuyers is slightly over \$26,000.

This is roughly half the median income for families buying other homes. When traditional site-built homes drop in price and become more widely affordable, demand for manufactured and modular homes declines because of consumer's preference of traditional on-site constructed homes. Suppressed conventional home prices spurred many of these low-income consumers to purchase traditional homes. The system built industry is thus consequently forced to price their products competitively. According to the Census Manufactured Homes Survey, the real average price of a manufactured home grew at a tepid annualized rate of 1.5 percent over the five years to 2016 (latest data available). Combined with rising input prices, this trend has led to declining profit margins for this industrial segment (O'Hollaren, 2017).

Three companies in the sector together controlling more than 45 percent of the market share in 2015 were Berkshire Hathaway Inc. (28.0%), Champion Enterprises Inc. (10%) and Cavco Industries Inc. (7.8%). In terms of product segmentation in 2015, 55.3% share was expected to be of manufactured mobile homes, 33.6% of prefabricated wood buildings that includes panelized and precut buildings and remaining 11.1% was nonresidential mobile buildings. Manufactured mobile homes shared the largest fraction of the product sales. In terms of market segmentation, 60.3% of the revenue was generated from the retail trade where most operators either have their own stores or market to multi-brand stores. Wholesalers generated 36.6% of this sales.

Existing international trade for the industry is very low at mere 3.1% of the annual revenue (Carter, 2015). In 2015, the factory built home industry alone recorded total exports of \$226.8 million. Seventy four percent of it was to Canada mainly because of geographical proximity (Carter, 2015). Japan, Australia and Mexico together accounted for another 15.7 percent.

Remaining 10.3 percent is dispersed among rest of the global market. Figure 83 shows the distribution of exports and share of each country. This shows that the export market for this product is low and there can be an opportunity for companies manufacturing wooden homes to capture new markets.

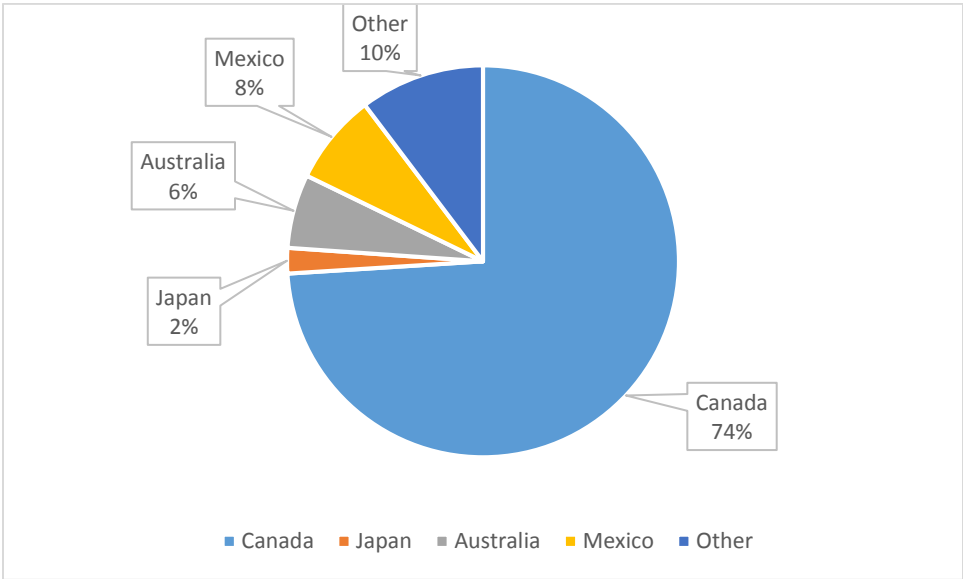


Figure 3 Exports of Factory Built Construction Industry (2015)

This also shows that the factory built home industry has a very small share of exports as compared to other forest products. This is despite the fact that the manufacturing needs considerable capital investment in setting up and maintaining the facility. The processed product creates more jobs and value for the U.S. economy as compared to raw products. Thus there is a need to further promote and increase the global operations of this sector in order to benefit the economy.

Housing market of developing countries in the South America

Housing conditions strongly influence physical and mental health of the dwellers, education, access to economic opportunities and vulnerability to social ills. Thus it is extremely important for the people to have sufficient and sustainable housing at affordable prices.

South and Central America (including the Caribbean) are among the highly urbanized regions of the world. It is estimated that this urban population will grow from 75.5 percent (2010) to 84.6 percent (2030) and match the likes of developed regions of Western Europe and North America. (McBride & French, 2011) These cities are attracting jobs, investments and people leading to the growth of the region. This fast growing urban population would mean increased need for housing in the cities of the region. This becomes a major challenge in accommodating increasing populations with services, employment and shelter. But majority of these countries have not been able to withstand the immense pressure on the supply and cost of urban land and housing. "Of 130 million urban families in the region, 5 million rely on another family for shelter, 3 million live in houses that are beyond repair, and another 34 million live in houses that lack either title, water, sewage, adequate flooring, or sufficient space" highlights Bouillon (2012).

Based on the nature and additional efforts required to achieve minimum standards of dwellings, housing gaps can be classified as quantitative and qualitative shortages. Quantitative shortage includes housing units that are damaged beyond repairs and are not suitable for living. Qualitative shortages include households living in units with insecure tenure or illegal titles, temporary structure, inadequate sanitation and overcrowding (Bouillon, 2012, p. 26; Rojas & Medellin, 2010). Bouillon (p.27, 2012) also quantified both of these qualitative and quantitative

shortages in the region of Latin America and the Caribbean. Table 43 summarizes the findings. Due to inequality in household income in the region, the populations per quintile vary a lot. As a result despite majority of the poor suffer from housing shortage, most of the households that fall in higher quintiles experience housing deficit. As reported, the poor with housing deficit consisted of 9.8 million households but 32.3 million households facing deficit in the region were not poor.

Table 3 Regional Housing Shortages in Latin America and the Caribbean 2009 (Percent of the Households) (Bouillon, 2012)

Housing Gaps	National	Urban	Rural	Urban quintiles by per capita household income				
				I	II	III	IV	V
Total Shortages	37 %	32 %	60 %	52 %	39 %	32 %	24 %	16 %
Quantitative Shortages	6 %	6 %	5 %	9 %	8 %	6 %	5 %	3 %
Qualitative Shortages	31 %	26 %	55 %	43 %	31 %	26 %	19 %	12 %

Table 4 highlights averages of the region but this shortage differs significantly from one region to another. Rojas and Medellin (2011) suggested that since each country in the region has different socio economic and geopolitical structures, the shortage should be tackled differently. Figure 4 shows the percent of households in Latin America and Caribbean region (Bouillon, 2012, p. 28). The shortage is highest in Bolivia (75%) and is lowest in Costa Rica (18%). Since the trade relations of most of these countries with the United States are amicable and supportive (Baack, Harris, & Baack, 2013), the manufacturers and suppliers of houses in the U.S. can explore the region as a potential market opportunity.

