HOUSING INNOVATIONS COLLECTION

Andrew R. Sanderford, Andrew P. McCoy
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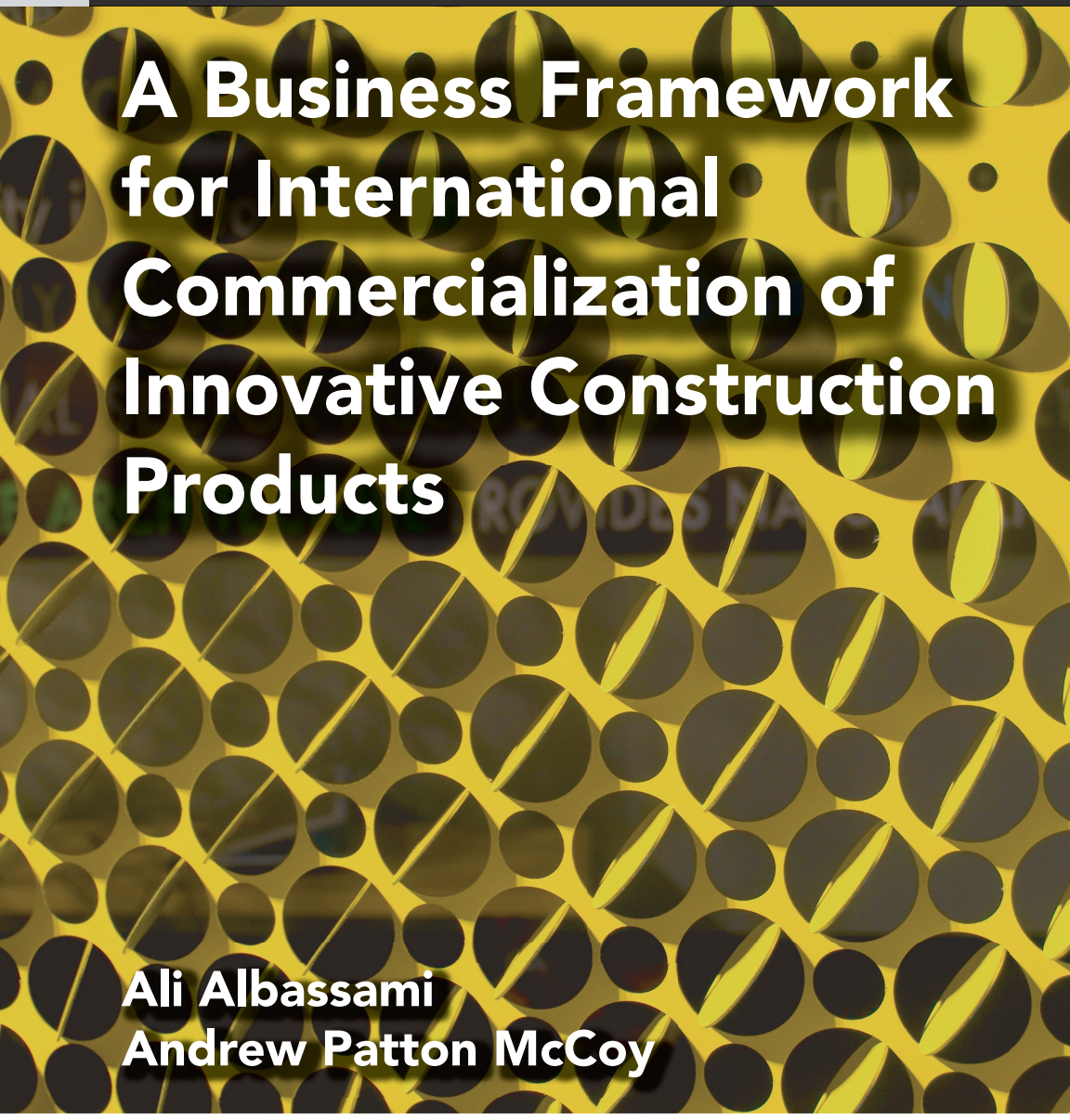

A Business Framework for International Commercialization of Innovative Construction Products

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MOMENTUM PRESS
ENGINEERING

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ABSTRACT

For too long, the construction industry, its organizations and its products have been limited to borders. This book is about broadening the scope of construction organizations and products- how local commercialization and development of innovation translates across international markets. It presents a framework that describes significant areas of the innovation decision process. To develop the framework, the authors examined six subjects related to international commercialization:

1. Previously developed local and international commercialization models
2. Barriers to commercialization
3. Critical stakeholders, actions, and decisions
4. Characteristics of innovations that are suitable for international use
5. Characteristics of foreign markets that are ideal for adopting such innovations
6. Strategies to overcome these barriers

Based on these six subject areas, the authors present literature review on international innovation commercialization and then test the framework using a case-based approach of one structural product, Structural Insulated Panels (SIPs). SIPs has been successfully developed and implemented in the United States and is being considered for commercial use in Saudi Arabia. The SIPs product is particularly appropriate because of its innovative nature and influence on the structure of residential buildings.

In developing perceived barriers to international commercialization, this work uses variables from literature to create open-ended questionnaires for two groups of key stakeholders in the supply chain of innovative structural products: 1) SIP stakeholders in the United States and 2) stakeholders of innovative structural products in Saudi Arabia. Responses establish the reliability of language and factors affecting the process of international commercialization. Next, the authors report on a second, closed-ended

questionnaire on market-based strategies for developing a framework for international commercialization in residential construction.

The study in this book relies on common business methodologies such as a sequential explanatory mixed-method research design. Such methodologies utilize distinct phases (Creswell 2003) in order to gain insight into the processes of commercialization. Initial quantitative data provide a general picture of the barriers to international commercialization in the available sample and are then mapped onto the preliminary framework. Then, qualitative data, collection and analysis refines and expands the statistical results by exploring participants' actual decision processes for mapping and expanding the framework. As a result, one final framework emerges for use by all interested in industry commercialization.

The results of this book also highlight perceived versus actual risks and barriers to international commercialization and, based on the barriers identified, market-based strategies for common business practices in residential construction.

KEYWORDS

Barriers to Commercialization, Commercialization Models, Construction Innovation, Diffusion, Innovation Adoption, International Commercialization, Residential Construction, Risk Tolerance, Saudi Arabia, Structural Insulated Panels (SIPs), Supply Chain, United States

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PREFACE

All over the world, local construction organizations are facing similar challenges in commercializing innovative products internationally. In more innovative markets, a number of organizations lack global strategies to diffuse domestically developed innovations to other international markets. On the other hand, many organizations in developing countries also lack such strategies to adopt innovation from more innovative markets.

As recent work suggests, though, commercialization processes are central to successful diffusion of innovation. To date, global effects on diffusion are the least understood because of a lack of research on the ways in which companies commercialize residential innovative products in new foreign markets; they are relatively ignorant of the risks and barriers they must overcome in the process.

Several researchers have begun to answer the need of understanding commercialization processes of new residential construction products or services (see e.g., Koebel et al. 2004 and McCoy et al. 2008). Attention has focused mainly on a development of domestic commercialization frameworks; however, variables across international markets have not yet been considered. While few scholarly endeavours have produced commercialization models of innovative products since the 1960s (Laborde and Sanvido 1994), many authors have criticized their international applicability, especially when dealing with the gamut of international concerns.

Thus, this book presents the development of a framework for international commercialization of innovative structural products in residential construction. The aim is to be utilized as a conceptual and operational roadmap to commercializing innovative products that have been developed successfully for launch in new, international markets. It would describe all of the significant decisions and actions (i.e., horizontally across associated time and vertically along functional areas) of the innovation decision process. This is an important distinction because of flaws in the existing development methods as well as in the application of market diffusion. As

both the US and Saudi Arabia have recently seen growth in the housing industry, the research results herein could highlight areas within commercialization in need of innovation stimulus. Such a stimulus could have tremendous economic impact on both countries. That being said, the work is intended to provide a better understanding of successful commercialization processes that would facilitate adoption and diffusion of such innovations.

We (the authors) hope that some of the propositions of this work will inspire professional construction organizations to seek and explore promising business opportunities through commercialization of innovative products internationally. It is also our hope that this work will inspire rigorous research for expanding the development of innovative businesses and entrepreneurs in the international construction industry.

ACKNOWLEDGMENTS

This work appears in its current form due to the assistance and guidance of several people. It gives us a great pleasure to express our gratitude to all those who supported us and have contributed in making this book possible. The authors wish to acknowledge the contributions of Dr. Eloise Coupey, Dr. James Jones, Dr. Theodore Koebel, and Prof. Jason Malone who have provided extensive support and guidance for the authors of this book.

LIST OF DEFINITIONS

We assume the following definitions for this work:

- **Product invention** is a novel idea or concept in a developable state that represents real change to the adopting institution. Product inventions involve resources to establish intellectual property and, therefore, legal protection (McCoy et al. 2010).
- **Innovative products** are novel ideas or concepts that have been implemented, representing real change to the adopting institution (McCoy et al. 2010). Innovation includes the use of an existing type of product in a new application or the development of a new product or idea (Gourville 2005).
- **Product commercialization** is the process for technical, marketing, and business decision practices (and resulting actions) required for successful implementation of a new product or service, from the development stages to introduction into the marketplace (McCoy et al. 2010).
- **Diffusion of innovation** is a process by which an innovation is spread through cultures over time. The origins of the theory of diffusion of innovations vary and span multiple disciplines (Slaughter 1993). While similar to commercialization, diffusion does not necessarily contain the concurrent nature of the decision-adoption process.
- **Adoption of innovation** means that the innovation is new to the adopting unit (van de Ven et al. 2000). It is intended to derive anticipated benefits from changes that the innovation may bring to the organization (West and Anderson 1996).
- **International commercialization** in this research is the process to commercialize locally developed innovative products to an international market.

- **Barriers to commercialization** are broadly defined for this work as factors that impede successful commercialization of innovative products, from the development stages to the introduction into the marketplace. In this study, actual barriers refer to the barriers to actual commercialization that are experienced by actual stakeholders, whereas perceived barriers refer to the barriers to international commercialization that stakeholders perceive before any actual commercialization is conducted.
- **Enablers to commercialization** are defined for this work as factors that facilitate successful commercialization of innovative products from the development stages to introduction into the marketplace.
- **SIPs** are environmentally responsible, prefabricated building systems applied to or incorporated into a building's structure that have both insulating and load-bearing abilities. They provide high levels of insulation and are extremely airtight, implying that the amount of energy used to heat and cool a home can be cut by up to 50% (Carradine 2002).
- **Commercialization risks** are inherent characteristics within the commercialization process that hinder overall success. Commercialization risks are also a category of barriers (McCoy et al. 2008).
- **Commercialization benefits** are inherent characteristics within the commercialization process that benefit overall success and are known as accelerators (McCoy et al. 2008).

CHAPTER 1

INTRODUCTION

The ability of a nation to sustain economic growth, increase its standard of living, improve human health, and better the environment often depends on its success in commercializing and diffusing new products, processes, and services that can meet the population's needs. Innovation is essential to the future well-being of today's globalized world. Therefore, innovation is vital to the long-term economic growth of established and emerging markets, and construction is no exception.

There is universal interest in successful commercialization of innovative construction products (McCoy et al. 2008). In the globalized world, innovation in residential construction is particularly relevant to the world's growing demand for affordable and sustainable housing. Innovations that successfully diffuse between established and emerging residential markets offer significant benefits to all, especially those developing the technology.

Unfortunately, for residential construction, attention has been focused mainly on domestic diffusion patterns of consumer durables and within a limited number of industrialized countries. Recent work suggests that commercialization processes are central to the successful diffusion of technology (Balachandra et al. 2010). To date, the understanding of global effects on diffusion has been hampered by a lack of research on the methods through which firms commercialize innovations of residential products to new foreign markets and the barriers they must overcome in the process. In today's rapidly changing economy, bolstering innovations that would otherwise contain barriers within the residential construction industry has become increasingly critical.

The residential construction industry and its success play a major role in stimulating economies worldwide. Real-estate development and housing prices (i.e., consumer spending) contribute positively or negatively to economic focuses such as the domestic economy, unemployment rates, and incomes. Housing is a major asset of many nations' wealth and

provides the ability to create additional wealth. Housing costs are often the largest expenditure in household budgets, and a house is usually the largest personal investment of individuals during their lifetime. Such costs, then, drive entire economies.

The construction sector ranks among the largest contributors to the gross domestic product (GDP) of industrialized economies. Within this sector, residential construction is a major portion of the market (Gann and Salter 2000). Compared with other complex project system (CoPS) industries, the residential construction industry is slow to adopt innovations (Koebel et al. 2004, Taylor and Levitt 2004). The global residential construction industry is generally believed to be a fragmented industry, and it has unique characteristics that adversely affect the rate at which new products are adopted, diffused, and commercialized. McCoy et al. (2008) developed a model of commercialization for residential construction in an attempt to reduce risk and increase the adoption of innovative products. To the author's knowledge, no such model has been developed for multiple markets to reduce international commercialization risk for developers of innovative products. Thus, commercialization model that considers risk is required to increase the use of residential construction innovative products throughout markets worldwide.

Residential construction contains specific risks that influence adoption. For example, building structure is a major liability because of the potential later complications. That is, if the structure fails, so does the building. The cost and quality of a residential building depend on the chosen structural system and the associated structural cluster of technologies. Furthermore, constructability and integration with other building systems (e.g., mechanical, electrical, or plumbing systems [MEP]) also depend on the building structure and its properties. Innovative structural products have therefore been closely studied for successful commercialization practices, but little has been proposed regarding study across industrialized markets. The United States is considered a world leader in advancing residential technologies, especially those around advanced structural systems. As a major component of residences worldwide, these innovations seem ideal for such a commercialization study.

The purpose of this research is to develop a framework for commercializing innovative structural products across industrialized residential construction markets. Such a framework will then act as a conceptual and operational roadmap to commercializing innovations that have been developed successfully for launch in new international markets, and it will describe all significant decisions and actions of the innovation decision

process (i.e., horizontally across the associated time and vertically along functional areas).

SCOPE AND CONTEXT: A CASE STUDY

The focus of this work includes enablers and barriers to successful commercialization processes for structural product clusters across industrialized markets (i.e., structural insulated panels [SIPs]). The research explores the continuity of innovation adoption by foreign markets and the different tools and practices used in developing an improved commercialization model.

