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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

A considerable portion of the developing world is living in substandard houses. Developed countries like the United States have substantially improved the residential construction sector by engineering new materials and developing efficient systems. Composite materials, factory-built prefabricated houses, advanced production methods, better designs, and access to abundant resources make the U.S. a world leader in the wood construction industry. This research is focused on characterizing the housing market for bottom-of-the pyramid buyers in developing parts of Latin America to give them an affordable yet sustainable alternative to traditional systems. This study attempts to link the capacity of the system-built wood construction sector in the U.S. to urban low-income housing markets in Peru, Ecuador, and Colombia. Case studies and surveys were used to assess key aspects of housing deficits. Our findings indicate that developing products for social housing programs can provide access to potential untapped markets. There is an opportunity to develop economic, sustainable, hybrid housing solutions for low-income households. Existing policies and trade relations would support this development. Current awareness of and perceptions about wood construction are very limited in the region, however. The lack of existing wood construction in these markets indicates a possibility of resistance to acceptance, but also assures no local competition. This research contributes to the opening of new markets for exports of prefabricated wooden buildings in other housing sectors. The same approach can be extended to improve U.S. exports of value-added wood products to Latin America.

Keywords: exports, system-built wood construction, panelized housing, social housing, internationalization

1 Introduction

Latin America (including the Caribbean) includes some highly urbanized regions of the world. It is estimated that this urban population will grow from 75.5% in 2010 to 84.6% in 2030, mirroring the developed regions of Western Europe and North America (McBride & French 2011). This fast-growing urban population has increased the need for housing, but the majority of the countries in the region have not been able to withstand the im-

mense pressure on the supply and cost of urban land and housing (UN-Habitat 2016). This is indicated by the appalling differences in the living conditions between the rich and poor (Bouillon 2012). As a result, housing affordability has become a critical issue (Brednoord, Lindert, & Smets 2014). Three major but interrelated factors commonly cited for a region's poor performance in the housing sector are high housing prices relative to family income, lack of access to mortgage credit, and high prices for land and construction (Bouillon 2012, Ferguson & Navarrete 2003).

Latin America's residential construction sector is largely dependent on manpower-intensive, on-site construction. The auto-construction or progressive housing approach, where households carry out construction in phases, is commonly practiced among low-income households of the region (McTarnaghan et al. 2016). This practice, over time, leads to an inadequate supply

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of housing, producing quantitative and qualitative housing deficits (Bouillon 2012). By contrast, European and North American countries are accustomed to using prefabrication in construction. An example of this is system-built wood construction for residential and commercial buildings (McGraw-Hill Construction 2011). In 2015, a total of 717 system-built wood construction businesses were active in the United States, generating a revenue of \$7.4 billion (Carter 2015). Three companies, Berkshire Hathaway Inc. (28.0%), Champion Enterprises Inc. (10%), and Cavco Industries Inc. (7.8%), together controlled more than 45% of the market share (Carter 2015). These system-built wood housing alternatives, built in the United States, have the potential to fill the housing deficit gap in developing countries by producing and exporting an affordable substitute to current practices in those target markets. In the United States, system-built housing has matched and even surpassed existing economic, social, and technical specifications of residential construction (McGraw-Hill Construction 2011). The geographical proximity, trade relations, and existing business corridors would further support the development and exportation of system-built housing from the United States to Central and South American countries (Zhang, Toppinen, & Uusivuori 2014). Despite these favorable business conditions, there is a considerable knowledge gap in the understanding of local regulatory policies, construction codes, potential housing demand and segmentation, and cultural aspects impacting the design and architecture to be used by U.S. businesses to develop these custom products.

This study identified key stakeholders and assessed the urban low-income housing markets of three countries in South America: Peru, Colombia, and Ecuador, where wood housing systems manufactured in the United States could be introduced. The analysis investigated the housing deficit and the affordability of low-income household solutions, with the goal of gathering key information characterizing the urban social housing market. The information collected will be helpful for system-built wood construction companies in the United States aiming to expand to urban social housing markets in these countries.