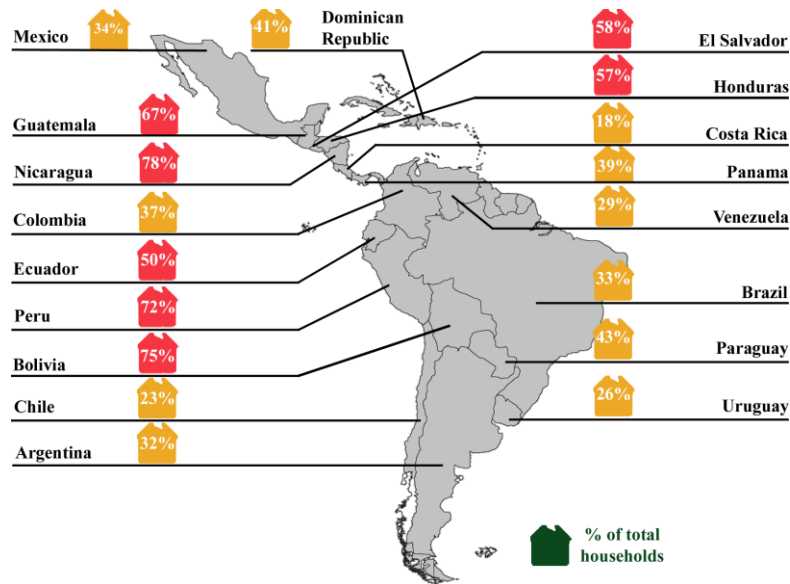


Figure 4 Housing Deficit by Countries, 2009 (Percent of Households) (Bouillon, 2012)

As a part of this research, Peru, Ecuador and Colombia were selected as candidate countries for assessment of potential implementation of U.S. manufactured system built wooden homes. These countries are selected because of the existing housing deficit in the region (Figure 114). These countries thus can provide a considerable market segment where the U.S. manufacturers can export. These countries also have amiable trade relation with the United States through different trade agreements making business transactions hassle free. Cultural difference is a major barrier to exports. All three of these countries have some similarities with the United States in socio-economic culture that would further support any business endeavors and product acceptance (Baack, Harris, & Baack, 2013). Lastly the political structure of these countries is fairly stable to safeguard and support any business transactions. With an attempt to be environmental friendly, these countries are eagerly attempting to shift to decrease their dependence on non-renewable resources. Thus it was important to study the government policies regulating social housing projects in the region, existing use of wood in construction

and identify different stakeholders involved in social housing value chain. The following sections discuss the social residential housing markets of these three countries in detail.

Motivation for this investigation

System built wood housing alternatives built in the United States has the potential to fulfill housing deficit gap in developing countries by developing and exporting an affordable substitute compared to current practices. Companies manufacturing system built homes in the U.S. can also considerably improve their business performance by exporting to these potential markets overseas. But there are many barriers associated with such an internationalization operation of factory built homes (Steinhardt, Manley, & Miller, 2013).

It is important that the units are designed specifically to fulfill local needs and match required standards in order to be successfully accepted in the market. There is a considerable gap of knowledge in understanding the local regulating policies, construction codes, potential housing demand and segmentation, cultural aspects impacting the design and architecture of residential construction in international markets. This information would also be useful in adjusting features to adapt to local conditions, designing the marketing strategies and mode of introducing system built wood construction system in target countries (Baack, Harris, & Baack, 2013).

This would give manufacturers in the United States an opportunity to expand to new and diverse markets as millions of families try to substantially improve their quality of living (Bouillon, 2012). Focusing on affordable housing would be a win-win situation where the manufacturers would get access to large potential markets and an opportunity to reduce social

inequality by generating new employments and the households can get an affordable alternative for the traditional construction system in foreign target markets. This would also be beneficial for the governments of target export countries that are trying to promote environmentally sustainable alternatives in construction sector.

System Built wood construction: Drivers for future growth

With aim to become efficient, communities all over the world are under pressure to create better-performing buildings that meet stringent codes, building performance requirements even when constructed under economic and tighter project schedules. This is when consumers are demanding high quality that is delivered quickly at a reasonable price. In a world full of improvements due to technology, many construction systems seem to lag behind in the adoption of innovation. System built construction that includes off-site manufacturing of components in a closed environment can assist not only in meeting above mentioned criteria but even surpass them. This investigation identified following key opportunities for this sector. Mechanization and industrialization of construction is good for economy as it can provide steady year-round employment with higher-quality buildings. Manufacturers in the United States can explore new market opportunities even with existing production capabilities.

The key feature of system built construction and adoption of factory manufacturing techniques in construction sector is improvement in project schedules. With optimized manufacturing processes, builders can achieve a considerable improvement in time taken to complete a project. Including prefabrication can also reduce construction costs mainly by optimizing material use and reducing waste. There can be substantial improvement in site safety with majority of the work done in the controlled environment of a manufacturing facility. Green and

Energy efficient buildings can be constructed in a more efficiently by including prefabrication. Prefabrication in construction can also give builders and architectures a flexibility to use wide range of materials and work without any interruption by inclement weather conditions (McGraw-Hill Construction, 2011). As the industry gain more maturity, these factors In future would further encourage the builders to adopt higher levels of off-site manufacturing in residential construction.

Exporting system built wooden houses

Pre-manufacturing of houses in a controlled environment and shipping them to the construction site is not a new idea. United States being one of the largest producers and consumers of wood fiber is perfectly poised to lead the global market. But this industrialized wood construction sector has been losing ground over the past decade even in the domestic market to on-site construction. Considering this background, these companies could expand to niche international markets by developing specific products. The experience of manufacturing for domestic markets, efficient building guidelines, availability of efficient delivery networks, and favorable international trade treaties places the US manufacturers in a favorable position to export this type of housing solutions.

Economic problems for the construction market have become a global trend. However, even as the United States continues to grow at slow but steady rate, opportunities are emerging for international contractors in developing countries, particularly those rich in resources. At the same time, the rise of construction activity in developing countries has caused an increase in competition in global market. Due to the instability of the global economy, the international construction market has been continuously marginally shrinking in recent years. Engineering

News Report (ENR)'s Top 225 International Contractors list indicates the global shift in the international construction market. The Top 225 as a group generated \$383.66 billion in 2010 contracting revenue from projects outside their home countries, which is slightly lower than 2008's figure of \$390 billion (Reina & Tulacz, 2011). Top 225's regional revenue breakdowns also indicate that contractors are shifting their focus to new and emerging markets. International revenue fell 6.6% to \$94.18 billion in Europe. It also fell 6.6% in the Middle East to \$72.43 billion and 6.5% to \$32.61 billion in the U.S. By contrast, international contracting revenue rose 25.6% to \$34.05 billion in Latin America and in the Caribbean, 6.7% to \$60.59 billion in Africa and 4.7% to \$76.64 billion in Asia and Australia. This shift in focus is leading to upheaval for major international contractors (Reina & Tulacz, 2010). The shift could be caused by the growth of mining sectors and the associated infrastructure required in these countries. As a traditional developed country, United States plays an important role in the world. Many industrial sectors of the United States lead the world economy. Construction is one of these sectors. With the development of internationalization and globalization, the construction industry in developing world has become more involved in the international market. This is even more important for residential construction where suitable housing not just a requirement but a necessity for living a quality life. System built wood housing manufacturers are strategically poised to take advantage of this huge market share.

Entering new and untouched markets is also beneficial for the sector as highlighted in the literature review. Internationalization and exports can prove to be strategically important for the U.S. manufacturing companies as it offers access to high and strategically consistent market shares without investing heavily in capacity improvement. The companies can keep using their

existing facilities and manufacture for international markets. This would also increase the existing revenue share for the system built housing industry form exports (\$226.8 million in 2015). Getting into the export markets would also expand the existing export base of U.S. forest products sector.

Table 4 Major Activities Associated with Exporting (Evans, 1990)

<p>STEP 1 Management Commitment</p>	<p>STEP 2 Analyze objectives, strengths, and weaknesses</p> <ol style="list-style-type: none"> 1. Short- and long-term goals 2. Personnel 3. Resources 4. Production 5. Financing 6. Knowledge of export Marketing 	<p>STEP 3 Develop contacts and collect current market information in the United States</p> <ol style="list-style-type: none"> 1. U.S. Government and State agencies 2. Banks with international departments 3. Freight forwarders 4. Marine insurance agents 5. U.S. port authorities 	<p>STEP 4 Conduct market analysis</p> <ol style="list-style-type: none"> 1. U.S. export statistics 2. Foreign import statistics 3. Current market developments and trends 4. Import barriers 5. Other factors (political, economic, geographic, and cultural)
	<p>STEP 5 Country/market selection</p> <ol style="list-style-type: none"> 1. Demand potential/ trends 2. Product identification 3. Standards and specifications and trends 4. Language requirements 5. Distribution channels 6. Business practices 7. Tariff and nontariff barriers 8. Licensing/phytosanitary requirements 9. Legal considerations 10. Shipping costs 	<p>STEP 6 Develop marketing approach targeted to every countries</p> <ol style="list-style-type: none"> 1. Organization of the firm 2. Determine production 3. Contact foreign importers 4. Schedule marketing/ sales trip to the country or market 	<p>STEP 7 Trade servicing</p> <ol style="list-style-type: none"> 1. Product development/ modification in response to changes in demand 2. Attention to importer's needs/ commitment to the market 3. Periodic visits to the market to maintain good customer relations and develop new contacts 4. Refine marketing Approach

Exporting clearly requires a long-term outlook from the company. The decision to enter the export market requires the manufacturer to commit sufficient managerial, economic, and financial resources to the task. Table 174 highlights major activities associated with exporting.