The United States and Saudi Arabia have various interests in exchanging technology in the residential marketplace. The United States is known for its competitive edge in innovation, for which it ranks fifth in the world (Global Innovation Index 2013). However, housing developments are integral to the crisis that has gripped financial markets since August 2007 and then escalated to a near complete paralysis of credit flows in late 2008. Although private financial flows have resumed, the recovery in credit markets is still in train and far from complete (Duca et al. 2010). Therefore, the diffusion of residential construction innovations into foreign markets plays an important role in creating substantial commercial opportunities for US companies, which generate billions of dollars in profit and create millions of jobs in the United States.

Saudi Arabia, once the Unites States' ninth largest trading partner, is currently experiencing rapid economic growth (U.S. Department of Commerce. 2009). It possesses one of the largest economies in the Arab world, it generates two-thirds of the aggregate GDP in the Gulf Cooperation Council (GCC) states, and it is the largest consumer of US goods and services in the Arab world (US-Saudi Arabian Business Council 2009). In particular, the residential construction industry is the largest in the construction sector and is governed by US building codes. As the fastest growing housing market in the Middle East in 2010, Saudi Arabia accounted for 46% of the total $448bn project pipeline in the Middle East and North Africa in 2012–2013 (RNCOS Industry Research Solutions 2011). However, the housing market in Saudi Arabia still suffers from a large demand–supply gap because of the rapid population growth and rapidly declining household sizes (Struyk 2005). Adopting foreign residential construction innovations that meet people's needs can play an important role in constructing more homes and, more importantly, in helping the Saudi Arabian economy grow.

RECENT COMMERCIALIZATION TRENDS IN CONSTRUCTION

1. **Theoretical**—Few studies have illustrated the barriers to international commercialization of construction innovative products.

Several researchers have begun addressing commercialization processes of new residential construction products or services (e.g., Koebel et al. 2004, McCoy et al. 2008). Attention has focused mainly on a development of domestic commercialization frameworks; however, variables across international markets have not yet been considered. Although few scholarly endeavors since the 1960s have produced commercialization models of innovative products (Laborde and Sanvido 1994), many authors have criticized their international applicability, especially when addressing the gamut of international concerns.

2. **Practical**—Firms developing international markets lack global strategies for domestically developed residential innovative products.

For the residential construction industry, attention has focused mainly on domestic diffusion patterns of consumer durables within a limited number of industrialized countries. As recent work suggests, commercialization processes are central to successful diffusion of technology. To date, the global effects of diffusion are not well understood because of a lack of research on the methods through which companies commercialize residential innovative products in new foreign markets. Furthermore, such companies are relatively ignorant of the risks and barriers they must overcome in the process.

To answer these needs, the authors established the following research questions as a basis for the survey instrument and interview questions.

1. What commercialization models exist for residential construction innovative products locally and internationally?
2. What barriers to commercialization of residential construction innovative products exist locally and internationally?
3. What are the stakeholders, actions, and decisions critical to international commercialization of innovative structural products in residential construction?

4. What innovative products are appropriate for international use? Should SIPs be considered appropriate?
5. What residential construction markets are ideal for studying the barriers of product development and adoption?
6. What are the market-based strategies that will help overcome barriers to international commercialization of innovative structural products in residential construction?

RESEARCH GOAL

The goal of this research is to develop a framework for international commercialization of innovative structural products in residential construction as a conceptual and operational roadmap to commercializing innovative products that have successfully been developed for launch in new international markets. It describes all of the significant decisions and actions (i.e., horizontally across associated time and vertically along functional areas) of the innovation decision process. This is an important distinction because of flaws in the existing development methods as well as in the application of market diffusion. As both the United States and Saudi Arabia have recently seen growth in the housing industry, the research results herein could highlight areas within commercialization in need of innovation stimulus that may have a tremendous economic impact on both countries. That said, the work provides a better understanding of successful commercialization processes that facilitate adoption and diffusion of such innovations.

METHODOLOGY

This study used a sequential explanatory mixed-method design consisting of two distinct phases (Creswell 2003). In the first phase, we collect quantitative data (on perceived barriers to international commercialization) using a web-based survey. The data are subject to a frequency analysis of the barriers affecting the process of international commercialization. The goal of the survey was to explore perceived barriers to international commercialization and to allow for purposefully selecting informants for interviews.

In the second phase, a qualitative case study approach was used to collect descriptive data through individual semi-structured interviews, documents, and other materials to help elicit actual barriers initially explored in the survey instrument of the first phase. The rationale for this approach is that the survey results provide a general picture of the barriers to international commercialization mapped onto an initial framework, while the interview analysis refines and explains the statistical results by exploring participants' actual decision processes in more depth to develop the final model.

The visual model of the procedures for the sequential explanatory mixed-method design of this study is presented in Figure 1.1. In this design, priority is given to the qualitative method, because it represents the majority of data collection and analysis conducted in the study; that is, it focuses on in-depth explanations of quantitative results using an actual case study.

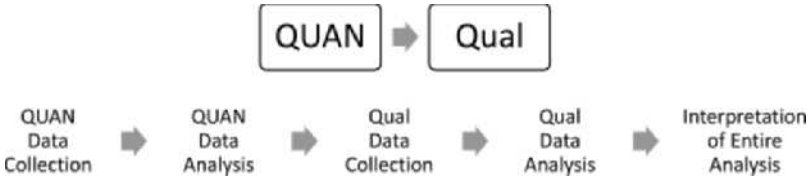

Figure 1.1. Sequential explanatory design (Source: Creswell et al. 2003)

STUDY SIGNIFICANCE

The resulting research and the future of its developments are relevant for a wide range of innovation agents, residential building professionals and stakeholders, scientific research groups, and innovation managers. On an institutional level, the research can provide alternative approaches for governmental agencies (e.g., research councils looking for ways to maximize the effects of the research they fund). For universities, it highlights important issues about innovative product commercialization in international residential construction markets. Mainly, the research focuses on the private sector with a particular emphasis on residential construction firms, as it includes a proposed roadmap to translate innovative products between markets.

BOOK STRUCTURE

Figure 1.2 presents the general structure of this book.

Figure 1. 2. General structure of this book

CHAPTER 2

INTERNATIONAL INNOVATION

In economics, globalization is a process of increasing the involvement of enterprises in international markets. Globalization of innovation implies that value chains are fragmented and that innovation and value creation may no longer occur in the same geographic location. Under globalization, increased international mobility and networking activities have resulted in a continuous increase of globalized innovation, linking local innovation hubs within global knowledge networks.

Several researchers have examined the benefits, risks, and barriers associated with innovation globalization to provide industry- and market-based strategies for promoting global innovation and enhancing overall performance (see Acs and Audretsch 1990, Baldwin and Gellatly 2003, Gomes-Casseres 1990, Karakaya and Stahl 1991, Ostler 1998, Rammer et al. 2005). However, to the author's knowledge, no study has addressed the globalization of innovation in residential construction. Therefore, this chapter presents a conceptual framework to examine four critical aspects of innovation globalization in residential construction: globalization models, drivers, barriers, and strategies to market entry.

INTRODUCTION

Economic globalization and intensified competition have stimulated a continuous increase in the adoption of innovation worldwide. Globalization pushes companies to enter foreign markets and implement technology and business innovations intended to improve economic well-being and societal prosperity (Robinson 1988). Therefore, the existence of a strong relationship between globalization and innovation is clear for technology-oriented companies, where globalization of innovation is essentially an export.

International trade is critical for a nation's economic welfare (Marin 1992, Meier and Rauch 1989). It is suggested that economies must export goods and services that generate revenue to finance imported goods and services that cannot be produced endogenously (Coutts and Godley 1992, McCombie and Thirlwall 1992). The concept of export-led growth predicts that export growth leads to economy-wide productivity gains in the form of enhanced levels of gross domestic product (GDP), improving economic well-being and societal prosperity. Then, because exposure to international markets requires improved efficiency, supports product and process innovation activities, and encourages profitable exploitation of economies of scale through specialization (Temple 1994), export performance stimulates a country's economy through technological spillovers and related positive externalities (Marin 1992).

Globalization and the innovation process are mutually reinforcing to the extent that current economic analysis considers them simultaneously when accounting for new dynamics of firms operating at the international level (Molero 2000). Innovation is a broad concept, and it is often observed that a successfully commercialized innovation in one country does not have the same degree of success in another market. Numerous factors influence the relationship between innovation and globalization, including firm heterogeneity and globalization approaches; the influence of innovation characteristics on firm behavior; the relationship between the level of trade in a firm and innovation (Wakelin 1998); the influence of technological capacity on the decision of a firm to export and export intensity (Lopez Rodriguez and Garcia Rodriguez 2005); the relationship between economic and innovative performance and the long-term globalization approach of the firm (Castellani et al. 2006); firm size; and the level of innovativeness and exports (Wakelin 1998). Furthermore, firms can be classified as domestic, exporting, controlling non-manufacturing activities abroad, or manufacturing abroad (Castellani et al. 2006); exporting or non-exporting (Filipescu 2007, Wakelin 1998), and non-exporting, low-exporting, or high-exporting (Lachenmaier and Wossmann 2006).

In a similar manner, export growth of innovative construction products is essential to a healthy, efficient, and technologically advanced construction industry that plays a strong role in developing international trade and building a vigorous domestic market. At the global level, an increasing number of construction firms have entered foreign markets in roles such as manufacturers, builders, distributors, and services providers. However, multinational construction firms typically operate in an environment fraught with large uncertainties and must continuously analyze these risks, adapt

their business strategies, and adjust culturally. Failure to fully understand these exposures to risk prior to making commitments can seriously affect the firm's profit, market share, and long-term stability objectives (Ashley and Bonner 1987). Thus, firms intending to enter a foreign market are required to assess this new market and to verify that they have the required knowledge, skills, and resources to manage this new environment. Then, a firm's level of innovativeness significantly affects its degree of globalization (Markusen 1984, Rugman 1981b).

GLOBALIZATION MODELS

Recent research has suggested that globalization is an incremental process where firms increase their export activity in stages. A popular model used to describe this incremental process is the Uppsala model (Figure 2.1), which suggests a stepwise, deliberate, and slow process of a firm incrementally adapting its international activity. The model illustrates that after a period of selling solely in the domestic market, the firm begins international activities in markets that are similar to the home country. For example, firms might align their interests based on cultural, economic, political, and/or social variables. Firms often first approach closer countries and choose physically distant markets in the future. Throughout this pilot process, the firm gains both objective and experiential knowledge. Essentially, as a firm enters a market and gains an understanding of the market, the perceived risk is reduced and the commitment to the market increases, making it easier to understand those markets entered first (Johanson and Vahlne 1977). As a firm progresses through various stages of globalization, it eventually produces overseas using foreign direct investment (FDI; Johanson and Wiedersheim-Paul 1975).

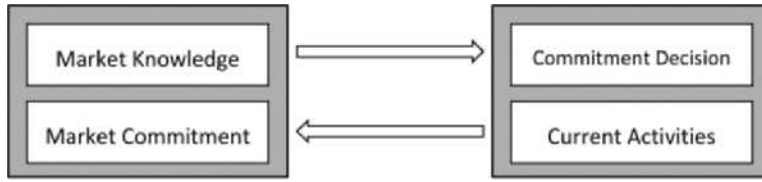

Figure 2.1. Uppsala globalization model (Source: Johanson and Vahlne 1977)

Models of incremental globalization, such as the Uppsala model, have come under scrutiny following the rise of the "Born Global" firm over the

past 15 years (Harris and Li 2005). Contrary to the Uppsala model, Born Global firms are prevalent among high-technology sectors and exhibit rapid globalization shortly after inception potentially using multiple methods of entry (Figure 2.2; Knight et al. 2004). This is likely because of the monopolistic advantage linked to investment in intellectual property, in which such firms have a unique competitive advantage over other firms derived from intangible, knowledge-based assets (e.g., patented or proprietary technology or process technology). The Born Global concept is linked to a resource-based view of the firm (Harris and Li 2005), where competitive advantages are derived from the firm's resources (Spence and Crick 2006). According to this view, the firm chooses to expand internationally to maximize the benefit of its competitive advantage at a low marginal cost (Dow 2005).

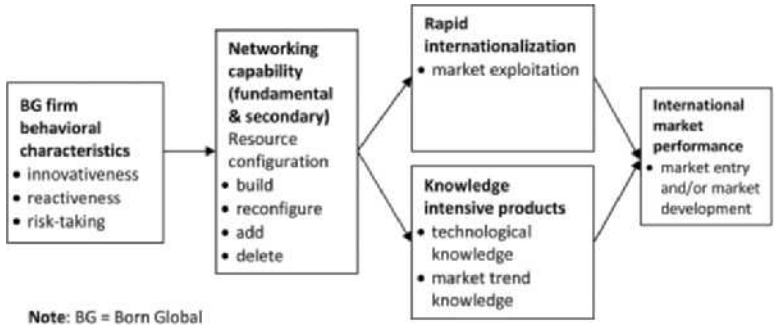

Figure 2.2. Born Global globalization model

The Born Global model should be considered in the globalization process of innovative construction products. Several factors have contributed to the rise of Born Global firms, including developments in telecommunications, declining transportation costs, and reductions in tariff and non-tariff barriers (Dow 2005). International communication technologies (ICTs) can assist firms in stimulating global demand by contributing to international advertising, promotions, order management, and communication with stakeholders such as potential clients, agents, and distributors. For example, a manufacturer of residential construction products can reach potential clients in a foreign market (e.g., homebuilders and distributers) through the manufacturer's website quickly, cheaply, and independently of distance and temporal differences. The website enables virtual communication and collaboration among stakeholders within the supply chain at all stages of the commercialization process, in particular, early in

the process where a better understanding of the market lowers perceived risk and increases market commitment.

The Born Global model represents the process of globalization in a linear fashion and separates two major stages (pre- and post-networking) around a central "networking" phase. The *networking* phase represents the resource configuration (i.e., build, reconfigure, add, and delete), in which a firm works to approach suitable stakeholders to commercialize an innovation in a foreign market. In the phase prior to networking, the firm characteristics represent only a single firm. Subsequent phases to networking represent the activities, actions, and decisions that are conducted by all involved stakeholders within the network.