2 Literature Review

With the advent of globalization and industrialization, urban migration and the expansion of cities has become a global trend. Central and South American countries

are among the most rapidly urbanized in the world. As more people migrate to urban areas in search of a better life, the cities of the region are growing in size and number (Ferguson & Navarrete 2003). This problem is a major concern for most of the developing world. The United Nations (UN) estimates that by 2050, 40% of the world's population will be living in substandard housing (United Nations 2016), as a result of urban expansions and population growth. This is due to the impact of rapid urbanization and the excessive strain on housing and serviced land. The UN estimates the slum population of Sub-Saharan Africa at 199.5 million; South Asia, 190.7 million; East Asia, 189.6 million; Latin America and the Caribbean, 110.7 million; Southeast Asia, 88.9 million; West Asia, 35 million; and North Africa, 11.8 million (United Nations 2016). The construction sector in these countries, along with other factors, has failed to match the housing demand using conventional systems, forcing people to resort to informal slum settlements.

The current housing need in Latin America is approximately 42 million units (United Nations 2016). To bring this into perspective, one out of every three families in this region lives in substandard housing. Both Nicaragua and Peru, with 78% of the population living in substandard housing, have the highest shortage of housing. Bolivia (75%), Guatemala (67%), El Salvador (58%), and Honduras (57%) are the other countries with high housing deficits in the region.

2.1 Residential Construction Industry in the United States of America

The construction industry is one of the major industries in the United States. In 2014, the sector accounted for 3.8% of the annual Gross Domestic Product (Bureau of Economic Analysis 2016). Wood is the primary structural component and is used in over 90% of houses (Piepkorn 2014). The wood sector was badly hit during the December 2007-June 2009 recession, with a net employment decline of 19.8% (Hadi 2011). While the domestic market is gradually improving, and there is the possibility of a rebound, the peak sales level (more than 1.5 million residential units) is not expected to occur within next 10 years (U.S. Census Bureau 2016). The development of a robust business model with diverse market penetration could be one of the options for growth, as well as to prepare for a similar catastrophe in the future (Baack, Harris, & Baack 2013).

Exports of forest products from the United States have grown over 80% from 2009 to 2014, with the ma-

job increment due to volume, as prices stayed uniform (Inouye 2015). However, compared to other goods, forest products are more sensitive to economic changes (Carter 2015) and thus need a more robust strategy. Figure 1 shows the division of different forest product groups and their share in total exports (Inouye 2015).

Assembled products, including factory-built wood buildings, fabricated structural membranes, assembled casks, doorframes, and joinery accounted for \$1.3 billion. In 2015, the factory-built home industry (part of the assembled products category) recorded total exports of \$226.8 million. Seventy-four percent of these exports were to Canada, mainly due to geographical proximity. Japan, Australia, and Mexico together accounted for another 15.7%. The remaining 10.3% was dispersed throughout the global market (Carter 2015). This demonstrates that the domestic market is the major focus of factory-built homes industry. Figure 2 shows the distribution of exports and the share for each of the countries.

Additionally, finished, value-added products create more jobs and value for the U.S. economy, compared to unprocessed or low value-added products. The system-built wood construction industry should look for a niche and new markets in order to rejuvenate and survive, rather than continue to decline (Carter 2015). Thus, there is a need to further promote and increase the global operations of this sector.

2.2 Low Income Housing as a Business Opportunity

While it is often perceived to be the public sector's responsibility to develop affordable housing, the government alone is not capable of meeting the housing demand. Public policy can act as an impetus to promoting private investment in low-cost housing. As demonstrated in Western Europe and America, support for public housing programs can significantly promote the private housing industry in reducing the overall deficit of low-cost housing (Chen, Stephens, & Man 2013). The Inter-American Development Bank's initiative, "Opportunities for Majority" (OMJ), also demonstrated that the private sector can stimulate profitable business opportunities by delivering valuable goods and services to the lower economic strata of the market. This population segment has significant buying power and could spend up to \$56.7 billion annually in Latin America and the Caribbean region (Stickney 2014a).

Rojas and Medellin (2010) suggested that since each country in the Latin America region has varied socioeco-

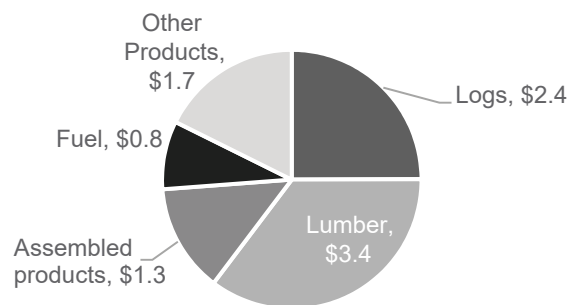


Figure 1. Export value of different forest products categories from the United States (in billions USD, 2014) (Inouye 2015).