Thus each company must weigh the advantages and disadvantages of exporting to determine if projected profits, possible losses, and inherent risks justify management's commitment to exporting.

Assessment of system built wood housing manufacturing industry in the United States conducted in this study highlighted some important findings:

- Industry can be characterized as small to medium sized firms with annual sales of \$7.4 billion (2015) and a profit of \$161.8 million. Share of exports for the same year was \$226.8 million.
- Internationalization within the industry is relatively low; most manufacturers operate domestically and sell within a relatively limited geographic scope. Transportation costs can go as high as 10% of total cost of the product.
- As mentioned before, international trade for industry products is negligible. Industry's performance in international trade is also impacted by the level of internationalization in upstream industries as they affects the availability and price of wood materials for system built home manufacturers.
- Findings shows that firms acknowledge that exports offer growth opportunities. However there exists various legal, economic and political risks associated with dealing in foreign countries.

- Product quality, customer relations and custom design are considered to be the most important business success factors.
- The companies that are currently exporting reported no negative impact of internationalization on their domestic sales. But the share of exports as compared to domestic sales is very limited.
- Majority of export currently done to Northern Asia and Pacific Rim region of the world.

Companies that are not exporting currently also want to know more and export their product

Barriers to industrialization of wood construction

Prefabricated system causes additional costs in the project like shipping, craning, installation on site, manufacturing facility overheads and increased company overheads (Prefabitats, 2016).

Key drawbacks with the practice of building off-site are:

- Design limitations: Despite the ease of working with wood, the architects and engineers are limited by the feasible manufacturing configurations. For example, simple rectangular wall with parallel top and bottom plates is far easier to automate and produce in a factory than walls with irregular dimensions and/or sloped tops. There is also a limitation of dimensions of panels due to machine and transportation medium restrictions (Anderson & Anderson, 2007).
- Shipping: The units, irrespective of their intermediary form, are required to be shipped to the construction site. Shipping costs associated with modules are considerably larger than that associated with panels and kits owing to the large size. This post manufacturing transportation is generally limited by the medium of transportation, distance and route followed and are often viewed as incremental costs. But it is also important to note that not

all of these costs should be considered additional as the traditional site built system also requires raw materials to be delivered to site. This increase in turn also limits the size and scale of manufacturing operations.

- On-site installation: Prefabricated construction requires the use of cranes and associated skilled labor at the time of installation on site. The requirement and complexity depends upon the nature of prefabrication; modular, panelized or precut along with the complexity in each design. The cranes act as a fixed cost and when coupled with the costs of hiring skilled operators can act as significant incremental cost. Such heavy machinery is not otherwise commonly implemented in on site traditional construction system. Degree of prefabrication is an important metric in this system. It differentiates the amount of work completed in the controlled environment of the factory and the remaining amount of work done on site. The costs fractions will then depend upon the nature and location of project (Anderson & Anderson, 2007).
- Manufacturing overhead: This is the major fraction of manufacturing cost which is usually omitted when comparing with on-site construction (Prefabits, 2016). Overhead costs associated with the production facility like rent, depreciation, management, utilities and insurance, safety and quality control and unallocated personnel. The best way to minimize these costs like any other manufacturing process is using economics of scale and scope provided there is a potential market.
- Company Overhead: The prefabricated systems are can be more expensive than the traditional construction because the manufacturing companies tend to keep considerably higher margins as compared to traditional contractors. This can be to cover corporate

overheads. These companies also offer better working conditions, assures safety of the workforce and have different departments (marketing, design, engineering and procurement) as compared to general contracting firms (Ludeman, 2008).

- Negative perception of quality: Off-site construction even in the domestic residential construction market of the United States is widely associated with a stigma of being built, low quality buildings that have a short life span and would need replacement. The technique of off-site construction is also regarded to in achieving efficient quality and detail as traditional on-site construction.
- Fear of innovation: As with any other mature industrial sector, fear of change also holds back the innovation in construction. Builders often try to avoid using system built components as they perceive it to be inconvenient and expensive.
- Lack of information and understanding: It is really important for all the stakeholders (clients, developers, owners, designers, engineering and construction professionals) to have confidence and clarity of the approach to implement prefabrication. There is a deficit of reliable information allowing owners and building professionals to make informed decision while selecting a particular building system or approach.

Thus in order to be competitive with the traditional site built homes, the prefab companies need to cover these incremental costs. This can be achieved using economies of scale and scope (Baack, Harris, & Baack, 2013). Large scale provides companies the benefits of reduced material, shipping, craning and site development costs. This also leads to decrease in manufacturing and corporate overheads. The prefab companies can invest in automated production lines, develop multiple configurations with same facilities, reduction in inventory

and labor costs. But all of this is possible only when there is enough demand in the market. This can be bit difficult when a variety of market is being targeted and no single location is capable of offering enough volume on its own. Figure 4 gives a perspective of the financial performance of this industrial sector in 2015 (Carter, 2015). After hard hit by the recession, a total profit of only 2.2% was expected in the fiscal year 2015. Majority (62.2%) of the revenue is used to purchase raw materials. Surprisingly, the labor costs accounts for considerably higher than the wood products sector by 7.4 percent. This could be because of labor intensive customizations, smaller size of firms with inability to invest in more automated facilities. Other expenses includes but not limited to rent and utilities, interest, general selling and administrative expenses, restructuring, marketing and legal expenses, among others.

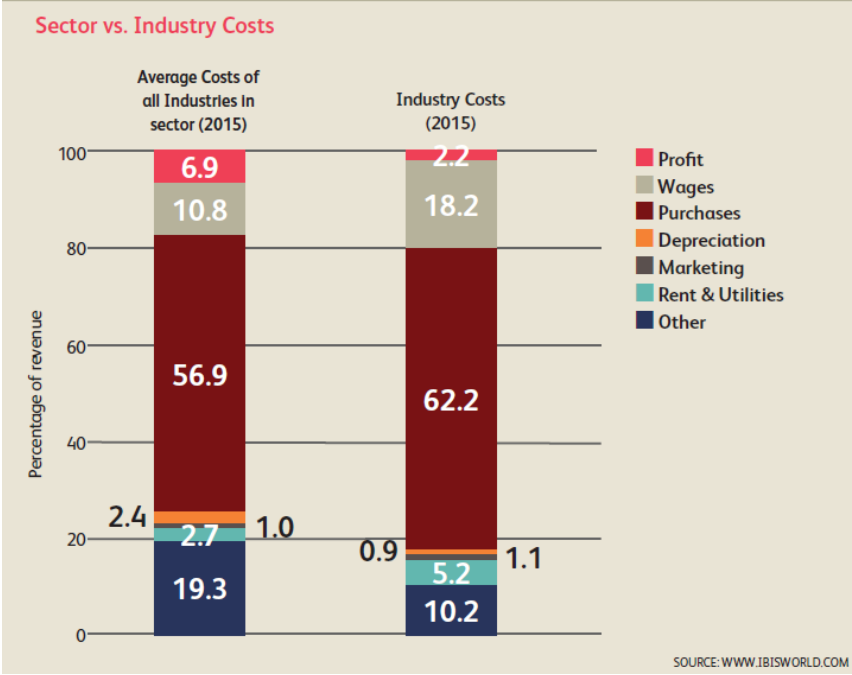


Figure 4 Cost Structure of the Off-site Manufacturing Industry in 2015 and Comparison with Wood Products Sector (Carter, 2015)

Despite the above mentioned hurdles, the prefabricated companies are more capable to incorporate green technologies and design efficient buildings. This can be achieved through

centralization and incorporation of design, engineering, procurement and manufacturing making it a competitive advantage over the traditional site built construction technology (McGraw-Hill Construction, 2011).