However, the Born Global model does not represent a detailed process across time for the technical, marketing, and decision processes (and resulting actions) required to launch innovative product commercialization (i.e., successful development) in a new foreign market. Therefore, this work develops a framework of international commercialization that represents the process in two sets of phases, describes all stakeholders involved in each phase, and details the significant decisions and actions of the innovation decision process across the associated periods and functional areas.

DRIVERS TO GLOBALIZATION

The following literature has identified key factors that lead to uncertainty and drive the decisions of firms when launching their products or services internationally:

- **Contacts:** Ease of finding customers or a suitable partner (Crick and Jones 2000, Rauch 1999)
- **Practicalities:** Ease of negotiating the business framework, logistics of doing business, or product modification (Miles, L. 2010)
- **Language and culture:** Ease of negotiation language/culture (OMB Research 2008, Rauch 1999)
- **Risk and IP:** Ease of IP protection or risks of getting paid, guaranteeing quality, or return on investment (OMB Research 2008, Rogers and Helmers 2008)
- **Resources:** Ease of staff recruitment/retention or low cost of resources (Child and Rodrigues 2008, Dow 2005)
- **Demand:** Level of demand (Dow 2005)

Therefore, consideration of such drivers prior to innovation globalization is essential to assure successful commercialization and adoption of innovation in a new market. In addition, effective communication and collaboration with other stakeholders in the new market may significantly increase the motivation level, which is highly influenced by factors within the new market environment. Early collaboration with stakeholders in the new market thus provides improvements such as better knowledge of the market, increased commitment, and access to resources.

BARRIERS TO GLOBALIZATION

There are internal and external market barriers to the process of international commercialization. These barriers are primarily issues of management, organization, firm competence, and interaction with other stakeholders within the supply chain in a specific industry or market. Success of international commercialization highly depends on the following several factors that act as either accelerators or barriers:

- **Language proximity barriers**

Language is a common barrier to companies commercializing innovations in international markets (Karakaya and Stahl 1991, Ostler 1998).

- **Entry restriction barriers**

In several countries, barriers concerning ownership requirements, permitting, and rating systems as well as procedures that prevent foreign investors from establishing permanent residence are widely used to protect the domestic construction market (Gomes-Casseres 1990). Moreover, there may be substantial restrictions for entering some foreign markets that increase the cost of globalization through high associated legal fees. In some cases, the increased cost may be prohibitively high, resulting in lost business opportunities.

- **Financing expansion barriers**

The scale of expansion required and the risks involved increase the difficulty of international commercialization. Financial barriers impede access to external finance and imply high innovation costs and thus high economic risks (Acs and Audretsch 1990, Baldwin and Gellatly 2003, Rammer et al. 2005).

- **Geographic, epistemological, and cultural barriers**

Geographic separation and epistemological and cultural barriers hamper knowledge-sharing required for innovation projects. Distance, time-zone differences, and culture create barriers and further imperfections toward international commercialization (Hadjimanolis 1999).

International commercialization invariably involves several stakeholders with international backgrounds. The resulting disparity requires a high degree of social competence and a sound understanding of cross-cultural interactions (Master Builders Association Malaysia 2007).

- **Lack of knowledge concerning foreign markets**

A critical barrier to international commercialization is the lack of knowledge concerning foreign markets (Erramilli and Rao 1993, Gatignon and Anderson 1988, Johanson and Vahlne 1977). The amount of knowledge that the decision maker has on international commercialization is influenced by several factors, such as level of education (Simpson and Kujawa 1974), foreign market experience, ability to speak a foreign language (Langston 1976), and whether they were born abroad (Simmonds and Smith 1968).

Therefore, consideration of such barriers prior to globalizing innovation is essential to assuring successful commercialization and diffusion of innovation in the new market. In addition, effective communication and collaboration with other stakeholders in the new market can lead to improved market understanding and increased commitment by all stakeholders, which significantly reduce the risks and uncertainty of a new market environment.

GLOBALIZATION METHODS

When choosing to globalize, a firm must not only select a market to enter but also choose a method of entry. Globalizing firms that follow a traditional pathway (e.g., an Uppsala process) tend to limit these forms to direct sales and sales via agents and distributors. In contrast, rapid globalization (e.g., the Born Global process) for knowledge-intensive products or services may use these two methods at the outset but is more likely to use or consider other forms of globalization, such as direct investment in an overseas site (Bell et al. 2004). For some methods of rapid globalization, agency agreements are attractive as they allow for rapid exploitation of

technology (Crick and Jones, 2000). Other evidence suggests that if a high-technology startup is resource-constrained, globalization conducted using collaborative arrangements with overseas partners may allow it to tap into the resources, assets, and capabilities of the partner and is thus the method of choice or even necessity (Burgel and Murray 2000). The benefits of using agents and distributors include their ability to identify potential customers in the market and help firms cope with the practicalities of the language and culture and access people who are knowledgeable in the market (OMB Research 2008).

Several factors motivate the selection of the entry method, which is often affected by risk. Firms entering markets that they perceive to be riskier tend to select methods that require low commitment. For some firms, the choice of method is considered a tradeoff between the high financial risk of engaging in FDI and the managerial risk of using an agent over whom they have no direct control (Child and Rodrigues 2008). That is, the lack of managerial control over an agent may result in the agent pirating products and becoming a competitor or neglecting to develop the market for the product, lowering potential returns (Chetty and Campbell-Hunt 2003).

Other scholars have related decisions concerning the globalization method to the firm's characteristics, products, and decision makers. The relationship that a firm has with stakeholders within the supply chain can strongly affect its method of globalization. Therefore, firms that need to be in closer contact with other stakeholders are more likely to develop direct sales channels, enabling them to meet stakeholder requirements and reduce risks associated with higher transport costs, tariffs, or non-tariff barriers (Crick and Jones 2000, Helpman et al. 2004).

For example, in residential construction, a builder may request that its manufacturers set up subsidiaries in the same country to maintain supply. Here, a collaborative arrangement between the manufacturers of innovative products in the home country with the homebuilding firm in the host country would be a better method of globalization. As mentioned previously, collaboration among stakeholders decreases the risks and uncertainty associated with globalization, and collaboration enables firms to obtain the required skills or resources more quickly, reduce asset commitments and increase flexibility, increase learning, share costs and risks, and build cooperation around a common standard (Mital 2007). Thus, it is critical to ensure that each stakeholder is selecting the right partner to minimize its chances of a future split by considering a set of criteria, such as resource needs, appropriate strategic objectives and styles, degree of rivalry, threats of entry or substitutes, and internal strengths and weaknesses.

CHAPTER 3

INNOVATION COMMERCIALIZATION IN RESIDENTIAL CONSTRUCTION

Innovation is a novel idea or concept that is implemented and represents real change to the adopting institution (McCoy et al. 2010), and it includes the use of an existing type of product in a new application or the development of a new idea or product (Gourville 2005). In residential construction, innovation is particularly relevant to the world's growing demand for affordable and sustainable housing. Innovations that successfully diffuse between established and emerging residential markets may offer significant benefits to all stakeholders, especially those developing the technology. However, residential construction is known for its resistance to adopting innovation (Koebel et al. 2004), which partially addresses the characteristics of the residential construction industry and market, supply chain, and risk tolerance. Therefore, this work examines the effects of these factors on the rate of innovation adoption within and across residential construction markets.

RESIDENTIAL CONSTRUCTION CHARACTERISTICS

INDUSTRY CONTEXT

Residential construction is a highly competitive, cyclical, and fragmented industry, but it is known for its resistance to innovation adoption (Koebel et al. 2004). Several studies have related this resistance to the nature and characteristics of the residential construction industry, which is immense in size and complex. Thus, change of one part is difficult, and total change is almost impossible (Hassell et al. 2003, Moavenzadeh 1991, Slaughter

1993, Toole 1994, 1998, Toole and Tonyan 1992). The following characteristics significantly affect the acceptance level of innovation among stakeholders in the residential construction industry:

- **Highly competitive nature among participants**

In residential construction, investors can easily enter and exit the market because of the industry's high fragmentation and low capital requirements (Bubshait 2002, NAHB Research Center 1989). As builders are risk-averse to innovations, they avoid adopting innovations that pose unnecessary risks that might affect their reputation and business. Furthermore, most builders consider resistance to innovation a good business practice (McCoy et al. 2008). In contrast, Hassell et al. (2003) argued that many builders are willing to adopt innovations to create a niche market for their services (e.g., energy-efficient builders).

- **Cyclical nature of construction**

The residential construction industry is highly cyclical (O'Brien and Al-Biqami 1998). There may be little or no demand for new construction in one period and excess demand shortly thereafter as the economy progresses and previously delayed purchasing decisions are simultaneously approved. This variability has led many industry players to cut unnecessary equipment and staff whose upkeep may push them into bankruptcy. Consequently, many homebuilders and trade contractors avoid adopting innovations that may require additional investment in equipment or training, particularly if such investment is expensive. Thus, such companies become risk-averse to training. This locks them into using standardized materials and procedures, as laborers are typically unfamiliar with or unable to conduct new processes without such training. Further, path dependency avoids risk resulting from change.

- **Dominance of small firms**

Because of the ease of entry and low capital requirements in the residential construction market, most homebuilding enterprises are small. According to Hassell et al. (2003), the most common type of homebuilding firm in the United States is a sole proprietorship, representing 70% of enterprises. Furthermore, small enterprises (less than 20 employees) represent 23% of the market, medium-sized enterprises represent 6%, and large enterprise comprise less than 1% of the firms in the market. Firms of these sizes were responsible for 15%, 23%, 28%, and 32% of the respective residential

construction projects (in terms of total number). In short, firms with fewer than 20 employees used to conduct 38% of the nation's residential construction work. Although this number has changed recently because of firm consolidation and economic downturns, small builders still conduct a large amount of the homebuilding.

Similarly, according to Shash and Al-Amir (1997), 62% of the construction firms in Saudi Arabia are small, conducting SR 25 million (USD 6.75 million) or less business by volume. Furthermore, 23% are medium-sized companies with an annual business volume greater than SR 25 million (USD 6.75 million) but less than SR 55 million (USD 14.85 million). Finally, large companies with an annual business volume greater than SR 55 million (USD 14.85 million) comprise only 15% of firms.

Because small firms are unlikely to adopt new products because they lack sufficient resources to learn about and implement innovations, residential construction has historically shown a low level of R&D expenditure (Blackley and Shepard 1996). Koebel (1999) argued that the real level of R&D is likely underestimated, as tracing construction-related R&D expenditures of manufacturers and material producers is extremely difficult. Recent literature also points to an increase in homebuilder adoption of certain types of innovation (Koebel et al. 2015).

- **Fragmented nature**

The residential construction industry is highly fragmented along geographic, vertical, and horizontal dimensions (Hassell et al. 2003, Koebel et al. 2004). The industry has unique characteristics that adversely contribute to such fragmentation, including variation in building codes and implementation within and across regions, dominance of small- and medium-sized enterprises (SMEs), competition among participants, and complex information-sharing.

- **Slow information-sharing**

The dominance of SMEs results in horizontal fragmentation, as even within a geographic area, homebuilders may not communicate directly with most of their competitors and trade contractors do not interact with contractors in other skilled trades (Slaughter 1993, Stewart and Stewart 1986). Data and information management has often overwhelmed builders (Shash and Al-Amir 1997), and a vertically fragmented industry complicates the sharing and dissemination of information among the key stakeholders of the residential construction industry (Hassell et al. 2003).

Today's information globalization culture positively improves the flow of innovation information, but educating all industry constituents requires significant time and effort. Unfortunately, high industry staff turnover is likely to deter investment in training, and free-flowing information over the Internet does not equate to training and experience.

- **Difficulty protecting intellectual property innovations**

It is difficult for homebuilders and others in the housing industry to protect their innovations (Rourke 1999). In most projects, the process is open and transparent to a large number of outside contractors. An innovator of a new product can spend a lot of money registering and protecting the innovation as intellectual property, which reduces the incentive for investors in the residential construction industry to promote innovation. Although the difficulty of protecting innovation implies that low-cost, easily implemented innovations have few barriers to dissemination, innovations are not created in the first place without incentives (Hassell et al. 2003).

These characteristics have shaped residential construction in most nations. They either enable or impede the acceptance of innovation by stakeholders within the residential construction industry. As innovation offers the potential for competitive advantages, many firms are looking for strategies and solutions that help them successfully promote innovation considering industry characteristics (accelerators and barriers).

For the residential construction industry in the United Sates, McCoy et al. (2008) proposed a commercialization model that considered such characteristics and objectives to successful commercialize innovations for the national market. The model serves as a roadmap for successful commercialization of innovation. It combines actions required for product success, including broad process phases and specific characteristics. It also helps develop progress measures and identify information and technical assistance needs, project development costs, and the requirements for forecasting financing.

To the author's knowledge, no such model has been developed for international commercialization of residential construction innovative products that have been successfully commercialized within a local market. As international commercialization implies greater risk and uncertainty, there is a substantial need for a commercialization model that can reduce such risk and increase the use of residential construction innovative products across global industrial markets.

MARKET CONTEXT

The homebuilding industry is a project-based industry where homebuilders or specialty contractors purchase most of the materials required for construction. They are constantly looking for product improvements for home construction, and upon the adoption of such products, they engage in high-frequency repeated purchases of these products. However, the decision to use any particular material might undergo multiple cycles before the user adopts the product completely (PATH 2006). The first decision the homebuilder makes is whether to try the product and incorporate it in their purchase portfolio. After a few use cycles, they become more familiar with the product characteristics and decide to either increase their purchase frequency and amount of the innovative product (potentially resulting in full adoption) or remove the product from their purchase portfolio (Ganguly et al. 2010). As builders are those most likely to innovate successfully, a better understanding of their role within innovation commercialization will facilitate innovation success for the residential construction market.