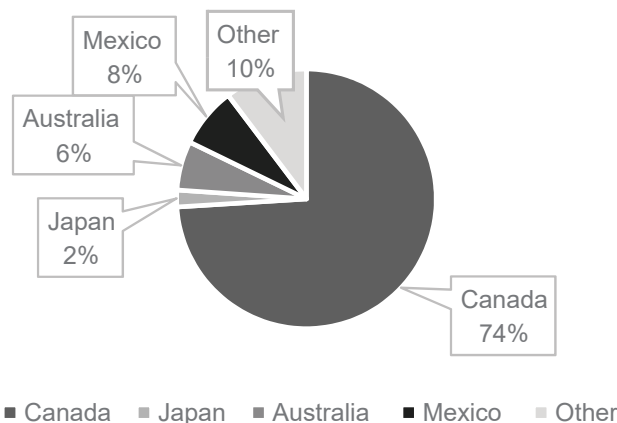


Figure 2. Exports of factory-built construction industry (Carter 2015).

economic and geopolitical structures, the shortage must be tackled differently in each. The improvement of current construction practices, use of better materials, use of new techniques, and government policies to support these changes are good starting points (IDB 2012). Stickney (2014a,b) demonstrated the need for private financing institutes for the housing portfolio in Latin America and the Caribbean region and an opportunity for low-cost housing developers, suppliers of construction materials, and NGOs in developing a complete solution.

A clear understanding of the various export parameters is necessary to assure the success of export-oriented businesses in the forest products industry (Parhizkar, Miller, & Smith 2010). Companies interested in developing and exporting prefabricated wood housing to developing countries would also need to have a clear understanding of local markets and the factors responsible for acceptance. Thus, it was important to study both the current government policies regulating social housing projects in the region and the existing use of wood in construction, and to identify the different stakeholders involved in the social housing value chain.

3 Methodology

3.1 Research Approach

A qualitative research design, specifically a case study method, was used to conduct this study. A qualitative design aims to explore and understand stakeholders' opinions regarding an issue and is useful when the goal is to understand the problem based on the information given by the participants (Creswell 2009). This also provides an opportunity to study the subject in its natural setting. Case studies are empirical forms of inquiry with a systematic approach for information gathering. This approach goes beyond pure data gathering by including different approaches to information collection. It involves recording life experiences and histories, related documents, and participant perceptions. This gives an opportunity to bring out the potential discrepancies or "fallout" related to the research topics, which might be missed by other approaches. Therefore, case studies are considered an efficient method of detailed and in-depth data collection (Berg 2004), and are part of this study.

3.2 Research Process

The initial research question was defined at the beginning of the research process as to "assess the opportunity of exporting prefabricated wood construction manufactured in the United States for residential applications." The next step was to define the target population and delineate potential subjects for the study. As mentioned earlier, this study targets urban social housing markets in developing countries of South and Central America that have high qualitative (housing conditions) and quantitative housing deficits. Peru, Ecuador, and Colombia were selected as case countries. This selection was based on the level of existing housing deficits in the region (Bouillon 2012), which can provide a scalable market share to potential manufacturers in the United States.

3.3 Research Methods and Instruments

As a first step, secondary information about the policies regulating social housing in each country was documented. This included details of existing projects. Companies' information was obtained through newsletters, company websites, books, and peer-reviewed journals. This information was used to prepare semi-structured interviews. This also helped validate the data collected through the later interviews by triangulation. The United States Commercial Service offers the "Gold Key Matching

Service" to help U.S. companies find potential links to gain knowledge of and access to overseas markets. This is conducted by arranging interviews with preselected stakeholders (International Trade Administration 2016). Stakeholders interviewed for this study included local and federal government agencies, builders, project development and management companies (both public and private), financial institutes, and nonprofit organizations. Semi-structured interviews served as a main tool for data collection, where the investigations were based on, but not limited to, predefined questions. The questionnaires were divided into sections targeted at specific stakeholders. Factors characterizing the social housing market highlighted by McBride & French (2011) and Bouillon (2012) were used as a basis to develop questions for each participant category. The interviews started with the demographics of the organization. For government agencies, the interview included questions about the policies concerning the regulation and management of social housing projects. For builders and project development and management companies, details about allotment and approval along with construction practices were collected. There was also a section on awareness and perception of the use of wood as a structural component in residential construction. Since the interviews had overlapping questions, the information was cross-validated based on the responses from participants within various categories.