Urban social housing in developing countries

Although prefabrication is a mature method of construction in many European countries and in the U.S., several countries in Latin America are still not familiar with this method. Because of the nature of their socio-economic system, Latin countries tend to use more actual manpower for constructions rather than prefabrication methods. Construction methods that require a lot of physical labor such as masonry, hand paint or cast-in-place concrete are common in the region (Brednoord, Lindert, & Smets, 2014). This gives companies in the U.S. a critical advantage to manufacture and fulfill this housing demand in the region with the advancement in its prefabrication systems and application of sustainable practices in wood construction. The geographical proximity, trade relations and existing business corridors would further support this endeavor.

Market opportunities: Urban Social housing in Peru, Colombia and Ecuador

This section summarizes the findings of the study from market analysis conducted in Peru, Colombia and Ecuador. Being first of its kind in the region specifically for analyzing market opportunities for U.S. built prefabricated panelized wood housing systems, the focus was to gather macro information from the major capital cities of the target countries. Key highlights of policies and schemes associated with the social residential housing are discussed first followed by current solutions in the market by major construction companies. The findings also include highlights of major financial and supervising institutions supporting/ monitoring such projects.

Lima, Peru

With construction industry one of the engines of economic growth, current housing deficiency is a major concern of the Peruvian government. There is additional pressure on the government as the cities expand and the households migrate to urban areas in search of better jobs. This also leads to increase in land prices indirectly affecting the construction costs. Most of these migrating households are low to medium income families that move to illegal constructions on the periphery of the major cities instead. Figure 14 shows the types houses currently available to low income households in the periphery of Metropolitan Lima, Peru.



Figure 5 Current Housing Solutions for Low Income Households in Metropolitan Lima

Policy: Techo Propio/ Adquisición de Vivienda Nueva (AVN) [Own Roof/New Housing Acquisition] is an umbrella policy in place to support social housing projects. This program has been implemented since 2002 with the aim to create a subsidized housing market for low-income households. The policy attempts to resolve the problem of high and increasing cost of land and construction, informality and social inclusion.

Current status of residential construction: Brick and concrete are the most commonly used material in construction. Prefabrication, both in wood and concrete, is not commonly used in residential construction. Despite different support programs, there are only few builders in

Lima, Peru working exclusively in social housing projects due to lack of profitability using current construction methods. Progressive housing is a common feature of low and middle income households in the country where they start with a very basic structure and empty lot. The family built floors and expand the house over time. Despite that, there weren't any specific cultural/regional design/architectural requirement reported, the durability and maintenance of wooden buildings as compared to concrete buildings in the humid climate of Lima can be a deciding factor. According to CAPECO (Chamber of Construction, Metropolitan Lima), metropolitan Lima alone had an expected demand of 443,544 units in 2014. But there were only 27,952 (6.3% of the demand) homes built. Fifty percent of the unfulfilled demand was for the units below the sale price of 40,000 USD (ownership cost including land and construction).

Use of wood as a construction material: The use of wood is limited to non-structural applications only. There are few high cost projects that used wood for structural applications but the market share is very limited. The policy has a major role to play in regulating the use of wood. According to existing guidelines, only the indigenous species can be used as structural component in government projects. There is a provision to include foreign wood species after going through the testing procedures. Grades of materials and guidelines approved by the United State agencies could be easily accepted by the Peruvian regulatory agencies and can help speed up the process. The interviewed stakeholders widely acknowledged the benefits of wooden construction in form of better seismic resistance, lower construction time, and low cost, environmental friendly over concrete construction. Wood construction can also be used as emergency shelters in the remote regions of the country. Ease and speed of building a prefabricated house can have an extra edge over concrete construction.

Bogota, Colombia

The Colombian housing market varies from luxurious homes to temporary shacks with bare minimum infrastructure. While there is a well-developed mortgage system to finance housing, the low income households still fail to get houses from formal market. As a result, this section of the market resort to informal construction. In Bogota alone, 54 percent of the homes built between 1993 and 2005 were built informally (Florian A. , 2011) which in itself varies in quality and concentration across different parts of the city.

Policy: The state does not build homes under any schemes, but encourages and supports private sector. Proposals for projects are invited once a need is determined by the government. The proposals are examined and projects regulated by Findeter, a third party mediator and a developmental bank. Findeter is financial management institution for social housing and is also involved in budget planning each year. The proposal does not specify any material or design usage. Project designs have to be approved by the government entity, “Curaduria Urbana” before it’s implemented. These homes should be durable and hard to break in. Despite high government interest, only a few construction companies participate in social housing projects. Returns from the projects were reported to be highly dependent on scale of projects. As of March, 2016, the housing policy in Colombia had four different schemes to support housing needs of low income households.

- **Mi Casa YA (My House Now):** This is a short term policy to support eligible households with income between 2 to 4 times the current legal minimum wage (689,455 Colombian Peso or 230 USD/month, 2016) to buy houses costing from 70 to 135 times the legal minimum

monthly wage. The scheme designed to benefit 130,000 households from 2015-2018. These houses can range from 16,100 – 31,050 USD.

- VIS (Affordable Social Housing): This program aims to build houses under the value of 135 legal minimum monthly salaries. Currently, a demand of 77,000 houses is estimated in this program. This policy covers houses under the cost of 31,050 USD without any restrictions on selection of beneficiary households.
- VIPA (Priority Interest housing): The maximum value of houses built in this program cannot exceed 70 legal minimum monthly salaries i.e. a total cost under 16,100 USD. This type of housing targets population in extreme poverty, the network “red unidos”, displaced rural population by guerrillas, and displaced citizens by natural disasters. Average size of these homes is 48 m². The program aims to cover more than 100,000 households in different zones (4, 5 or 6) of urban areas.
- *Fondo de Estabilizacion de la Cartera Hipotecaria* (FRECH): FRECH is a public hedge facility supporting social housing. The benefit provides reduced interest rates to eligible households and act as a stabilization buffer to counter inflation.

This limiting cost also includes the lot cost (< 53 m²) which goes up to 10 percent of the total cost of the single family unit. The allotted project may include availability of a fully developed site with installed utility lines or it may also include site development as builder’s responsibility.

Current status of residential construction: The building code is designed specifically to withstand high seismic activity. The projects also need to demonstrate effective performance with energy and water consumption efficiency, a focused area in current national Sustainable Energy law. A total of 19,758,964 m² in area licenses were issued in the year 2015 for

residential house construction out of which 25 percent (4,971,147 m²) of the land was dedicated to VIS projects. The majority of the households that fail to get support from any of these schemes; prefers progressive housing as a solution through self-help process. This incremental self-construction is major feature of low-income housing market in Bogota as well. Concrete in combination with steel is the most prevalent construction material in the nation. Share of other materials, including bricks is approximately 11 percent. Every new material to be used in construction requires an approval from Colombian Society of Engineers.

Use of wood as a construction material: The majority of the interviews reported lack of expertise for building with wood. Current use of wood in construction is predominantly limited to non-structural applications. This is also due to unavailability of graded, rated lumber and the negative impression of wood construction. The wood is considered either for expensive construction projects or very low cost temporary housing. Three types of projects involving wooden construction in Colombia were recorded. TECHO, nonprofit international firm, has built 1500 units (6X3 meters) in Valle Aurra region of the country. These units were reported to be imported from Chile. Programa “Aldeas” (Program “Village”) is one of the flagship initiative for social housing by EPM, group of companies located in Central America, Chile, Mexico, United States, Spain and Colombia, with headquarters in Medellin, Colombia. Wood from their private plantation was used to develop the project. The project aims to deliver 1400 homes in 3 phases. Along with poor families, they are also covering households relocated due to hydrothermal projects in 6 districts of the region.

A foreign company can participate in bidding process by demonstrating a construction experience of up to 5 years or by partnering up with local companies. Current housing projects

for low income households range from 100 to 2000 dwelling units per project. With current practices, at least 400 units are necessary to make a project profitable for the builder. Big companies already tend to subcontract construction processes if deemed feasible. The builders prefer vertical construction to reduce costs but the people like horizontal construction more.