Characteristics of the residential construction industry adversely affect the rate at which new products are adopted (Ganguly et al. 2010). Because of differences in culture, climate, consumer preferences, and regulations, product characteristics vary within and across nations. Building codes and regulations are known examples within the industry that impede the diffusion rate of building materials (Blackley and Shepard 1996, Cantrell et al. 2004, Oster and Quigley 1977, Slaughter 2000, Toole 1998, Ventre 1973). Regulations that guarantee markets might spur innovation (Miozzo and Dewick 2002), but government regulations have generally been viewed as hampering innovation (Dubois and Gadde 2002). Gann and Salter (2000) stated that government regulatory policies have a large effect on demand and are critical to shaping the direction of technological change. However, Koebel et al. (2004) argued that builders generally disagreed that codes and regulations were a barrier to technology diffusion.

SUPPLY CHAIN

A supply chain is a complex and dynamic supply and demand network (Wieland and Wallenburg 2011). The success of product development highly depends on the supply chain that produces it (Gokhan 2007), and supply chain design and development are essential steps in any commer-

cialization project, including construction projects (Jiang et al. 2003, Vaidyanathan and O'Brien 2003). According to Lambert and Cooper (2000), product development and commercialization managers must coordinate with customer relationship management to identify customer-articulated needs, select materials and suppliers in conjunction with procurement, and develop production technology in the manufacturing flow to produce and integrate into the supply chain flow for the best combination of product and market.

Markets with similar characteristics of and actors in supply chain seem to have better chances of integrating for commercialization success. In the context of this work, in US residential construction, stakeholders along the supply chain include raw material suppliers, manufacturers, distributors, retailers, developers/builders, installers, inspectors, and end users (McCoy et al. 2009). Some stakeholders may not physically possess a product but play critical roles in deciding whether the product proceeds to the next stakeholder in the chain (McCoy et al. 2008). Several studies have indicated that the Saudi residential construction market has a supply chain similar to that of the United States for the commercialization of products and services (see, e.g., Al Falah et al. 2003, Al-Harbi et al. 1994, Al-Jarallah 1983, Bubshait and Al-Musaid 1992).

McCoy et al.'s (2008) commercialization model incorporates all decisions and supply chain entities required over time for the successful development of a product in US residential construction (Figure 3.1; McCoy et al. 2008). However, international commercialization poses additional challenges owing to its global scope; therefore, lead times are substantially longer. International commercialization covers trends owing to globalization (including global supply chains which require improved worldwide coordination and planning to achieve the global optimum), increased cross-border sourcing, collaboration within parts of the value chain with low-cost providers, shared service centers for logistical and administrative functions, and complex problems (which have increasingly required the involvement of mid-sized companies that can absorb more risk). Therefore, key stakeholders involved in international commercialization must clearly understand their needs, benefits, and risks to achieve the best results.

Manufacturers and builders are key stakeholders in the construction technology supply chain, where manufacturers represent manufacturer-based innovation and builders represent user-based innovation. Both sides jointly form the commercialization process along with other critical stakeholders whose contribution is essential for the success of the commercialization process (McCoy et al. 2008).

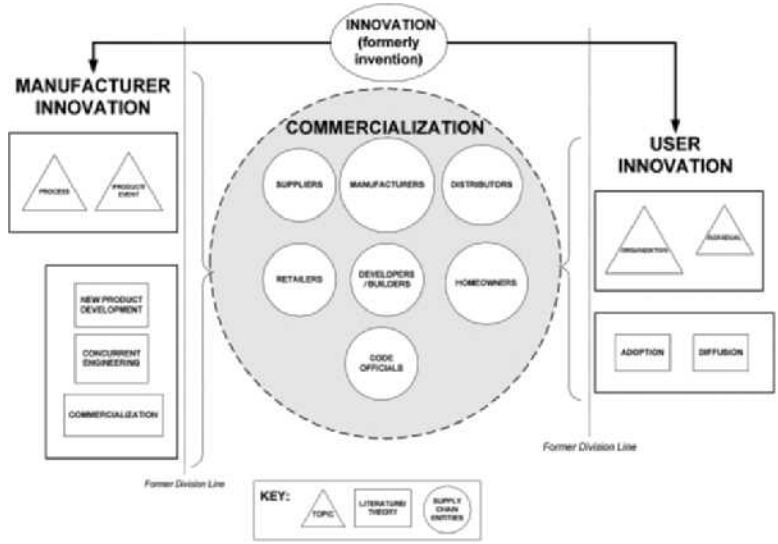

Figure 3.1. Supply chain of innovation commercialization

In Saudi Arabia, the number of foreign enterprises that encompasses stakeholders in construction (e.g., manufacturers, developers, builders, and suppliers) has been rising since the country became a WTO member in 2005 (Saudi Arabian General Investment Authorit; SAGIA 2006). However, several firms still face a number of challenges that affect their business success. This is especially true for those entering the market for the first time that use imported control systems that ignore local conditions and result in legal and administrative problems, including delays, cost overruns, and liaison issues (Al-Jarallah 1983). Al-Falah et al. (2003) indicated that foreign manufacturers' joint ventures (JVs) with local Saudi enterprises appear to be more mature than local private manufacturers (i.e., 100% Saudi) concerning supply chain management (SCM) awareness in both planning and implementation. Therefore, choosing the right entry mode significantly promotes successful commercialization of an international product.

RISK TOLERANCE

Residential construction has unique characteristics that significantly affect the spread of innovation. Builders and other construction stakeholders are

often described as risk-averse to innovations (James Hickling Consultants 1989). New products typically have the potential to disrupt a builder's scope of operations, and thus, core business processes (McCoy et al. 2008). Moreover, adversity to liability among small builders is not monitored through a communication network of peers, which leads builders and sub-trade contractors to reject innovations because of potential future liabilities (McCoy et al. 2008). Therefore, clarifying innovation benefits and risks of adoption for builders is an essential element in the commercialization of innovation.

The approval of products in the market depends on regulatory resistance and approval from regulatory bodies, which, in turn, determines the pace of diffusion. It reflects the government's need to set standards in product performance and testing or secondary delayed effects of a product (McCoy et al. 2008). According to SAGIA (2006), companies in Saudi Arabia often choose to pay for approval rather than comply with inconsistently applied regulations. Thus, government support or assistance for R&D, demonstration, training, or sales clearly aids diffusion because it lowers costs, favors communication, reduces risk, and increases relative advantage (McCoy et al. 2008).

Finally, consumers may resist innovation for reasons such as preferences for traditional houses and visible benefits (i.e., aesthetics) over invisible building improvements unless they provide a short-term payoff (Koebel et al. 2004). Other reasons may include low consumer confidence in new products (SAGIA 2006) and strong opinions formed about certain products that constitute consumer resistance and are affected by the purchasing behavior of builders and developers who are unwilling to take market risks or spend time and money to educate consumers (McCoy et al. 2008). Therefore, to improve consumer confidence and cooperation in the commercialization of innovation, consumers must be provided accurate information and have a clear understanding of innovation needs, benefits, and risks.

In residential construction, international commercialization of innovative products has substantial risks and barriers that impede the acceptance of innovation among stakeholders in the supply chain. The process of international commercialization addresses substantial differences in culture, climate, consumer preferences, and regulations. Building codes and regulations are known examples within the industry that impede the rate of diffusion of building materials (Blackley and Shepard 1996, Cantrell et al. 2004, Oster and Quigley 1977, Slaughter 2000, Toole 1998, Ventre 1973). However, successful international commercialization of residential

construction innovation can be achieved through improved collaboration and coordination among all stakeholders of the supply chain by developing market-based strategies to mitigate international commercialization risks and barriers.

COMMERCIALIZATION IN RESIDENTIAL CONSTRUCTION

Commercialization is the process of introducing technical, marketing, and business decision practices (and their resulting actions) required for successful implementation of a new product or service from basic development to the introduction into the marketplace (McCoy et al. 2010). As market globalization has increased, there has been a large need of and interest in understanding commercialization processes across construction markets. Attention has mainly focused on domestic diffusion patterns of consumer durables and within a limited number of industrialized countries, and there has been a lack of research on the ways in which firms commercialize innovations of residential products in new foreign markets and the barriers they face. Therefore, this work examines the barriers to domestic commercialization as well as scholar-developed models and strategies to mitigate them. By mapping the barriers on an international level, globalization of innovation in residential construction can be promoted through successful commercialization.

BARRIERS TO COMMERCIALIZATION

For many enterprises worldwide, it is no longer possible to act in the marketplace without considering risks and opportunities presented by foreign and/or global competition (Ruzzier et al. 2006). Regarding international adoption of new products, the perceived endogenous and exogenous risks to the adopting unit are numerous and multifaceted. A paucity of literature (Bilkey 1978, Chetty and Campbell-Hunt 2003) has identified key factors in the process of international commercialization: managerial commitment, product competitiveness, pricing, perceived export benefits, government support, market information, financial resources, transaction risks, and cost for exporting and documenting goods. Literature factors are meant to be neutral—increased government support enhances commercialization, whereas reduced support hinders it.

International commercialization success highly depends on a number of factors. Innovation is commercialized by taking a conceptual idea to a final product in marketplaces nationally and internationally to serve the needs of its stakeholders in the industry. Therefore, industry, stakeholder, and innovation characteristics must be considered, as each characteristic serves as either an accelerator or a barrier to the commercialization process. Furthermore, different types of barriers exist: internal barriers within the firm, external barriers associated with other stakeholders within the supply chain, and international barriers associated within the context of a foreign market.

A clear understanding of the benefits, risks, and barriers associated with commercialization of an international innovative product is essential for all stakeholders involved to assure increased perception, collaboration, and success.

CHARACTERISTICS AFFECTING INTERNATIONAL COMMERCIALIZATION

Within residential construction, industry and firm characteristics either positively or negatively affect the perception of barriers to innovation commercialization (McCoy et al. 2008). On an international scale, the effects of these characteristics on international commercialization are greater as they involve different environments, resources, stakeholders, and legislation. Moreover, a close relationship exists between innovation at the firm level and that of the system in which the firm operates. Thus, factors hampering firms' innovation activities are likely to differ between countries.

Industry characteristics

As previously explained, residential construction is a highly competitive, cyclical, and fragmented industry known for its resistance to adopting innovation.

Firm characteristics

Firm characteristics (e.g., firm innovativeness) substantially affect the success of international commercialization projects in residential construction.

In general, less-innovative and low-performing firms perceive higher barriers to the process of international commercialization than high-performing and more-innovative firms do (Ylinenpaa 1997). In contrast, Tourigny and Le (2004) argued that non-innovative firms perceive barriers to be less strong than innovative firms do.

The perceived competition level also plays a critical role in most international commercialization projects. On average, multinational firms, which tend to be larger, have a higher level of accumulated competence and tend to be more research-intensive than purely domestic firms (Iammarino et al. 2007). Ylinenpaa (1997) identified seven innovation barriers related to competence, listed in descending order of impact:

1. Cost of utilizing external competence
2. Insufficient marketing competence
3. Difficulties of finding external competence
4. Lack of market research
5. Insufficient technical competence
6. Lack of information on technical developments
7. Inadequate knowledge of regulations

Another factor contributing to the success of international commercialization is the highly trained personnel within the team. Several studies have indicated the importance of qualified personnel, skills, competence, and human resource management (HRM) for commercialization success (Baldwin and Johnson 1995, McCoy et al. 2008). Furthermore, firm employees have critical innovation knowledge that should be advanced through continuous updates and training (Jong 1999).

Residential firms must also understand the needs, benefits, risks, and barriers to commercialization (McCoy et al. 2008). As commercialization includes the full spectrum of activities required to move a new technology, product, or process from its conceptual stage to the marketplace (US Department of Energy 2005), barriers to commercialization include barriers to both manufacturer-based innovation and user-based innovation. These barriers exist within the firm (internal) and outside the firm (external), as described in section “Barriers to Commercialization” of this chapter. However, as previously mentioned, international commercialization contains endogenous and exogenous barriers with international dimensions (Table 3.1).

Table 3.1. Categories of barriers to international commercialization in terms of firms

	Internal	External
International	**Internal barriers to international commercialization** *e.g., financing expansion barriers*	**External barriers to international commercialization** *e.g., entry restriction barriers*
Domestic	**Internal barriers to commercialization** *e.g., management barriers*	**External barriers to commercialization** *e.g., consumer resistance*

Internal barriers

Within the construction industry, many barriers are found within the enterprise (e.g., large gaps in understanding the benefits of innovative processes; Sexton and Barrett 2004). Within an established firm, a variety of barriers to innovation affect the firm's ability to commercialize (Assink 2006):

- *Adoption barriers* are related to dominant designs, path dependency, and successful products that limit the ability to search for new disruptive innovations. Excessive bureaucracy leads to a status quo bias where deviations from the standard are perceived as negative. Bureaucratic hurdles, including long administrative procedures and restrictive laws and regulations, often increase these barriers (Acs and Audretsch 1990, Egeln et al. 2006, Keller et al. 2004, Rammer et al. 2005).
- *Mindset barriers* are related to the inability to unlearn the old logic of how products and markets work. They may be associated with the lack of distinctive competencies to detect and exploit opportunities arising from external changes.
- *Risk barriers* are associated with an excessive reliance on routines and experience and an unwillingness to cannibalize the firm's own product markets. Thus, disruptive innovations often threaten existing products of established firms.

- *Management barriers* are associated with management's ability to foster new thinking (i.e., thinking out of the box) in managing the innovation process. Limited internal expertise in managing the innovation process effectively and efficiently acts as a barrier to commercialization (e.g., by missing project management know-how; Egeln et al. 2006, Mohnen and Rosa 1999, Rammer et al. 2005).

These barriers are internal and closely related to the specific management and organizational style of a firm. They do not necessarily imply that a firm cannot take an innovation and commercialize it internationally but indicate that existing organizations naturally resist changes. Moreover, not every innovation project is worthy of execution. Thus, innovation barriers can also be considered organizational screening devices to filter worthy innovation projects from unworthy ones. Tang and Yeo (2003) argued that such internal barriers might even lead to an improvement of the innovation performance of enterprises. In other words, these factors may act as accelerators or barriers of international commercialization of innovative products in residential construction and must therefore be considered.

External barriers

External barriers to international commercialization are related to the industry and market and are thus closely associated with market, government, and system failures. Internal barriers to international commercialization are primarily an issue of management, organization, and firm competences, whereas external barriers emerge when the firm interacts with other local or international stakeholders within the residential construction supply chain, such as interaction between a builder and a manufacturer to use a product in a project. More importantly, issues of standardization, financing, regulation, skilled personnel, and technology transfer may reduce external barriers to international commercialization for firms with high-potential innovation projects and form the basis for policy measures that enable the diffusion of innovation into a foreign market.