4 Results

This section summarizes the findings of the study from the market analysis conducted in Peru, Colombia, and Ecuador. Because it was 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 1 summarizes details of the interviews conducted, categorized by stakeholder groups. Each interview had two to three participants (in other words, these were not individual interviews).

The key highlights of policies and schemes associated with 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.

Table 1. Interview details.

Stakeholder groups	Number of interviews			Total
	Lima, Peru	Bogota, Colombia	Quito, Ecuador	
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-profits	0	1	1	2
Trade firms/ certification agencies	1	4	2	7
Wood users / suppliers	2	10	2	14
Housing projects residents	1	1	1	3
Total	10	24	14	48

4.1 Lima, Peru

Within the construction industry, one of the engines of economic growth—the current housing deficiency—was a major concern of the Peruvian government. There was additional pressure on the government as cities expanded and households migrated to urban areas in search of better jobs. This also led to an increase in land prices, indirectly affecting construction costs. Most of these migrating households were low- to medium income families that moved to illegally constructed structures on the periphery of major cities.

4.1.1 Policy

Techo Propio/ Adquisición de Vivienda Nueva (AVN) [Own Roof/New Housing Acquisition] is an umbrella policy supporting social housing projects. This program was implemented in 2002, with the goal of creating a subsidized housing market for low-income households. The policy attempts to resolve the problem of the high and increasing costs of land and construction, informality, and social inclusion.

4.1.2 Current status of residential construction

Brick and concrete were the most commonly used construction materials. Prefabrication, both in wood and concrete, was not commonly used in residential construction. Despite different support programs, there were only a few builders in Lima working exclusively in social housing projects, due to the lack of profitability using current construction methods. Progressive housing was common in low- and middle-income households in the country, where a family would begin with a very basic structure and an empty lot. Over time, the family would build floors and expand the house. Despite this, there were no specific cultural/regional design/architectural requirements 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 Chamber of Construction, metropolitan Lima alone had an expected demand of 443,544 units in 2014. However, there were only 27,952 (6.3% of the demand) homes built. Fifty percent of the unmet demand was for units below \$40,000 USD (ownership cost, including land and construction) (CAPECO 2011).

4.1.3 Application of Wood

The reported use of wood was limited to non-structural applications only. There were a few high-cost projects that used wood for structural applications, but the market share was very limited. Policy has a major role in regulating the use of wood. According to existing guidelines, only indigenous species can be used as a structural component in government projects. There is a provision that allows foreign wood species to be included, however, after it has gone through testing procedures. Grades of materials and guidelines approved by U.S. agencies could be easily accepted by the Peruvian regulatory agencies and could help speed up the process. The interviewed stakeholders widely acknowledged the benefits of wooden construction, including better seismic resistance, shorter construction times, lower cost, and being more environmentally friendly, compared to concrete construction. Wood construction can also be used as emergency shelters in more remote regions of the country. The ease and speed of building a prefabricated house can give this type of construction an extra edge over concrete construction.

4.2 Bogota, Colombia

The Colombian housing market varies from luxurious homes to temporary shacks with a bare minimum of infrastructure. While there was a well-developed mort-

gage system to finance housing in the country, the low-income households still failed to get houses through formal markets. As a result, this section of the market resorts to informal construction. In Bogota alone, 54% of the homes built between 1993 and 2005 were built informally (Florian 2011) and varied in quality and concentration across the city.

4.2.1 Policy

The state does not build homes under any schemes, but encourages and supports the private sector. Proposals for projects are invited once a need is determined by the government. The proposals are examined and projects are regulated by Findeter, a third-party mediator and developmental bank. Findeter is a financial management institution for social housing and is also involved in budget planning each year. A foreign company can participate in the bidding process by demonstrating five years of construction experience or by partnering with local companies.