Quito, Ecuador

The deficiency in the housing in Ecuador is spread across both the rural and the urban parts of the nation. Housing conditions vary considerably from city to city, but unfortunately there is very little data to compare cities in Ecuador, either among themselves or with cities outside Ecuador.

Policy: The constitution of Ecuador guarantees the right to housing which implies that the state is responsible for ensuring that all its citizens are properly housed. But it's not state's primordial function to produce the necessary assets and services, but the state will guarantee that society will have the required mechanisms for accessing these assets and services. Its basic role will be to motivate, to channel, to facilitate, to regulate, to set norms, and to coordinate the agents engaged in urban development. The government has taken an enabling role where instead of being directly responsible for producing the houses, it oversees and corrects the housing sector as a whole. In other words, the government enacts and enforces laws and regulations, corrects market failures, and provides institutional, technical, and financial support to the stakeholders, while relinquishing control over the building, lending for, buying or selling, owning or renting, managing or maintaining houses and apartments. This enables the key stakeholders in the housing sector dwellers and communities, builders, lenders and local governments to work efficiently and equitably towards meeting housing needs.

Current status of residential construction: Evaluating the housing markets, despite the slow economic growth, it is fairly easy for the buyer to secure credits and get a home. Progressive housing is again one of the major features defining residential construction in low and medium cost construction. The household expands the building both vertically and horizontally on the same lot over time. This cultural aspect is used by the builders as well. Selling a unit with basic minimum required construction reduces the cost. It also gives the household an option to make a custom designed unit that best suits their needs. One of the companies interviewed during the visit very efficiently incorporated modular design to allow future expansion and delivering units with different levels of finish to keep the costs down.

The social housing policy requires the unit cost to be under \$40,000 USD 15-20 percent of which is usually the land cost and rest is allocated to the site development and construction. Many companies develop projects with units of mixed costs ranging from medium to low in order to assure the overall viability of the project. These builders also prefer vertical construction to save on land costs. But the consumer still prefers detached homes or horizontal homes. Since the current use of wood is limited with little wood working knowledge, there is a need to develop marketing and promotion plans educating the stakeholders of the benefits of wood in construction.

Use of wood as a construction material: The use of wood is majorly restricted to non-structural applications. Limited knowledge about the application, poor perception and availability of wood were found to be the major reasons for low utilization of this resource in residential construction. Despite low current use, the market size and push to find alternating materials capable of better sustaining the earthquakes gives an opportunity to promote the use of wood

as structural component in residential construction. This was evident from the increasing use of Bamboo in residential construction of earthquake prone coastal regions. The perception to use it as structural component among the low-income consumers changed substantially after recent devastating earthquake of April 2016 in south-eastern region of the country. But lack of performance standards for building with Bamboo or any other alternate material was a major concern among the builders and designers. There are no reported restrictions on the use of wood in construction. There are agencies that can assist the companies in planning projects and drafting proposals for the social housing projects. There is no restriction on participation of foreign companies provided the project is approved. The awareness of benefits of using wood and education and perception of using it can be major hurdle in the Ecuadorian market. But the push to find renewable materials and architectural abilities when supported with correct programs can help break this taboo. This would help opening new markets for the wood construction in general and prefabricated wood building manufacturers in the United States can take a lead in this market.

This study introduced the possibility of using prefabricated wood construction system developed in the United States to develop affordable alternatives to current construction practices in urban social housing. Table 18 summarize findings across all the three countries. As highlighted before in the report, pre-fabrication in building helps in optimizing construction by reducing time, environmental effects, health and safety risks, building defects and its life cycle cost. The technique also increases net productivity, whole life performance and net profitability. The housing market deficit of the studied countries summarized in Table 4 shows an opportunity for innovative techniques to fulfil the gap. Wood pre-fabricated housing

systems can be one of the possible alternatives. This generates an opportunity for such system manufacturers in the U.S. These manufacturers can take advantage by developing custom products for each housing market segment.

Table 4 Summary of the Findings

	Peru	Colombia	Ecuador
Identified housing deficit (fraction of total households)	72%	37%	50%
Government's concern to tackle social housing	Yes	Yes	Yes
Traditional construction method	Block and concrete	Block and concrete	Block and concrete
Preferred building type	Detached	Apartment buildings (Up to 5 floors)	Both detached and apartment homes
Average floor area of social housing (m ²)	20-25 m ²	20-30 m ²	45-60 m ²
Selling price of single family homes (USD)	\$25,000-\$45,000	\$16,000-\$32,000	< \$40,000 (social housing) \$40,000-\$70,000 (public housing)
Profitability of social housing projects	Average	Below average	Average
Use of wood in construction	Non-structural	Non-structural	Non-structural
Building code for wood	Absent	Present	Present
Restriction on using imported wood species	Yes	No	No
Awareness of use of wood in construction	Limited	Limited	Limited
Social perception of wood construction	Poor	Poor	Poor
Other probable markets	Mining displacement camps and housing in hilly regions	Projects with less than 250 units	Coastal and high seismic prone regions

Due to urgent need and large scale of projects, social housing segment can prove to be a favorable segment. Existing trade channels and policies between the U.S. and these three countries would further support such expansion. The mode of entry depends upon the levels of corporate control, internationalization cost and associated risk the company is willing to maintain. U.S. pre-fabricated system manufacturers can go international by exporting straight to the local builders with or without using intermediaries. Direct exporting would mean least investment risk and costs but lacks the control over supply chain. Manufacturers from the U.S. can also make long term partnerships with local agencies to form joint ventures with certain level of ownership. Local partners can be responsible for providing access to residential construction market, site selection and development while the U.S. manufacturers could be responsible for developing and manufacturing the wood housing systems. This entry mode would involve higher costs of internationalization as compared to exports. The risk of failure now would be shared between both the partners. Joint venture involves formation of a separate legal entity. If any of the partner is not willing to do that, there is an option of formulating strategic alliance. It is very similar to joint ventures but does not involve formation of new organization. Another major entry mode that the companies in the U.S. can take is by establishing a wholly owned subsidiary. But this would require the U.S. companies to comply with local rules, adjust to local culture and language, accommodate to local economic conditions and expect support from local infrastructure.

- **Increase the market share**

The system built wood construction industry in the United States needs to communicate the value in better way to residential consumers. Current market share highlights this need.

Without this added value proposition, the industry will eventually lose ground to traditional on-site construction. Product quality, customer relations and custom design were the three most important success factors for the industry in this research. The companies should built on these performance measures while improving their market share.

- **Industry collaboration and integration**

One of the key barriers hindering the progress of this industry identified in this research was lack of sufficient collaborative efforts. It is particular not to just the system built sector but all of the residential construction industry. This was further supported by this work that identified knowledge and information related factors preventing foreign trade. Majority of the companies surveyed in this research lack required knowledge for using foreign trade agreements and associated regulatory complexity. Difficulty on forming partnership and providing after sales service were other two important barriers to exports. The companies can come together and work on these issues collaboratively with a comprehensive focus of improving long term acceptance both in domestic and international market.

- **New markets and market segments**

Findings from the research indicate that the sector needs to increase its market share in residential construction market as compared to the other developing countries in Europe and North America. It is clear that more research and development needs to be conducted both to develop product and market. This would help the industry to gain confidence of stakeholders and move to a widely appreciated technique. Some of the current requirements include further improving design and manufacturing capabilities to develop custom products both for domestic and international markets. The companies also need to invest in researching new and

innovative ways to convey the benefits of off-site wood construction and hence convince more customer to use it.

- **Need for better guidance and communication**

The industry should work on developing a best practices guide that includes all the information regarding performance, quality, materials to be used, dictating construction codes and benefits of projects preventing confusions of owners, professionals and associated jurisdiction authorities. It is also important to have consensus of all the stakeholders and use regular communication during marketing, development and promotion of system built wood construction projects.

Specific Recommendations

- Develop extensive programs and marketing strategies to introduce system built wood construction manufactured in the United States targeted for specific markets. Such programs should be directed at informing and educating all stakeholders associated to housing market. This should include but not limited to builders, consumers, suppliers, government official and policy makers as key stakeholders who would need to be informed of the benefits of using off-site construction. This might include project demonstrations, information on performance of such systems, educational activities and developing partnerships.
- Use existing manufacturing and export of wood housing systems all over the world to develop benchmarks and identify best business practices.
- Analyze social perceptions, current construction practices used in new markets or specific market segments and use the information for developing custom design and production systems.