James Hickling Consultants (1989) identified external barriers to adoption and diffusion of innovation, including risk, distributor strength, trade resistance, regulatory resistance, liability, and consumer resistance.

- *Risk barriers* hamper the adoption of risky innovations for building stakeholders.
- *Distributor strength barriers* represent the limited ability of a distributer to undertake promotion, advertising, and training activities required for successful commercialization.
- *Trade resistance barriers* deter building professionals from adopting innovations that may upset the inertia of trade practices.
- *Regulatory resistance barriers* include the cost and time required to obtain product approval from regulatory bodies.
- *Liability barriers* reflect the increasing fear among builders of downstream legal liabilities that can accrue from using an innovation.
- *Consumer resistance barriers* negatively affect purchasing behavior for innovations. Consumers, as immediate customers, mostly adopt innovations that have positive purchasing behavior for the end users. In markets with relatively low energy costs, consumers tend to resist innovations that are more expensive than traditional products despite increases in energy efficiency. Koebel and Cavell (2006) indicated that the trend most affecting future building technology innovation is the increase in energy costs.

Innovation characteristics

Innovative product characteristics also affect the spread of innovation in residential construction (James Hickling Consultants 1989, Slaughter 1993). Residential building professionals and stakeholders are continually looking for products that meet their needs and eliminate their concerns. However, contractors, owners, designers, and other construction team members have a low-risk tolerance. Consequently, they avoid adopting innovations that carry market, competitive, or financial risk (McCoy et al. 2008). Rogers (2010) indicated that five product characteristics influence how attitudes toward new products and services are formed: *relative advantage*, *complexity*, *compatibility*, *trialability*, and *observability*.

- *Relative advantage* is the degree to which an innovation is perceived as being better than the idea it supersedes.
- *Compatibility* is the degree to which an innovation is perceived to be consistent with the existing values, past experiences, and needs of potential adopters.

- *Complexity* is the degree to which an innovation is perceived as difficult to use.
- *Trialability* is the opportunity to experiment with the innovation on a limited basis.
- *Observability* is the degree to which the results of an innovation are visible to others

Therefore, stakeholders wanting to commercialize an innovative international product should ensure that it offers a substantial relative advantage and that it is relatively easy to integrate with existing technologies and practices, straightforward to learn and use, easy to try, and readily visible to those who might adopt it. In the context of this work, structurally integrated panels (SIPs) appear to have such characteristics. Therefore, in this book, SIPs are considered for commercialization across the US residential construction market and are investigated in detail in Chapter 4.

BARRIERS TO INTERNATIONAL COMMERCIALIZATION

An unclear understanding of benefits, risks, and barriers associated with international commercialization of innovative products in the residential construction markets significantly contribute to such risk aversion; therefore, development of a framework that considers the risks and barriers to international commercialization is required to improve stakeholder understanding. Improved consideration of risks and barriers leads to better development of market-based strategies that can successfully drive international residential construction innovative products.

COMMERCIALIZATION MODELS

McCoy et al. (2008) developed a commercialization model for residential construction for the US market. The model represents the commercialization of innovation and describes the process of coordinating and optimizing all technical and business decisions to successfully introduce a new product or service to the marketplace (McCoy et al. 2008). Later work advocated concurrent engineering for innovative construction products, termed concurrent commercialization (CC; Table 3.2).

Table 3.2. McCoy's CC model

			PHASE							
			Concept	**Feasibility**	**Planning**	**Review planning**	**Early production**	**Review early production**	**Standardization**	**Maturation**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		Definitions	*Specifying conceptual design of product and business*	*Assessing feasibility of product and viability of business*	*Designing the product and the business plan*	*Testing product design and business plan*	*Initial product release*	*Evaluate initial release and revise product design and business plan*	*Standardize product design and business plan*	*Ongoing product/process improvement*
FUNCTIONAL AREAS	**Product design**	*Specifying the technical design of a product*	PD1: Technical research	PD2: Conceptual design	PD3: Detailed design	PD4: Test prototype	PD5: Initial product release, test in field	PD6: Field Testing results, redesign	PD7: Standardized product	PD8: Next generation of product designs
	Process planning	*Establishing the needed production capability and capacity*	PP1: Research process technologies	PP2: Select process technologies	PP3: Design processes	PP4: Test, Review processes	PP5: Measure process times, quality, and costs	PP6: Early production results, redesign	PP7: Standardized process	PP8: Process improvement design
	Marketing	*Identifying the requirements of available markets for a product.*	M1: Market research	M2: Market fit and segmentation	M3: Forecast demand and marketing plan	M4: Review marketing plan	M5: Test Market through production run	M6: Revise marketing plan	M7: Manage sales	M8: Discover new markets
	Supply chain management	*Establishing the chain of business entities for manufacture and distribution*	SCM1: Identify sourcing and outsourcing options	SCM2: Configure supply chain	SCM3: Detailed design of supply chain	SCM4: Model supply chain performance	SCM5: Execute production run	SCM6: Adjust supply chain	SCM7: Standardize sourcing and outsourcing	SCM8: Improve supply chain management, discover new sources

Human resources	*Defining the personnel requirements for the supply chain and acquiring human resources*	HR1: Identify project leaders and responsibilities	HR2: Create leader positions, other labor roles and responsibilities	HR3: Create hiring, firing, and promotion plan	HR4: Review labor costs, reassign or dissolve labor	HR5: Recruit, create, train, and supervise for production run	HR6: Review staff costs, reassign or dissolve labor	HR7: Manage human resources	HR8: Review human resources for new generation product
Accounting and information systems	*Implementing the AIS system for all business functions*	AIS1: Research information technology	AIS2: Design accounting and other information systems	AIS3: Plan and acquire IS implementation	AIS4: Install and test IS	AIS5: Audit IS through production run	AIS6: Revise from audit	AIS7: Support and standardize IS	AIS8: Improve IS
Financial management	*Acquiring capital for the commercialization project*	FM1: Identify sources of capital, financing rates	FM2: Define capital configuration	FM3: Prepare capital plan	FM4: Estimate capital costs and risks	FM5: Acquire capital	FM6: Revise estimates and capital plan	FM7: Manage capital resources	FM8: Improve capital plan
Legal management	*Satisfying legal and regulatory requirements*	LM1: Identify liabilities and regulatory requirements, tariffs, partners	LM2: Design liability, warranty, patent, regulatory protections	LM3: Write contracts and procedures	LM4: Review protections and standards by external certifiers	LM5: Monitor and control production run	LM6: Revise contracts and standards	LM7: Monitor and control claims	LM8: Adapt contracts and standards to changing environment

Source: McCoy et al. (2010).

McCoy's CC model requires collaboration in all phases among all stakeholders within the supply chain for increased market success early in the process. However, early collaboration in international commercialization is a challenge, because the process includes international barriers. The key factor here is networking with stakeholders in the foreign market. *Networking* is the configuration of resources (i.e., build, reconfigure, add, and delete) that a firm sets to approach suitable stakeholders to commercialize its innovation in a foreign market. Thus, it is critical to ensure that each stakeholder selects the right partner to minimize the chances of a future split by considering criteria such as ability to meet resource needs, strategic objectives and styles, degree of rivalry, threat of entry or substitutes, internal strengths and weaknesses, and strategic objectives.

CHAPTER 4

A CASE STUDY OF COMMERCIALIZATION FOR STRUCTURAL INSULATED PANELS

Next, the authors introduce a commercialization case study of structural insulated panels (SIPs) from the US residential construction market (i.e., the home market) to Saudi Arabia (i.e., the host market). Figures 4.1 and 4.2 show the logical structure of different domains and areas involved and their intersection within the study. The following theoretical framework is new and is intended to articulate and organize literature into appropriate categories.

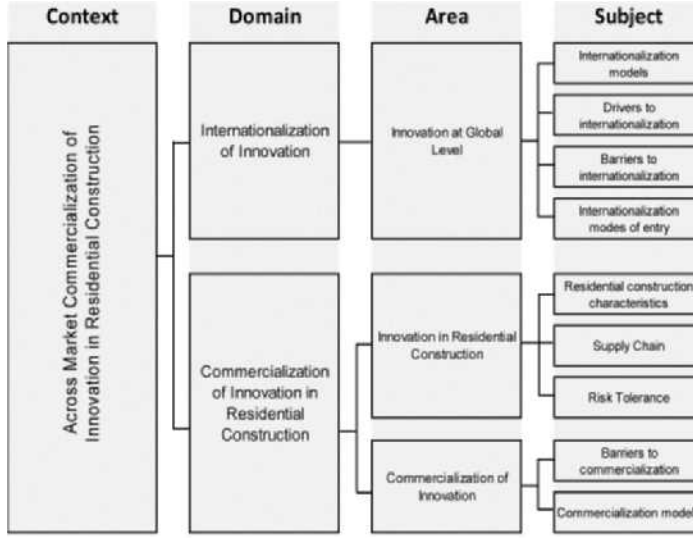

Figure 4.1. Research fields and structure

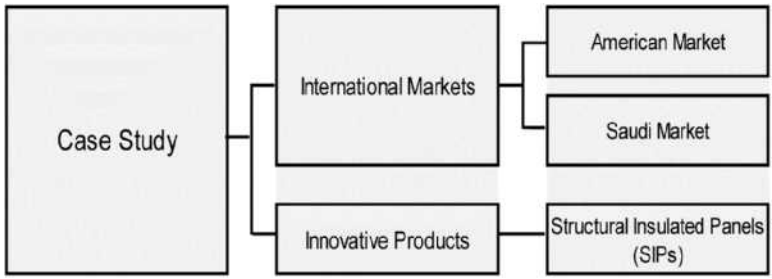

Figure 4.2. Case study fields and structure

INNOVATIVE PRODUCTS: SIPS

SIPs are composite building materials that have become a nationally-used alternative construction material for homes and other buildings (Mosey et al. 2009). They consist of an insulating layer sandwiched between two layers of structural board. SIPs are most commonly made of oriented strand board (OSB) panels sandwiched around a foam core made of expanded polystyrene (EPS), extruded polystyrene (XPS), or rigid polyurethane foam, but at least 30 types of insulating materials can be used for the core of an SIP (Morley 2000). SIPs are prefabricated insulated structural elements used in building walls, ceilings, floors, and roofs. They provide superior and uniform insulation compared with more traditional construction methods (i.e., studs or stick frames), offering energy savings of 30–50% (Mosey et al. 2009).

According to the Partnership for Advancing Technology in Housing (PATH), SIPs are very airtight when built correctly and allow little infiltration. As a result, they have higher *R* values than similarly sized walls in traditional US systems, improving thermal performance (PATH 2006). The thermal performance of SIPs may significantly reduce costs for heating and air conditioning, which is one of the major expenses of home ownership. SIPs used in the building industry today have provided many benefits for not only the buildings but also the environment. They are quicker and easier to assemble than traditional construction. As SIPs are prefabricated, laborers need only basic carpentry skills and do not require the skill level of conventional framing crews, which can further reduce the costs for builders (Mullens and Arif 2006). SIP structures are highly resistant to wind damage; therefore, they are suitable for areas with stringent wind shear or seismic codes (Lee et al. 2006).

COMMERCIALIZATION OF SIPS

The innovation of SIPs originated from the identification of needs within the homebuilding industry. McCoy et al. (2012) indicated that SIPs required a long, trial-by-error commercialization process that proved to be beneficial as it was rooted in known operational risks. SIPs addressed four of six total risks early in the commercialization process, including *consistency of installation, product lifecycle, market awareness,* and *breadth of code compliance.* In addition, SIPs did not undergo concurrent development in the earliest stages of the commercialization process and therefore took longer to adopt and reach market saturation (McCoy et al. 2010).

BARRIERS TO SIP COMMERCIALIZATION

Barriers to SIP commercialization include barriers to SIP innovation. The US Department of Housing and Urban Development (HUD 2005) noted the following barriers to SIP innovation:

- **Business environment barriers** address factors that negatively affect the introduction of SIPs in residential construction: reduced availability and quality of materials (wood products), increased labor costs, a reduced trained labor pool, and increased energy costs.
- **Legal barriers** such as class action lawsuits are perceived as rampant because they often target the largest and wealthiest organization. Industry fragmentation creates barriers for builders, because it is difficult to determine who is responsible if the supply chain fails.
- **Insurance barriers** include perception by insurers who are afraid of class action lawsuits and avoid insuring contractors in building trades. Then, willing insurers often have low reserves and demand high insurance rates.
- **Fragmentation of builders' market barriers** occurs as the market includes all homebuilding firm sizes and rules differ among states and, often, municipalities. In addition, builder profiles have changed dramatically, as they are no longer simply craftsmen. Furthermore, as builders tend to be transaction-oriented and often lack the vision to bring on new technologies, their goals may differ from those of consumers.

- **Channel barriers** occur as no clear commercialization process exists. New products often imply new technologies and new installation methods. In addition, vertical, horizontal, and geographical fragmentations demand alternative solutions.
- **Trade barriers** must be addressed, as they are accustomed to a one-for-one solution. Some relationships are threatened by innovation that carries market, competitive, and especially financial risk. Therefore, builders, designers, and other construction team members have a low risk tolerance.
- **Consumer awareness barriers** affect the purchasing behavior of builders and developers who are unwilling to take market risks or spend time and/or money educating consumers.

NEEDS AND OFFERS MATCHING: THE UNITED STATES AS INNOVATION HOME MARKET

As part of today's globalization, the United States and Saudi Arabia have strong bilateral relations in many industries (SAGIA 2006), including construction. US companies can provide Saudi Arabia expertise in competition and innovation, which are key factors to the success of any economy. The US economy is highly diversified and is characterized by constant innovations and technological advances (SAGIA 2006). Alternatively, Saudi firms seek to collaborate with international companies to achieve ambitious development plans. American contractors are favored in Saudi Arabia, where they enjoy an excellent reputation. Similarly, American hardware and construction products are known for their high quality and durability (Council-USSABC 2009).

According to the Global Competitiveness Report (Schwab 2014), the United States is among the top innovative countries in the world and is ranked 5th in innovation. US companies are highly sophisticated and innovative and are supported by an excellent university system that collaborates admirably in R&D with the business sector. These qualities, combined with flexible labor markets and the scale of opportunities afforded by the sheer size of its domestic economy—the largest in the world by far—continue to make the United States very competitive.