Proposals do not specify any material or design usage; however, project designs have to be approved by the government entity, "Curaduria Urbana," before the project is implemented. The proposed homes should be durable and secure from break-ins. 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 project scale. Current housing projects for low-income households range from 100 to 2,000 dwelling units per project. With current practices, at least 400 units are necessary to make a project profitable for the builder. If feasible, large companies already tend to subcontract construction processes. Builders prefer vertical construction to reduce costs but the people prefer horizontal construction.

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

- **Mi Casa YA (My House Now):** This is a short-term policy to support eligible households with incomes between two to four 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 was designed to benefit 130,000 households from 2015-2018. These houses can range from \$16,100 to \$31,050 USD.
- **VIS (Affordable Social Housing):** The goal of this program is to build houses under the value of 135

legal minimum monthly salaries. Currently, there is an estimated demand of 77,000 houses in this program. This policy covers houses under \$31,050 USD without any restrictions on the 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 populations in extreme poverty, the network "red unidos," rural populations displaced by guerrillas, and citizens displaced by natural disasters. The average size of these homes is 48 m². The program strives 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 that supports social housing. The benefit provides reduced interest rates to eligible households and acts as a stabilization buffer to counter inflation.

The limiting cost for all four low-cost housing schemes also includes the lot cost (< 53 m²), which can be 10% of the total cost of a single-family unit. The allotted project may include the availability of a fully developed site with installed utility lines, or the site development may be the builder's responsibility.

4.2.2 Current Status of Residential Construction

The building code is designed specifically to withstand high seismic activity. The projects also need to demonstrate energy and water consumption efficiency, a focus area of the current national Sustainable Energy Law. A total of 19,758,964 m² in area licenses were issued in 2015 for residential house construction, out of which 25% (4,971,147) of the land was dedicated to VIS projects (Gilbert A. 2014). The majority of the households fail to get support from any of these schemes, preferring progressive housing. This incremental self-construction is a major feature of the low-income housing market in Bogota as well. Concrete in combination with steel is the most prevalent construction material in the nation. Shares of other materials, including brick, make up approximately 11%. Every new material used in construction requires approval from the Colombian Society of Engineers.

4.2.3 Application of Wood

The majority of the interviews reported lack of experience building with wood. The current reported use of

wood in construction was predominantly limited to non-structural applications. This was also due to the unavailability of graded, rated lumber and the negative impression of wood construction. Wood is considered for use in either expensive construction projects or for very low cost, temporary housing.

Two types of projects involving wooden construction in Colombia were recorded. TECHO, a nonprofit international firm, has built 1500 units (of 6 x 3 m each) in the Valle Aurra region of the country. These units were reported to be imported from Chile. Programa “Aldeas” (Program “Village”) is one of the flagship initiatives for social housing by EPM, a group of companies located in Central America, Chile, Mexico, United States, Spain, and Colombia with headquarters in Medellin, Colombia. Wood from a private EPM plantation was used to develop the project. The project aims to deliver 1,400 homes in three phases. The homes will go to poor families, as well as to households relocated due to hydroelectric projects in six districts of the region.

4.3 Quito, Ecuador

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

4.3.1 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. However, it is not the state’s main function to produce the necessary assets and services, although the state guarantees that society will have the required mechanisms for accessing these assets and services. Its basic role is to motivate, channel, facilitate, regulate, set norms, and 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, buying or selling, owning or renting, management or maintenance of houses and apartments. This enables the key stakeholders in the housing sector,

inhabitants, communities, builders, lenders, and local governments to work efficiently and equitably towards meeting housing needs.

4.3.2 Current Status of Residential Construction

In evaluating the housing markets, we found that despite the slow economic growth, it was reportedly easy for buyers to secure credit and get a home. Progressive housing was again one of the major features defining residential construction in low- and medium-cost construction, as households expand their buildings both vertically and horizontally on the same lot over time. This cultural aspect of incremental construction was used by builders as well. Selling a unit with only the basic minimum of 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 had efficiently incorporated modular design to allow future expansion and was delivering units with different levels of finish to keep the costs down.

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

4.3.3 Application of Wood

The use of wood was found to be primarily restricted to non-structural applications. Limited knowledge about its application and the poor perception and availability of wood were found to be the major reasons for the low utilization of this resource in residential construction. Despite low current use, the market size and the push to find alternative materials capable of better sustaining earthquakes provide an opportunity to promote the use of wood as a structural component in residential construction. This was evident from the increasing use of bamboo in residential construction in earthquake-prone coastal regions. The perception of using it as structural component among low-income consumers changed

substantially after a devastating earthquake in April 2016 in the southeastern region of the country. Nevertheless, lack of performance standards for building with bamboo or any other alternative material was a major concern among builders and designers.