- Demonstrate risks and returns of system built wood construction solutions compared to traditional construction.
- Develop easy to use custom guidelines both for domestic and international markets for the stakeholders to use and make informed decisions on incorporating system built wood construction solutions into projects. It should include design principles, performance guidelines, building strategies, project timelines to be used as tools to support strategies and associated decisions.
- Provide overview of manufacturing and supply capabilities of the industry in United States to be used by associations and trade groups in foreign markets. This also includes developing long term associations.

Develop long term plans for internationalization of U.S. manufacturing. Identify partners, develop associations and develop investment roadmap aiming to make a successful export business model.

Specific strategies that can be implemented in studied market of urban social housing in Peru, Ecuador and Colombia

- Develop awareness programs by partnering with stakeholders in target markets with an aim to educate on benefits of wood construction. These programs should be designed and implemented specifically for each of the stakeholders in housing value chain to the foreign market. Programs developed for government should aim at assisting policy and regulatory framework for using wood construction. Programs for construction companies and builders should intend to introduce principles of wood construction and associated design parameters

used in residential construction in the United States. There should also be programs for the final consumers to help improve the perception of use of wood in construction. This can include but not limited to different demonstration projects, development of education materials in local language highlighting risks and returns associated with prefabrication of wood construction.

- Based on the inputs from stakeholders, develop a roadmap with key indicators impacting decisions to use wood prefabrication from beginning to the end. This should include development of custom design parameters depending upon the local environmental conditions and selection of appropriate materials. There should also be tools in place incorporate efficient certification systems in place assure uniformity and replicability in future projects. This can be done by using construction code in the U.S. and that of the target market.
- The companies in the United States interested in exporting to these markets should also work closely to understand local building criteria, bidding strategies, project economics and critical stakeholders in the complete value chain.
- Develop product performance parameters acceptable in foreign market. These product performance standards for structural testing, serviceability, consumer perception, durability and protection, social acceptability, energy and environmental performance, fire and seismic performance, acoustic performance and onsite installation and after sales performance.
- Since a single manufacturer in the U.S. might not be able to be able to invest in all of the above mentioned recommendations, formation of a consortium or an association of the

companies dedicated to working closely with the stakeholders in foreign markets in mapping out and identifying key actors. The findings from interviews conducted in this study according to agendas attached along can act as a guideline in drafting the initial planning.

- The association of manufacturers in the United States should also work on developing an overview of existing manufacturing capabilities and identify major companies that have the capacity to export.

Appendix:

Meeting agendas for Lima, Peru



Gold Key Service

Schedule of Appointments - Lima, Peru

Virginia Tech University

Prepared for: Mr. Gaurav Kakkar, Virginia Tech University
Dr. Bob Smith, Head Department of Sustainable Biomaterials

Contact: Gustavo Romero - Commercial Specialist

Email: gustavo.romero@trade.gov

Phone: (51) 967-719-127

Contact: Erickson Rafael, Commercial Assistant

Email: erickson.rafael@trade.gov

Phone: (51) 947-033-261

Translator: Mariella Luna

Cell: (51) 997-978-804

Driver:

Cell:

Vehicle:

Wednesday October 14, 2015

08:45 – 09:00AM

Meet-up at lobby

Hotel Westin – Calle Las Begonias 450, San Isidro – Lima

10:00 – 11:00 AM

InGroup – InMobiliari / InConstructora

Av. El Derby 250 – Of.2001 Surco

Phone: (51)-1-615-3800 Ext.3914

Contacts:

Ing. Adolfo Molina, Ing. Alfredo Trabucco, Sr. Juan Carlos Alvarado

Erika Rodas, InConstructora Secretary

erodas@inconstructora.com.pe

Company Description:

InGroup (InMobiliari, InConstructora, InGerencia, ViBien) dedicated to the construction of residential, business, commercial and social housing projects like “Mi Vivienda” around Lima.

Web: www.inmobiliari.com.pe

11:30 – 12:30PM

Ministerio de Vivienda, Construcción y Sanamiento

Paseo de la República 3361, Edificio Petroperú, San Isidro

Phone: (51)-1-211-7930 Ext. 1701

Contacts:

Arq. Lucia Ledesma – General Director for Programs and Housing Projects

Sonia Huaman, Vice-Ministers' Secretary

Shuaman@vivienda.gob.pe

Company Description:

Lead Government agency in the field of Urban Planning, Housing, Construction and Sanitation, responsible for designing, regulate, promote, monitor, evaluate and implement sectoral policy. Contributing to the competitiveness and sustainable territorial development of the country, benefiting preferably population with fewer resources.

Web: <http://www.vivienda.gob.pe/>

LUNCH

03:00 – 04:00PM

PROMOCASA

Av. Mz. W2 Lt 8 Sector E-4 – Pachacutec, Ventanilla - Callao

Phone: (51)1-641-9475

Contacts:

Julio Quispe – General Manager

Cesar Leon – Commercial Manager

Technical Staff

cleon@promocasa.pe

Company Description:

Promocasa with 11 years of experience on Construction has been involved in social housing projects working along with Government agency with “Techo Propio” and “Mi Vivienda” projects.

Web: <http://promocasa.pe>

CONFIRMED

CAPECO (Friday 16th at 4PM)

Víctor Andrés Belaunde 147 - Edificio Real 3 - Of. 402 San Isidro - Lima

Phone: (51)-1-422-5566 Anex.216

Contacts:

Jose Luis Ayllon – Instituto de Construcción y Desarrollo President

jayllon@capeco.org

Company Description:

CAPECO, “Construcción Peruvian Chamber” is an organization, grouping and representing firms that operate in the construction sector in Peru. With over 50 years of experience. Organizer for ExCon – Peru.

Web: <http://www.capeco.org>

CONFIRMED

GMI S.A. (TBD in the morning)

Av. Paseo de la Republica 4667, Piso 7, San Isidro - Lima

Phone: (51)-1-213-5600 Anex.5843

Contacts:

Jorge Pimentel – Industry Division Manager

jpimentel@gmisa.com.pe

Company Description:

GMI, a leading Engineering Consultancy company, part of Graña y Montero Group. It has over 28 years of experience. Involved with multi-family residential house projects.

Web: <http://www.gmisa.com.pe/en/>

Meeting agendas for Quito, Ecuador



FINAL REPORT

**GOLD KEY MATCHING SERVICE
DEPARTMENT OF SUSTAINABLE BIOMATERIALS, VIRGINIA
TECH**

For: Mr. Gaurav Kakkar, Graduate Research Assistant, Department of Sustainable Biomaterials
 Dr. Henry Quesada, Associate Professor, Department of Sustainable Biomaterials
 Dr. Robert Smith, Professor and head, Department of Sustainable Biomaterials
E-mail: kakkarg@vt.edu

PREPARED BY:	LODGING: Quito
Sofía Zárate, Commercial Specialist Phone: +593-2-398-5512, Cel: 0981329500 E-mail: zaratesc@state.gov	Torres de Suites by InAmazonas Av. Orellana 1172 y Av. Amazonas +593 2-297-2102

To conduct your matchmaking service, Partner Post Ecuador office contacted 18 companies/organizations in Ecuador. The companies/organizations were carefully selected from our local contacts, industry sector directories, our Client Management System, local association lists, and other Commercial Service sources.

Based on the telephone conversations, e-mail correspondence and the information gathered from your presentation, we feel these firms can provide good insight for your research. We are still in the process of confirming matchmaking meetings with them. Please review the information provided and let us know your comments.

SUMMARIZED AGENDA

Tuesday September 6, 2016

Inmobiliaria CORBAL Mr. Jeff Sheedy CEO sheedyjeff@gmail.com	Time: 8:30am – 9:30am Location: Naciones Unidas 234 y Sanchez de Avila. Teléfonos de contacto: 593.2.2451.122, 593.2.2451.125, Celular: +593987376800
Confirmed www.corbal.com.ec	
Company profile: Inmobiliaria Corbal - Ciudad & Campo Cía. Ltda. was created in April 1974 to provide quality Real Estate services in Ecuador. The experience and expertise of its leaders allowed them to form a professional, efficient and visionary team that has achieved positive results. One of their key areas is Real Estate promotion.	