On the other hand, some weaknesses in particular areas remain to be addressed. The business community continues to be rather critical, with trust in politicians still somewhat weak (48th), concerns about favoritism of government officials (47th), and a general perception that the government spends its resources relatively wastefully (73rd). The macroeconomic

environment remains the country's greatest area of weakness (113th), although the fiscal deficit continues to narrow and public debt is slightly lower for the first time since the crisis.

Therefore, diffusion of US innovations to promising foreign markets that enjoy macroeconomic stability has been considered in many industries, including residential construction. By commercializing international innovations, local companies can compete with the best companies in the world and are therefore driven to be more innovative and use the newest technology and management practices. This benefits not only firms but also the overall US economy. Other reasons to consider international commercialization include global competitiveness, knowledge transfer from "learning by doing," long-term survival of firms, and allocative economic efficiency.

Firms commercializing internationally are exposed to different markets and are thus able to take advantage of overseas innovation for the US residential market. International commercialization positively assists both the recipient and the US residential construction market, benefiting the overall economies of both. It also stimulates growth and development, provides employment opportunities, assists in technology and knowledge transfer, and expands the potential global network for US firms.

NEEDS AND OFFERS MATCHING: SAUDI ARABIA AS INNOVATION HOST MARKET

The Saudi Arabian construction and real estate market is the largest and fastest-growing market in the Gulf region (i.e., Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates). In 2011, Saudi Arabia accounted for 55% of all projects awarded, totaling $66 billion in investment (Council-USSABC 2009). Furthermore, the construction sector is the largest non-oil economic sector in Saudi Arabia, and it is undergoing major growth driven by a number of factors:

- Increase in demand by foreign investors caused by a relaxation of local laws and the downfall of its biggest competitor in the Middle East (Dubai)
- Strong economic performance in light of the global financial crisis, indicating economic stability
- High liquidity
- Low-interest-rate financing
- High population growth
- New mortgage laws

Saudi Arabia's building sector is booming in line with the Kingdom's expanding population. It is estimated that 1.76 million new housing units are to be built in the Kingdom between 2013 and 2022 for an investment of nearly SR 880 billion or approximately USD 235 billion (Alshahrani and Alsadiq 2014). On an occupancy basis, it was estimated that approximately SR 90 billion is required to build around 175,000 new housing units annually up to 2025 (National Commercial Bank 2015).

However, the residential sector in Saudi Arabia is expected to experience a significant growth in future as the population is rising at a rate of 2.5 % per year and only 24% of the Saudi nationals have their own homes (Deloitte 2010). Assaf et al. (2010) identified several factors that negatively affect the affordability of housing in Saudi Arabia, including inadequate labor availability, material standards, cost of materials, domination of the construction industry by foreign firms, level of competitors, cost of labor, the number of ongoing construction projects, the effects of weather, and the lack of productivity standards. Assaf et al. (2010) indicated that the current supply seemed less likely to offer future surprises unless key industry stakeholders consider adoption of innovation that has significant effects on the cost of residential construction. However, the author knows of no innovative product that has been commercialized in the Saudi residential construction market, largely owing to an unclear understanding of the needs, benefits, risks, and barriers to commercialization. Therefore, a strategic approach to commercializing innovation successfully from a foreign market to the Saudi residential construction market is still necessary.

Saudi Arabia's 30 million increasingly prosperous consumers are at the heart of the Middle East/North Africa (MENA) region's population of 400 million. As one of the world's 25 largest economies (19th) and the largest in the MENA region, Saudi Arabia ranks 11th out of 183 countries for overall "ease of doing business" according to the International Finance Corporation/World Bank's "Doing Business" report for 2012. It is one of the fastest-growing countries worldwide, and per-capita income has been forecast to rise from $20,700 in 2007 to $33,500 by 2020. In addition, Saudi Arabia is the top foreign investment destination in the Arab realm and among the top 20 globally. Therefore, Saudi Arabia is considered an exciting and rewarding place to invest and do business.

Saudi Arabia has ample capital to advance the country by making large investments in targeted growth areas, including residential construction. Saudi Arabia's economy ranks third in the world for macroeconomic stability because of one of the world's most stable currencies (the riyal), a healthy fiscal environment, relatively low interest rates, and controlled inflation. Moreover, the stability and transparency of rules and regulations

that are applicable to both endogenous and foreign firms greatly enhances the environment for attracting FDI and expanding JVs (Al Falah et al. 2003).

However, as stated in the Global Competitiveness Report (Schwab 2014), there are also barriers to doing business in Saudi Arabia, including *restrictive labor regulations*, *an inadequately educated workforce*, *inefficient government bureaucracy*, *access to financing*, and *poor work ethic in the national labor force*. In contrast, the main barriers of doing business in the United States include *high tax rates*, *restrictive tax regulations*, *inefficient government bureaucracy*, *access to financing*, and *restrictive labor regulations* (Figure 4.3).

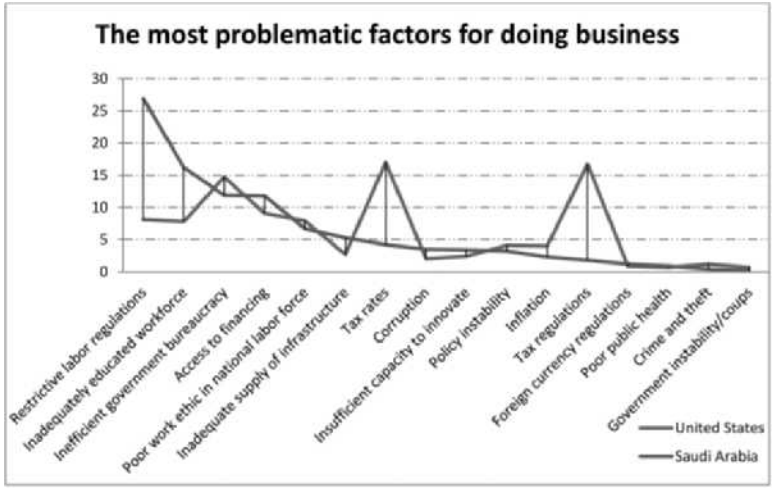

Figure 4.3. Most problematic factors for doing business

Therefore, understanding these barriers is essential for decision makers and involved stakeholders within the supply chain, as it helps in assessing projects and making decisions. As discussed in Chapter 3 in the International Commercialization Models section, a JV can be considered a market entry strategy as it offers speed, access, risk-sharing, and the ability to combine local in-depth knowledge with a foreign partner that has expertise in the technology or process. In addition, it offers sharing and leveraging of underutilized resources, high profits, and backend income. If the partners carefully map out in advance what they expect to achieve and how, many issues can be overcome.

CHAPTER 5

INITIAL FRAMEWORK DEVELOPMENT AND ANALYSIS

The framework proposed in this work was developed based on a literature review of general innovation globalization and innovation commercialization in residential construction in particular. In this chapter, we rely on existing models, barriers and enablers, and needs and risk tolerance levels of involved stakeholders within the supply chain to develop a literature-based framework of international commercialization of innovative products in residential construction.

In addition, we investigate reliability for frameworks developed to evaluate the factors influencing the process of international commercialization. Reliability ensures an international understanding of (1) business terminology and modeling language used and (2) variables related to international commercialization. We use a split-halves method to establish instrument reliability, with separate versions of the survey created for each group. To determine consistency, we conduct a correlation analysis between these two survey versions.

BARRIERS TO INTERNATIONAL COMMERCIALIZATION IN RESIDENTIAL CONSTRUCTION

There is an abundant body of disjoint literature that describes barriers to globalization of innovation in general and to commercialization of innovation in residential construction in particular. To assure that the context of barriers to international commercialization of innovative products in residential construction is addressed from all angles, four domains of barriers

are thoroughly investigated in this work (i.e., the residential construction industry, the international market, innovative products, and innovative organizations). Table 5.1 presents the barriers to international commercialization of innovative products in residential construction within these four domains.

Table 5.1. Barriers to international commercialization of innovative products in residential construction

	Barriers	Resources
Residential Construction Industry	Highly competitive nature among participants	NAHB Research Center et al. 1989, Bubshait 2002, Hassell et al. 2003
	Cyclical nature of construction	O'Brien and Al-Biqami 1998
	Dominance of small firms	Hassell et al. 2003, Shash and Al-Amir 1997, Blackley and Shepard 1996, Koebel 1999
	Fragmented nature	Hassell et al. 2003, Koebel et al. 2004
	Lack of access to information	Slaughter 1993, Stewart and Stewart 1986, Shash and Al-Amir 1997, Hassell et al. 2003
	Difficult protection of innovations	Rourke 1999, Hassell et al. 2003
International Market	Networking barriers	Crick and Jones 2000, Rauch 1999
	Practicality barriers	Miles 2010
	Resource barriers	Child and Rodrigues 2008, Dow 2005
	Demand barriers	Dow 2005
	Language proximity barriers	OMB Research 2008, Rauch 1999
	International regulations	Karakaya and Stahl 1991, Ostler 1998
	Entry restriction barriers	Gomes-Casseres 1990
	Financing expansion barriers	Acs and Audretsch 1990, Baldwin and Gellatly 2004, Rammer et al. 2005
	Lack of knowledge	Johanson and Vahlne 1977, Gatignon and Anderson 1988, Erramilli and Rao 1993, Simpson and Kujawa 1974, Langston 1976
	Geographical and cultural carriers	Hadjimanolis 1999, Master Builders Association Malaysia 2007

(*Continued*)

Table 5.1. (*Continued*)

	Barriers	Resources
Innovative Products	Business environment barriers	HUD 2005
	Legal barriers	HUD 2005
	Insurance barriers	HUD 2005
	Builder market fragmentation	HUD 2005
	Channel barriers	HUD 2005
	Trade barriers	HUD 2005
	Consumer awareness barriers	HUD 2005
Innovative Organization	Adoption barriers	Acs and Audretsch 1990, Keller et al. 2004, Rammer et al. 2005, BMBF 2006
	Mindset barriers	Assink 2006
	Risk barriers	Assink 2006, James Hickling Consultants 1989
	Management barriers	Mohnen and Rosa 2002, Rammer et al. 2005
	Distributor strength barriers	James Hickling Consultants 1989
	Trade resistance barriers	James Hickling Consultants 1989
	Regulatory resistance barriers	James Hickling Consultants 1989

INTEGRATIVE FRAMEWORK

Certain barriers (e.g., lack of knowledge and legal barriers) recur in the literature on innovation globalization. Thus, aggregating the barriers into four broad stages is useful for facilitating the discussion on commercialization of construction technology.

1. Matching market needs and product offerings

Issues related to the "discovery" phase of globalizing an innovative product include lack of appropriate tools and skills to identify and reach the right market with the right innovative product, lack of visibility of relevant research, and lack of potential partners to establish collaborations with. Prior to commercialization, stakeholders attempt to ensure that the innovative product offers a substantial relative advantage in the new market and that it is relatively easy to integrate with existing technologies and practices, straightforward to learn and use, easy to try, and readily visible to those who might adopt it.

Matching needs and offerings in this work describes the movement of an innovative product between two international residential construction markets—the innovation home market and the innovation host market. Stakeholders in the host market usually adopt the innovative product they demand for their needs, whereas stakeholders in the home market diffuse them to the new market. In residential construction supply chains, the stages typically occur in both adoption and diffusion.

2. Stakeholder networking

Issues related to "stakeholder networking" within the supply chain in international residential construction include difficulties for stakeholders within the supply chain to recognize, create, or act on business opportunities in an international market, collaborate efficiently and effectively, and create joint value that cannot be created by a single firm. Effective communication and collaboration with other stakeholders in the new market may significantly decrease the risk and uncertainty levels that are highly influenced by factors within the new market environment. "Uncertainty" represents the likelihood of an event, whereas "risk" represents the effects of this event (Pritchard 1997). Thus, early collaboration with stakeholders in the new market provides better knowledge of the market and increased commitment of all stakeholders. Moreover, collaboration enables firms to obtain needed skills or resources more rapidly, reduce asset commitments and increase flexibility, learn from partners, share costs and risks, and build cooperation around a common standard (Mital 2007). Therefore, it is critical to ensure that each stakeholder selects the right partner to minimize the chances of a future split considering criteria such as meeting resource needs, appropriate strategic objectives and styles, degree of rivalry, threat of entry or substitutes, effects on internal strengths and weaknesses, and effects on strategic direction.

3. Feasibility study

Issues related to "pre-execution" that can be identified prior to execution/commercialization include risk and uncertainty associated with commercialization adoption and diffusion of innovation in residential construction and fears of most firms to commercialize innovations owing to ambiguity. Therefore, firms commercializing innovations must constantly analyze risk, adapt business strategy, and adjust culturally. Failure to fully understand these risk exposures prior to commitments may seriously affect the firm's profit, market share, and long-term stability objectives (Ashley

and Bonner 1987). Thus, a firm intending to enter a foreign market is required to assess this new market and verify that the members have the required knowledge, skills, and resources to address the new environment.

4. Execution

Barriers to execution include those encountered during the actual technical, marketing, and business decision processes (and the resulting actions) required for successful implementation of a new product or service (i.e., from the planning stages to the introduction into the new foreign market), and they may not have been identified in the pre-execution stage.

Here, if all stages of discovery, matching and networking, and pre-execution scenarios are performed well, it is easier to decide whether to proceed to execution or stop before exposure to major and/or catastrophic risk. The decision is based on presently available information (e.g., the business case and risk analysis) and required resource availability (e.g., money and people with correct competencies).

To meet these requirements, the proposed framework in this work is largely derived from three frameworks: the CC model, the Stage-Gate model, and the BG model (previously examined). The CC model describes the process of coordinating and optimizing all technical and business decisions required by the successful introduction of a new product or service to the construction marketplace. This model requires parallel involvement of all parties in the design and development of a new construction product in the early stages of a commercialization project. A Stage-Gate model is a conceptual and operational road map for moving a new-product project from idea to launch that groups the effort into distinct stages separated by management decision gates (i.e., "gatekeeping"). The BG model describes the accelerated process of accessing competitive advantages across national borders, allowing firms to be as efficient, effective, and competitive as possible from the start. Table 5.2 summarizes the strengths and weaknesses of each model.