There were no reported restrictions on the use of wood in construction. There are agencies that can assist companies in planning projects and drafting proposals for social housing projects. There were no reported restrictions on the participation of foreign companies, provided the project was approved. Perceptions about wood, awareness of the benefits of using wood, and education about its use are major hurdles in the Ecuadorian market. However, the push to find renewable materials and determine their architectural uses, when supported with the correct programs, can help break this taboo. This would help open new markets for wood construction in general, and prefabricated wood-building manufacturers in the United States could take a lead in this market.

5 Discussion

Pre-manufacturing houses in a closed 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. However, 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 place U.S. manufacturers in a favorable position to export these housing solutions. Table 2 summarizes findings across the three studied countries.

Prefabrication of buildings helps in optimizing construction by reducing time, environmental effects, health and safety risks, building defects and 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 2 shows an opportunity for innovative techniques to fill the gap. Wood prefabricated housing systems can be one of those alternatives. This generates an opportunity for system manufacturers in the United States. These manufacturers

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

There are a few limitations to the approach of this study. The findings reported are country specific and cannot be used for other Latin American markets. Some of the information collected could also be limited to the selected stakeholder's perspective. In addition, the 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 for this study, and these cities were used to represent the low-income urban housing market for each country. Although the policies regulating and controlling the social housing sector would stay essentially the same throughout a country, the market dynamics may change from region to region.

Table 2. Summary of the findings.

	Peru	Colombia	Ecuador
Identified housing deficit (fraction of total households)	72%	37%	50%
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	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 construction	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

6 Conclusions

By using an exploratory approach, the research sheds light on key factors characterizing the urban social housing markets in Peru, Colombia, and Ecuador. Current policies governing economics, scale, and the type of construction in the urban residential sectors in these countries were recorded. Personal interviews with building- and project-management companies, along with site visits, were helpful for insight on the current construction practices in the region. This helped identify vital cultural features defining residential construction. Key findings from this study are as follows:

- There exists a high, unmet demand for low-cost houses in the urban regions of Peru, Colombia, and Ecuador.
- There is little interest in developing low-income housing markets among the local builders due to low profitability, which further expands the deficit gap.
- Current trade policies, the rising cost of construction, and economic development of the region make it a favorable market for expansion.
- The region lacks knowledge on the use of wood and its associated benefits as a construction material. Wood is labeled as a cheap construction material with negative 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 of wood prior to entering the market to assure acceptance.

This can be done by forming collaborations with the government, builders, NGOs, and project developers in the foreign market. Developing a hybrid design that incorporates both traditional construction and wood prefabricated systems may prove to be the most favorable. This would mean that manufacturers would need to work closely with local builders. This would largely depend upon the selection of entry mode by the company. Other market segments such as disaster relief or emergency relocation shelters in the regions should also be examined by the manufacturers of system-built construction in the United States as possible market segments. The social housing market is further divided into a variety of market segments each requiring tailored products and approaches.

Based on this analysis and reported market potential, it appears that companies in the United States could develop products for social housing projects with promising market access. However, there is a lack of knowledge specifically related to policy, current construction practices, and social perceptions of wood construction in foreign markets. This work helped in identifying potential expansion opportunities for system-built wooden house manufacturing companies in Latin American countries. The existing production chain was evaluated to identify factors supporting or hindering business expansion

7 Future Recommendations

Assessment of the market is important, but it is not the only process in developing a viable business plan. While this study looked at accessing only three poten-

tial markets in the Central and South American region, future studies should look into other markets as well, in order to compare and find the appropriate country to target. This study explored the possibility of introducing system-built wood construction in the social housing market segment only. Nevertheless, the same strategy can be used to assess the market potential for exporting to other segments of the residential and commercial construction market. This study can further be augmented by assessing the supply side of the value stream by evaluating existing manufacturing capabilities and the interest of U.S. manufacturers in export. By combining these aspects, a viable export business plan for system-built wood construction manufacturers in the United States can be created.

8 References

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