Wednesday September 7, 2016

<p>EMPRESAS PÚBLICAS PICHINCHA/ COVIPROV Guillermo Fernando Ruiz Cisneros fruib@empresaspichincha.com, Arq. Mauricio Peña mpeña@empresaspichincha.com Arq. Juan José Crespo, Gerente de la Unidad de Vivienda jcrespo@empresaspichincha.com, Arq. Claudia Páez, cpaez@empresaspichincha.com, Arq. Juan Carlos Báez</p>	<p>Time: 8:30am – 9:00am Location: Corea E1-48 e Iñaquito, Edificio Colegio de Ingenieros Civiles de Pichincha, piso 4, Unidad de Negocios Inmobiliarios. Telefonos: del (593)-02 - 2279-918 al 2279-929</p>
<p>Confirmed www.heq.com.ec https://www.facebook.com/COVIPROV/info?entry_point=page_nav_about_item&tab=pag_e_info</p>	
<p>Company profile: Empresas Públicas Pichincha/Covipro is the housing company of the Province of Pichincha, with fourteen years of real estate experience. The goal is to satisfy the housing demand, preferably of families that do not own homes, in compliance with rules and regulations. The company strives to continually improve processes and providing a rapid, timely and after-sales service.</p>	

<p>UN TECHO PARA MI PAÍS ECUADOR Gabriela Arrastua, gabriela.arrastua@techo.org</p>	<p>Time: 10:00am – 11:00am Location: 10 de Agosto y Villalengua, Edificio Inteca, Of 402. Teléfono: 0969096670.</p>
<p>Confirmed www.techo.org/paises/ecuador/</p>	
<p>Company profile: Techo is an organization operating in Latin America and the Caribbean that seeks to overcome poverty experienced by thousands of people live in slums, through joint action by its people and young volunteers. Techo is convinced that poverty can be overcome if society as a whole recognizes that this is a priority issue and works actively to resolve it. Therefore, ROOF has three strategic objectives:</p> <ol style="list-style-type: none"> 1. The promotion of community development. 2. The promotion of awareness and social action 3. The impact on policy. <p>85,000 families have worked together with volunteers in the construction of their homes.</p>	



<p>ARCHITEKTEN Arq. Felipe Palacios Partner fpalacios@architekten.land</p>	<p>Time: 12:00pm – 1:00pm Location: Distrito Creativo La Tejedora, Oswaldo Guayasamin E5-25 y Siena, Oficina 6, Cumbaya. Ofico: +593 2 2891 911, Cell: +593 984679588</p>
<p>Confirmed architekten.land/</p>	
<p>Company profile: Architekten is a collaborative and multidisciplinary studio, interested in exploring innovative solutions and opportunities in the overlap of space, program, form, budget and materiality. It is comprised of a team of architects who believe in the power of design as a tool to transform cities. Architekten has some experience with the use of sustainable materials in Ecuador.</p>	

[Lunch, Location TBD]

<p>COLEGIO DE ARQUITECTURA Y DISEÑO INTERIOR CADI – USFQ / COLLEGE OF ARCHITECTURE AND INTERIOR DESIGN Diego Oleas, M.Sc Director de Relaciones Internacionales CADI doleas@usfq.edu.ec icevallos@usfq.edu.ec</p>	<p>Time: 2:30pm – 3:30pm Location: CADI-USFQ, en la sala de profesores, Universidad San Francisco de Quito Diego de Robles y Vía Interoceánica, Cumbaya. Teléfono: 297 1764 / 297 1700 ext. 1527</p>
<p>Confirmed www.usfq.edu.ec/programas_academicos/col egios/cadi/Paginas/Contacto.aspx</p>	
<p>Company profile: The College of Architecture and Interior Design offers programs aimed at reaffirming the postulate that architectural design has been and will be the basis of professional education. The education of students is aimed at the development of a high level of excellence in project design and in their ability to build them effectively. The program provides students with rigorous training that integrates the creative and technical aspects of Architecture and Interior Design.</p>	
<p>COLEGIO DE ARQUITECTURA Y DISEÑO INTERIOR CADI – USFQ / COLLEGE OF ARCHITECTURE AND INTERIOR DESIGN</p>	<p>Time: 3:30pm – 4:30pm Location: Universidad San Francisco de Quito Diego de Robles y Vía Interoceánica, Cumbaya. Teléfono: 297 1764 / 297 1700 ext. 1527</p>
<p>Confirmed</p>	<p>Presentation by Dr. Henry Quesada "Mechanical, Acoustic, and Fire Properties of Southern Pine Cross-Laminated Timber."</p>



Thursday, September 8, 2016

ECO-ARQUITECTOS Arq. Pablo Castro Director General pablo@tec.com.ec	Time: 8:30am – 1:30pm Location: Burgeois N34-507 y Republica. Telefonos: 3 317 206, 3 316 429, 3 317 423.
Confirmed www.eco- arquitectos.com/web/index.php/nosotros/asociados	
Company profile: ECO Architects started operations more than 30 years ago by Eduardo Castro Orbe. It is mainly engaged in the construction of housing complexes in the form of price at cost. In 1999, the government created the "Housing Bonds" and the company created a partnership with the Ministry of Housing (MIDUVI) to run real estate and housing projects. Until today, this company has built more than 100 projects around the country, mainly in Quito and San Antonio de Pichincha. ECO Architects S.A. has 70 technicians and has built 48 buildings, 1,022 multifamily homes, 4,830 social housing homes and a total of 2,212 housing bonds executed.	

[Lunch, Location TBD]

AIMA (ECUADORIAN ASSOCIATION OF INDUSTRIAL WOOD) Christian Riofrio Director Ejecutivo director@aima.org.ec	Time: 4:00pm - 5:00pm Location: Av. Amazonas y Republica, Edif. Las Camaras, Piso 7. Telf: (02) 226 0980 / (02) 243 9559. Cel: 099 333 8138. director@aima.org.ec
Confirmed www.aima.org.ec	
Company profile: Aima is a trade, national, private, nonprofit organization created in 1976 under Ecuadorian law, with the aim of promoting sustainable forest development, encourage reforestation and promote the growth and competitiveness of the timber industry.	



<p>SECRETARÍA DE TERRITORIO, HABITAT Y VIVIENDA, DIRECCIÓN DE EJECUCIÓN DE PROYECTOS Y ESTUDIOS (MUNICIPAL HOUSING COMPANY IN QUITO) Carlos Francisco Estupinán Trujillo, Especialista de Ejecución de Proyectos y Estudios (carlos.estupinan@quito.gob.ec) Sebastián Zuquilanda Peralvo, Gerente General (dzuquilanda@hotmail.com, sebastian.zuquilanda@quito.gob.ec)</p>	<p>Time: 12:30pm – 1:30pm Location: Av. Amazonas N79-39 y Av. de la Prensa, Centro de Eventos Bicentenario, Tercer piso. Teléfonos: (593) 2 3303682 ext 146 - 120.</p>
<p>Confirmed www.quito.gob.ec/index.php/secretarias/secretaria-de-territorio-habitat-y-vivienda</p>	
<p>Company profile: The Empresa Pública Metropolitana de Hábitat y Vivienda was created to execute the policies issued by the Metropolitan District of Quito (Municipality) on land supply; urban development and promotion of first homes for families or individuals; families with low and middle-income, vulnerable or in a risk situation; urban renewal and housing improvement: new housing for land owners in urban and rural areas, thereby helping to reduce the housing deficit.</p>	

[Lunch, Location TBD]

<p>MIDUVI, Subsecretaría de Hábitat y Asentamientos Humanos (MINISTRY OF HOUSING) Verónica Bravo Subsecretario de Estado (vpbravo@miduvi.gob.ec), Elvia de Lourdes Villafuerte, Servidor Público 1, (lvillafuerte@miduvi.gob.ec)</p>	<p>Time: 3:30pm – 4:30pm Location: Av. Amazonas entre Luis Cordero y Calama. Teléfono: (593) 2 2983-600 ext 1002, 1031</p>
<p>Confirmed www.habitatyvivienda.gob.ec/</p>	
<p>Company profile: Promote sustainable urban development and a dignifying and safe habitat. Exercise stewardship and implement public policy, guaranteeing citizens access to a safe and healthy habitat, decent housing and inclusive public space.</p>	