The process modeling representations used for these three models are the *framework matrix*, the *flowchart*, and the *functional flow block diagram*, respectively. These modeling tools form Business Process Modeling Notation (BPMN) elements: flow objects (events, activities, gateways), connecting objects (sequence flow, message flow, association), swim lanes (pool, lane), and artifacts (data object, group, annotation). The process modeling representation used in each of the three models is briefly described as follows.

Table 5.2. Strengths and weaknesses of the CC, Born Global, and Stage-Gate models

	Strengths	Weaknesses
CC	• Thoroughly describes the process of coordinating and optimizing all technical and business decisions required by the successful introduction of a new product or service to the marketplace • Stimulates collaboration in all phases among all stakeholders	• Early international commercialization collaboration is a challenge as the process has additional international barriers
BG	• Using ICTs, it can assist firms in stimulating global demand by using their potential to assist in processes such as international advertising, promotions, order management, and communication with potential clients, agents, and distributors • Enables virtual communication and collaboration among stakeholders	• Does not represent a detailed process across time for technical, marketing, and business decision processes
Stage-Gate	• Firms can benefit from accelerated processes of accessing competitive advantages across national borders • Allow firms to be as efficient, effective, and competitive as possible from the start	• It can be much more difficult to manage rapid international expansion because of the complexity

- **The BG model** is a functional flow block diagram that describes the accelerated process of accessing competitive advantages across national borders (Figure 5.1). It allows firms to be as efficient, effective, and competitive as possible from the start, as it helps them exhibit rapid globalization shortly after inception.
- **Stage-Gate** is a model developed by Cooper (1994) for moving a new product from idea to launch (Figure 5.2). It is a flowchart that serves as a conceptual and operational road map. The proposed flowchart is an effort grouped into distinct stages separated by management decision gates (gatekeeping). That is, the process modeling representation adopted by Cooper not only enumerates the tasks to be completed but also identifies the decision points.

- **The CC model** is a framework matrix of eight period phases and eight technical and business functional areas (Figure 5.3). The framework's architecture accepts various data inputs and establishes commercialization efforts critical to construction industry products through areas, actions, and sequences. It also indicates the importance of localized processes that require additional attention when taking a product to market.

The following list numbered 1, 2, 3, and 4 denotes the numbers circled in Figures 5.1 to 5.3.

1. Networking derived from the BG model (McKinsey and Co. 1993)
2. Feasibility derived from the CC (McCoy et al. 2008) and BG models (Cooper 1994)
3. CC derived from McCoy's model (McCoy et al. 2008)
4. Review stage (Stage-Gate) derived from the Stage-Gate model (Cooper 1994)

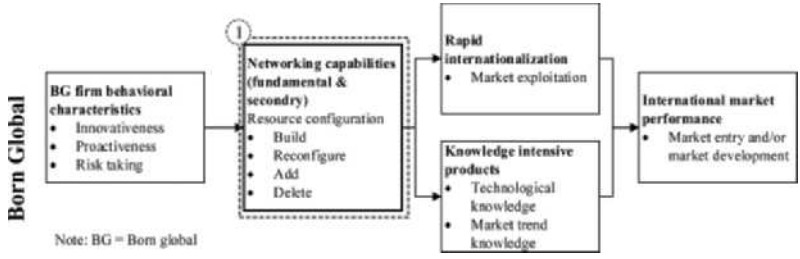

Figure 5.1. The BG model (McKinsey and Co. 1993)

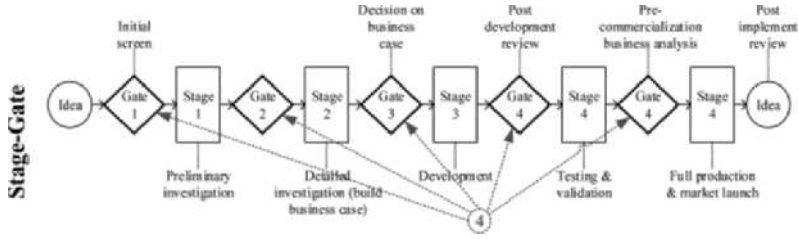

Figure 5.2. The Stage-Gate model (Cooper 1994)

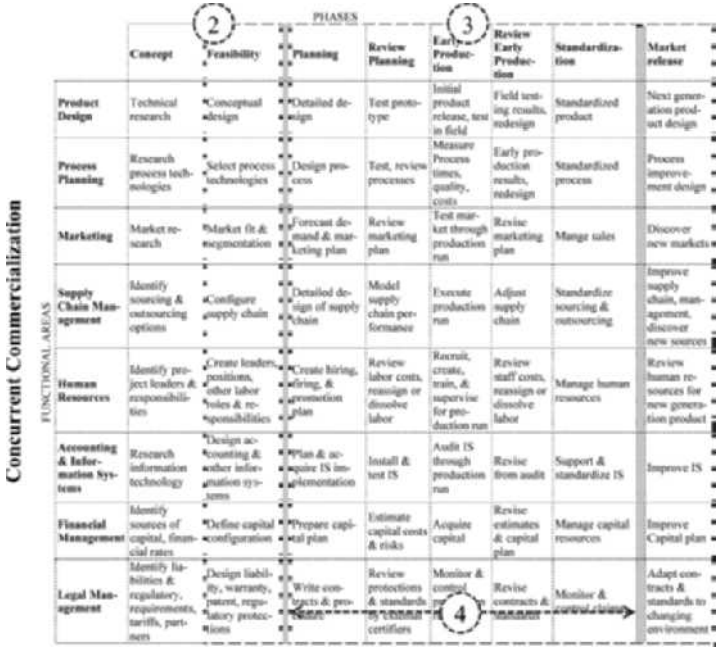

Figure 5.3. The CC model (McCoy et al. 2008)

BPMN MODELING LANGUAGE

BPMN is a modeling language considered in this work to develop the final model for international commercialization of innovative structural products in residential construction. It is seen as an appropriate graphical language for communicating business processes to big audiences, as it allows the creation of initial process drafts and supports process implementation, management, and monitoring (Schumm et al. 2009). The BPMN provides a graphical notation for capturing business processes, especially at the domain analysis and high-level systems design levels (Fernando et al. 2007).

Twenty years ago, Integration Definition (IDEF) was considered the "standard" for business process analysis. IDEF and BPMN have many objectives and foundations in common, but BPMN is more advanced in terms of formalization, whereas IDEF (or IDEF-0, which was the most widely used IDEFX technique) is less formal and more human-oriented. According to Belaychuk (2012), a BPM specialist, BPMN has crucial advantages over other modeling languages:

- BPMN is the only common notation that fosters executable business processes
- BPMN is a two-in-one notation: it includes a full palette for executable diagrams and a basic palette for simplified, intuitive ones
- BPMN Standard 2.0 caused industry consolidation and pushed BPMN into the mainstream

Belaychuk (2012) presents the applicability of different process notations in Table 5.3:

Table 5.3. Comparison of different business process notations

	Workflow	**IDEF**	**DFD**	**UML**	**EPC**	**BPMN**	**BPEL**	**TOTAL**
Architectural drawings[1]	–	+	±	–	±	–	–	2
Process drawings[2]	+	±	±	–	+	+	–	4
Workflow automation[3]	–	–	±	+	+	+	+	4.5
Direct execution[4]	–	–	–	–	–	+	±	1.5
TOTAL	1	1.5	1.5	1	2.5	3	1.5	12

[1]How do firms make money? What does the process-functions-resources matrix look like? Which business processes are served by which IT systems? Rectangles should be labeled with the firm's name to include it in the value chain and to depict links between core processes. Here, IDEF is best. DFD is also a viable option, but BPMN is not.

[2]The widest range of process instruments available (e.g., semi-formal workflow diagrams, EPC, or BPMN) can be used here to understand and manage how employees participate in particular processes to better manage the company or pass a certification.

[3]If software development is key and a process is just one aspect of the software, UML is the natural choice. EPC is strong for ERP implementation and customization rather than development.

[4]Translation of process diagrams into code works well under the assumption that it is a one-way path: first, analysts draw process diagrams; then, programmers implement the diagrams in a software application; finally, the process undergoes production.

This table demonstrates that the optimal notation selection depends on the task:

- If the organization is modeling the architecture and processes without execution plans, IDEF + Workflow or IDEF + EPC are a better choice than BPMN.
- A range of options is best if the organization is interested in one-way automation.
- If the organization is interested in direct process execution, there is no real alternative to BPMN.

The table indicates that BPMN offers three out of the four applications, which is the widest range possible. This is an important advantage, because organizations do not always know how the process initiative will evolve. Thus, BPMN provides two notations in one:

- Use a full BPMN palette if modeling for execution
- Use a basic BPMN palette if there is no need to detail processes down to execution

Those who criticize BPMN for complexity often overlook this point. Belaychuk (2012) indicates that BPMN is complex only when modeling an executable process where there is no effective alternative. He points out that if an organization faces a simpler task, BPMN is as simple as a workflow diagram. Furthermore, in contrast to EPC, the basic BPMN palette is intuitive and does not require formal training to understand.

Therefore, BPMN is considered in this work to develop the final model for international commercialization of innovative structural products in residential construction. It provides a graphical notation for specifying technical, marketing, and business processes based on a flowcharting technique (Simpson 2004). The objective of BPMN is to support BPM for both technical and business needs by providing a notation that is intuitive to all users. Thus, implementation of the BPMN can make the commercialization process readily understandable by all stakeholders involved in the commercialization project. A better understanding of the process contributes to good decision-making by ensuring that the right people use the right information at the right time, and the BMPN can help stakeholders to better manage and control the process using notation that describes all significant decisions and actions.

LITERATURE-BASED FRAMEWORK

This work proposes a framework for international commercialization of residential construction innovations (Figures 5.4 to 5.6). It consists of four main stages—*needs and offers matching*, *networking*, *feasibility study*, and *actual execution*. The overall system of these four stages can be considered a linear process, but the real execution involves implementing the CC theory developed by McCoy et al. (2008) and the Stage-Gate strategy developed by Cooper (1986). The overall process is considered more agile by rethinking the flows of needs and offers and avoiding duplicated efforts and unsolicited contacts. This can be conducted without the need to change behaviors (i.e., modify cultural variables) or fundamentally shift priorities. Simply improving the discoverability of a suitable innovative product for an international market and proactively matching the current pool of needs with potential "partners" in the new market will promote successful new product launches with minimal risk.

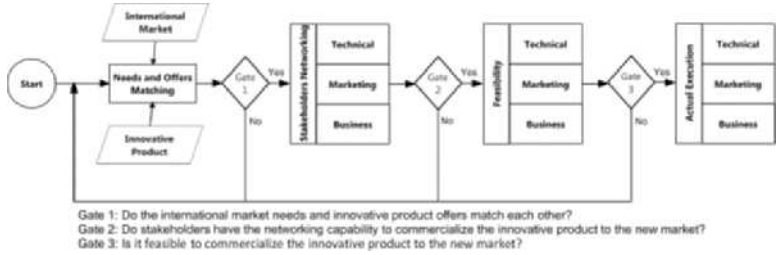

Figure 5.4. Literature-based framework

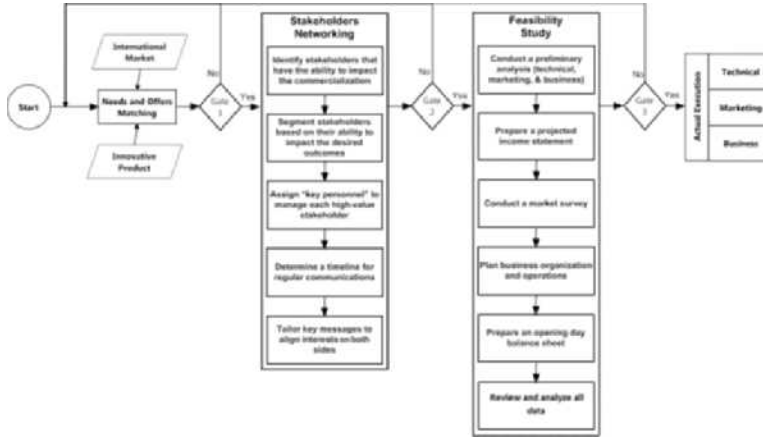

Figure 5.5. Literature-based framework (sub-tasks of stakeholder networking and feasibility study)

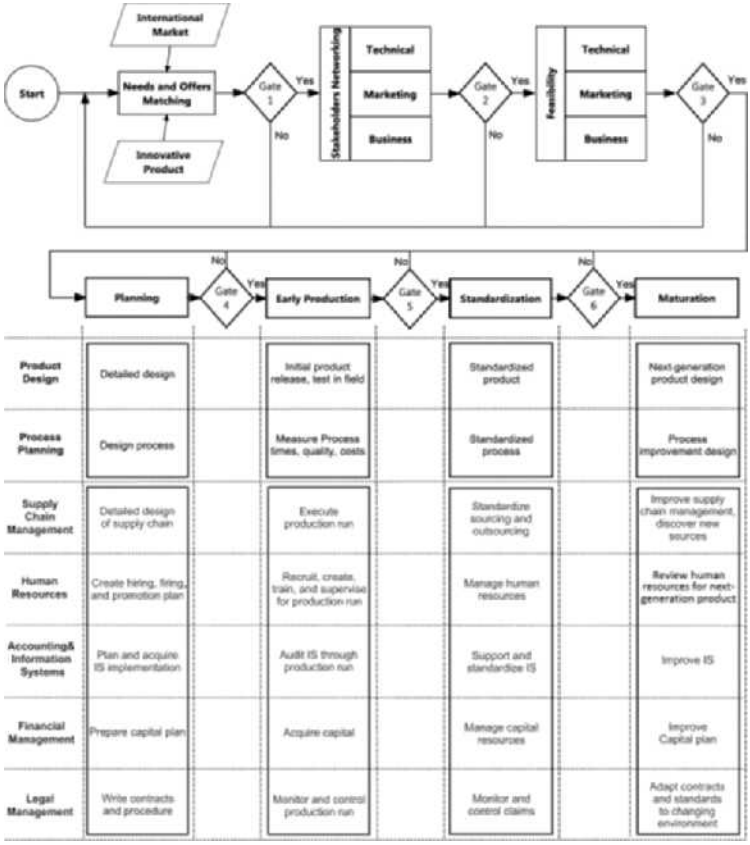

Figure 5.6. Literature-based framework (sub-tasks of actual execution)

This implies a change in focus and the realization that technology push and pull should be simultaneously coordinated and not parallel endeavors. It is also critical to reframe the role of innovation commercialization if open innovation is to be embraced internationally. The objective of this process is to foster true collaboration and co-creation of potentially disruptive innovation in new international markets, which implies that critical issues in the international commercialization process should have explicit guides and evidence to find and map expert opinion.