<p>CAMARA DE LA INDUSTRIA DE LA CONSTRUCCIÓN, CAMICON (CHAMBER OF CONSTRUCTION) Ing. Ivan Zaldumbide Jefe del Departamento Técnico izaldumbide@camicon.ec Arq. Daniela Cifuentes dcifuentes@camicon.ec Ing. Estefanía Abad eabad@camicon.ec Ing. José Parrales jparrales@camicon.ec</p>	<p>Time: 9:45am – 10:45am Location: Calle Juan Pablo Sanz e Inaquito esquina, Edificio CAMICON. Telefonos: (593)-2 2442187 2439241 2432370 ext. 630 / 0998768773. izaldumbide@camicon.ec</p>
<p>Confirmed www.camicon.ec</p>	
<p>Company profile: The Chamber of the Construction Industry is an organization that promotes socio-economic development and welfare of the population by promoting the construction of infrastructure and quality housing, by promoting ethics and transparency principles, as well as care for the environment. The Chamber provides training, mediation, legal advice and research services and organizes trade shows and events for its members and the community.</p>	

<p>CORPORACIÓN FINANCIERA NACIONAL - CFN Ing. Santiago Revelo S. Gerente de División de Productos y Servicios srevelo@cfn.fin.ec</p>	<p>Time: 11:00am – 12:00pm Location: Inaquito 36A, entre Naciones Unidas y Corea, Telf: + (593 2) 3935700 - ext. 2163. srevelo@cfn.fin.ec</p>
<p>Confirmed www.cfn.fin.ec/</p>	
<p>Company profile: The National Financial Corporation is a public financial institution whose mission is to channel financial and non-financial products aligned to the National Plan for Good Living to serve the productive sectors of the country.</p>	

Meeting agendas for Bogota, Colombia



AMCHAM MATCHMAKING SERVICE

AMCHAM MATCHMAKING SERVICE VIRGINIA TECH

For: Gaurav Kakkar
E-mail: kakkarg@vt.edu

PREPARED BY:	LODGING: Bogotá	TRANSLATOR
Natalia Mendez , Trade and Investment Center Executive Phone: (57 1) 587 78 28 ext. 123 Mob: 318 409 69 14 E-mail: centrodecomercio2@amchamcolombia.com.co		
TRANSPORT		

SUMMARIZED AGENDA Monday, March 14th 2016

ARRIVAL TIME OF THE DRIVER	Time:
HOTEL	

CAMARA COLOMBIANA DE CONSTRUCCIÓN Karen Ortega - Construction Studies Coordinator	TIME: 10:00 AM
Confirmed	Address: Carrera 19 # 90 - 10 - 3d Floor, Camacol Building Phone: +57 (1) 743 0265 ext. 1365 E-mail: kortega@camacol.org.co Web site: www.camacol.co
Profile: CAMACOL leads the urban responsible and sustainable development, looking for a deficit reduction housing and the projection of the sector to new business opportunities and new markets.	



AMCHAM MATCHMAKING SERVICE

CONSTRUCTORA OIKOS John Jairo Beltrán – Planning Control Manager	TIME: 4:00 PM
Confirmed	Address: Carrera 16A # 78-55, 6 th Floor Phone: +57 1 651 6141 E-mail: gerenciasip@oikos.com.co Web site: www.oikos.com.co
<p>Profile: OIKOS line of construction development is based on 4 pillars: Architectural design and coordination of technical studies, Budget and Programming work, Construction of Buildings and environmental sustainability and operational efficiency. This company makes various housing projects for low income families in Colombia known as social housing.</p>	

Wednesday March 16th, 2016

ARRIVAL TIME OF THE DRIVER	Time:
HOTEL	

CONSTRUCTORA BOLIVAR Fernando Ospina - Director of Research and Processes	TIME: 9:00 AM
Confirmed	Address: Calle 134 # 72 - 31 (Av. Boyacá con Calle 134) Phone: +57 1 6258330 E-mail: fernando.ospina@constructorabolivar.com Web site: www.constructorabolivarbog.com
<p>Profile: CONSTRUCTORA BOLIVAR has released the construction of urban projects for all social strata and now has full capacity to perform the work of Construction Management, Sales and Promotion directly.</p>	



AMCHAM MATCHMAKING SERVICE

Tuesday March 15th, 2016

ARRIVAL TIME OF THE DRIVER	Time:
HOTEL	

CONSEJO COLOMBIANO DE CONSTRUCCION SOSTENIBLE Miguel Orejuela – Education Director	TIME: 9:00 AM
Confirmed	Address: Carrera 7 No.74-56 Office 609 Phone: +57 1 7430950 E-mail: educacion@cccs.org.co Web site: www.cccs.org.co
<p>Profile: The Colombian Sustainable Building Council (CCCS) is a private nonprofit organization founded in 2008. This organization leads the transformation of the collective consciousness towards a sustainably built environment with the support of its strategic capital and +200 Members (companies, schools, universities, NGOs and associations).</p>	

Instituto de Desarrollo Urbano - IDU Sandra Liliana Angel - Deputy Director General Infrastructure	TIME: 11:00 AM
Confirmed	Address: Calle 22 # 6-27 Phone: +57 1 338 6660 ext. 1801 E-mail: sandra.angel@idu.gov.co Web site: www.idu.gov.co
<p>Profile: Governmental entity that looks to develop integrated urban projects to improve mobility conditions in terms of equity, inclusion, safety and accessibility of the inhabitants of the Capital District.</p>	



AMCHAM MATCHMAKING SERVICE

FINDETER Ana Maria Cifuentes-Planning Manager	TIME: 11:30 AM
Confirmed	Address: Calle 103 No. 19-20 Phone: (571) 623 0311 E-mail: icastro@findeter.gov.co acifuentes@findeter.gov.co Web site: www.findeter.gov.co
<p>Profile: Findeter is the development bank for sustainable infrastructure in Colombia. The organization leads and finances programs of national and regional interest focused on sustainable projects. Findeter works with the Colombian Government through the Ministries of Finance and Public Credit, Housing Minister and national agencies such as the Department of National Planning, among others.</p>	

METROVIVIENDA Alejandro de Angulo - Technical Director of Works	TIME: 2:00 PM
Confirmed	Address: Calle 52 No. 13 – 64, 7 th Floor Phone: +57 1 359 9494 ext. 440 E-mail: alejandrodeangulo@metrovivienda.gov.co Web site: www.metrovivienda.gov.co
<p>Profile: Metrovivienda is a company of the town hall of Bogota that promotes the construction and acquisition of affordable housing in the city, with the primary aim of ensuring the most vulnerable and disadvantaged housing a decent housing with access to public services, recreation areas, facilities for urban areas, and in general, spaces that promote the effective exercise of the full human rights.</p>	

Appendix J: IRB approval letter



Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website <http://www.irb.vt.edu>

MEMORANDUM

DATE: December 16, 2015
TO: Henry Jose Quesada Pineda, Gaurav Kakkar
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)
PROTOCOL TITLE: Increasing Exports of US Wooden Modular Homes to Developing Countries
IRB NUMBER: 15-1058

Effective December 16, 2015, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: Expedited, under 45 CFR 46.110 category(ies) 7
Protocol Approval Date: December 16, 2015
Protocol Expiration Date: December 15, 2016
Continuing Review Due Date*: December 1, 2016

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

MEMORANDUM

DATE: January 9, 2017
TO: Henry Jose Quesada Pineda, Gaurav Kakkar
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)
PROTOCOL TITLE: Increasing Exports of US Wooden Modular Homes to Developing Countries
IRB NUMBER: 15-1058

Effective January 9, 2017, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at: <http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date: **December 16, 2016**
Protocol Expiration Date: **December 15, 2017**
Continuing Review Due Date*: **December 1, 2017**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Invent the Future