Beyond the new framework presented by this study, a core objective of this research is to contribute to easing the problem of international commercialization of innovative products in a residential market using methods and tools. The framework supports networking across horizontal and vertical boundaries and creates linkages among markets. This approach, when properly implemented, aims to accomplish several objectives:

- Differentiating and knowing how to use a push–pull strategy is beneficial in identifying an appropriate match between an innovative product and an international market.
- Networking through *collaborative arrangements* and cooperation around a common standard helps stakeholders in obtaining needed skills or resources more quickly, reducing asset commitments and increasing flexibility, learning from partners, and sharing costs and risks.
- CC helps create a competitive advantage, increases performance, and reduces design and development times.

INITIAL FRAMEWORK ASSESSMENT

A framework for international commercialization of innovative structural products in the residential construction industry must be developed that serves as a conceptual and operational roadmap for products that have been successfully developed but not yet launched in new international markets. In addition, it must describe all significant decisions and actions of the innovation decision process. This distinction is important because of flaws in the existing development methods as well as in the application of market diffusion.

In developing the framework, it is necessary to gain insights into the processes surrounding commercialization, which can be achieved by implementing a sequential explanatory mixed-method research design of quantitative surveys followed by qualitative interviews. The quantitative data and their results provide a general picture of the barriers to international commercialization in the available sample that can be mapped onto a framework, whereas the qualitative data and its analysis refines and expands statistical results by exploring participants' actual decision processes. The two outcomes need to merge to develop the final framework.

Thus far, research questions have been established as the basis for the survey instrument and interview questions, incorporating variables derived from the literature. However, a critical issue in defining and evaluating the factors influencing the process of international commercialization is the lack of reliable instruments to measure variability and uncertainty associated with business processes (e.g., stakeholders, actions and decisions critical to the process, product/market characteristic barriers). Consequently, instrument reliability is critical to ensure that the business terminology and modeling language used is understood globally and that it is a viable language for international commercialization.

We employed the *split-halves method* to establish reliability for the instrument using two survey versions for two respective groups of key stakeholders in the supply chain of innovative structural products: (1) SIP stakeholders in the United States and (2) innovative structural product stakeholders in Saudi Arabia. The split-halves method is defined as a self-reporting instrument established by testing two versions of the tool simultaneously. Here, investigators separate the items and compare the results for the two forms after subjects complete the instruments (Likourentzou et al. 2007). The correlation between the two split halves is used in estimating the test reliability.

LITERATURE FINDINGS

BACKGROUND OF BUSINESS TERMINOLOGY AND MODELING LANGUAGE

The literature includes a number of business terms that are critical to the process of international commercialization, such as "foreign market entry mode," "JV," and "strategic alliance." Therefore, prior to measuring their effects on the process, establishing the reliability of the instrument with such terms is required.

In addition, a literature-based framework for international commercialization of innovative structural products in residential construction has been previously developed (McCoy et al. 2008). To increase the reliability of the final framework, this framework was triangulated with other empirical frameworks. Prior to triangulation, it was thus necessary to ensure an international understanding of the modeling language used in this work.

The literature describes the following terms related to business terminology and modeling language used in this work:

1. **Foreign market entry mode** is "an institutional arrangement that creates the opportunity for an organization to enter into the overseas country market" (Madhok 1997).
2. **Licensing** is "an international agreement that allows foreign firms, either exclusively or non-exclusively, to manufacture a proprietor's product for a fixed term in a specific market" (Brooke and Skilbeck 1994).

3. **Franchising** is "a system in which semi-independent business owners (franchisees) pay fees and royalties to a parent company (franchiser) in return for the right to become identified with its trademark, to sell its products or services, and often to use its business format and system," (Zimmerer et al. 2002).
4. **A wholly owned subsidiary** is a company that is completely owned by another corporation to operate in a foreign market (Boardman et al. 1997).
5. **A JV** is a business agreement in which the parties agree to develop, for a finite time, a new entity and new assets by contributing equity (Mariti and Smiley 1983).
6. **A strategic alliance** is an agreement between two or more parties to pursue a set of agreed-upon objectives while remaining independent organizations (Wheelen and Hungar 2000).
7. **BPM modeling** is a method for creating a framework of business processes and for analyzing or improving their systems' performances (Kog et al. 2012). It consists of simple diagrams constructed of the following:
    a. Flow objects (events, activities, gateways)
    b. Connecting objects (sequence flow, message flow, association)
    c. Swim lanes (pool, lane)
    d. Artifacts (data object, group, annotation)

BACKGROUND OF VARIABLES RELATED TO INTERNATIONAL COMMERCIALIZATION

BPM modeling processes are based on previous literature related to (1) barriers to international commercialization, which are key characteristics of innovative and international products; (2) stakeholders, actions and decisions critical to the process; and (3) market-based strategies to commercialize internally.

METHODOLOGY

Two web-based versions of the survey instrument were developed to collect responses. The survey consisted of two sections: 1) questions aimed to test proper business terminology and modeling language and 2) questions aimed to test variables related to international commercialization across

all parties. In the first section, the survey included seven terms along with their definitions in the literature. The participants were asked whether they agree or disagree with each term's definition. In case of disagreement, they were requested to provide the proper term they used for that definition. Details of the second survey are included later in this chapter.

PARTICIPANTS

The study employed an unbiased sampling process. Target respondents for the study included 1) SIP stakeholders who are members of the SIP Association (SIPA) in the United States and 2) stakeholders of innovative structural products in Saudi Arabia registered by the Ministry of Commerce and Industry (MCI).

To conduct quantitative surveys and qualitative interviews with selected participants, the researcher obtained approval from the Virginia Tech Institutional Review Board (IRB). The assistant commissioner of both SIPA in the United States and the MCI in Saudi Arabia reviewed and fully endorsed all invitations to members, and the endorsement letters provided affiliated members with a survey email link. After accessing the secure website, each respondent reviewed board information regarding confidentiality before being granted access to the point-and-click survey procedure.

SURVEY DESIGN

To ensure that all related variables were included in the survey instrument, the study employed open-ended surveys developed using Survey Monkey. The surveys consist of two sections: 1) preliminary questions regarding common use of terms used in the surveys to ensure that participants fully understood the meaning of these terms and 2) questions for testing the comprehensiveness of variables related to international commercialization across all parties.

Beyond this chapter, the study employed closed-ended surveys that included all variables from the reliability step to assure that participants had an equal understanding of questions and variables. The aim of the open-ended questionnaire was to increase the reliability of the instrument; that is, issues related to the understanding of correct terms and variables related to international commercialization without a finite or predetermined set of responses had to be determined. The second questionnaire (closed-ended) was intended to further measure individual variables and select participants for subsequent qualitative interviews (Figure 5.7).

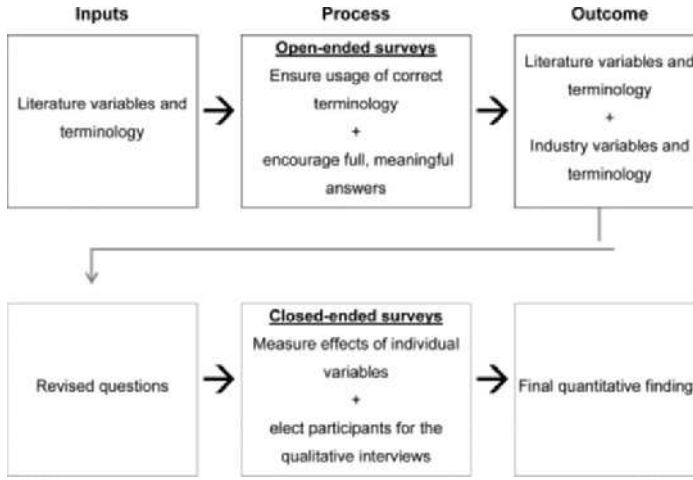

Figure 5.7. The quantitative data collection process

DATA COLLECTION PROCEDURE

The data collection and analysis procedure was conducted between May 2013 and August 2015 and involved post-survey interviews with 26 participants. The open-ended questionnaires were embedded in the email invitations sent to both SIP stakeholders and MCI members. After 2 weeks, a reminder email was sent to participants who did not respond. A final reminder was sent after 3 weeks, allowing respondents one more week to respond.

The online tool captured all responses to each questionnaire automatically and merged them into a separate spreadsheet. Of 86 stakeholders contacted in the United States, 59 responded to the questionnaire for a response rate of 68.6%. In Saudi Arabia, out of 80 stakeholders, 42 responded to the questionnaire for a response rate of 52.5%. Because of the open-ended process, 11 participants in the United States and 15 participants in Saudi Arabia were contacted for further details.

FINDINGS ON SURVEY INSTRUMENT RELIABILITY

This section reports on survey consistency of the two groups surveyed. The reliability of this research instrument concerns the extent to which the survey instrument yields similar results from both groups regarding business terminology, modeling language, and international commercialization variables derived from the literature.

BUSINESS TERMINOLOGY AND MODELING LANGUAGE USED

The goal of this section was to identify international business terminology barriers. At the start of the questionnaire, seven terms and their literature-based definitions related to the process of international commercialization were introduced. In the questionnaire, participants agreed or disagreed with whether they used the selected definition for each term within their organizations. Those that disagreed were encouraged to provide the term they used within their organization.

There was considerable agreement on the use of these terms within the participating organizations. In the United States and Saudi Arabia, 100% of the respondents agreed that the following terminology was correct in both business environments:

- Foreign market entry mode
- Licensing
- Franchising
- WOS
- JV
- Strategic alliance
- BPM framework: flow objects, connecting objects, swim lanes, and artifacts.

As a result, the instruments for these business process terms are considered reliable for this work. The reliability test yielded standardized terminology and definitions that could be used for further measurement. Furthermore, the literature terms seem to be consistent across viable business environments. This finding is intriguing because of the lack of consensus on such terms in the literature related to international commercialization of innovation in residential construction.

VARIABLES RELATED TO INTERNATIONAL COMMERCIALIZATION

The reliability of variables distilled from the literature into the surveys included survey questions around the following issues: 1) barriers to international commercialization, 2) stakeholders, actions, and decisions critical to the

process, 3) key characteristics of innovative products, 4) key characteristics of international markets, and 5) market-based strategies for international commercialization. Instrument reliability highly depends on the consistency in understanding the variables across multiple cultural and business environments.

Therefore, this work employed a separate survey version for each group surveyed. To determine consistency, correlation was conducted between these two versions by comparing the percentage of each group's understanding of each variable. For example, 83% of participants in the United States and 90% of participants in Saudi Arabia were familiar with the variable *ease of product modification.* The correlation for this particular variable is 0.83 in the United States and 0.90 in Saudi Arabia. This correlation only estimates the reliability of each version of the test. For research purposes, a minimum reliability of 0.70 is required for attitude instruments, which indicates a 70% consistency in the scores produced by the instrument. Many tests, such as achievement tests, strive for 0.90 or higher reliabilities.

Barriers to international commercialization and key characteristics of innovative products and international markets

The following section reports on the reliability of all variables related to factors influencing the success level of international commercialization (enablers and barriers). Each survey version included two sub-questions that directly asked participants to rate the influence of potential benefits and barriers on a Likert scale from high to low or indicate N/A if any variable listed is unclear or does not apply. As shown in Table 5.4, variables related to the potential benefits are considered very reliable, as most participants could understand them and indicate their ratings accordingly. In the United States, the variable *ease of staff recruitment/retention* had the lowest reliability score (0.81). In Saudi Arabia, the variable e*ase of product modification* had the lowest reliability score at 0.90 (Table 5.4).

Similarly, both survey versions indicated high reliability of variables related to the potential barriers of international commercialization. In the United States, the variable *high turnover of staff* has the lowest reliability score at 0.83, whereas in Saudi Arabia the variables *regulations and legal*

barriers, entry restriction barriers, language proximity barriers, geographic/cultural barriers, and *multinational business barriers* have the lowest reliability score at 0.90 (Table 5.5).

Table 5.4. Reliability of variables related to potential benefits from international commercialization

		Reliability Score		
	Variables (Potential Benefits)	**United States**	**Saudi Arabia**	**Remarks**
1	Profitable market/Increased profit	0.92	1.00	Very reliable
2	Increased demand over current supply	0.94	1.00	Very reliable
3	Low cost of resources	0.85	1.00	Very reliable
4	Ease of negotiating the business framework	0.85	0.93	Very reliable
5	Ease of business logistics	0.88	0.93	Very reliable
6	Ease of staff recruitment/retention	0.81	0.93	Very reliable
7	Ease of product modification	0.83	0.90	Very reliable
8	Improved code and regulation requirements	0.85	0.93	Very reliable
9	Established image as a multinational innovator	0.85	0.93	Very reliable
10	Increased competitiveness	0.85	0.93	Very reliable
11	Helped meet customers' expectations	0.90	1.00	Very reliable
12	Reduced build time	0.85	1.00	Very reliable
13	Reduced call backs	0.83	1.00	Very reliable

Finally, both survey versions (United States and Saudi Arabia) indicated high reliability of variables related to barriers to firms' sustainability in international commercialization. In the United States, the variable *high turnover of staff* has the lowest reliability score at 0.83. In Saudi Arabia, the variables *regulations and legal barriers*, *entry restriction barriers*, *language proximity barriers*, *geographic/cultural barriers*, and *multinational business barriers* have the lowest reliability score at 0.90 (Table 5.6).

Table 5.5. Reliability of variables related to potential barriers to international commercialization

	Variables (Potential Barriers)	Reliability Score		Remarks
		United States	Saudi Arabia	
1	Highly competitive industry	0.94	1.00	Very reliable
2	Cyclical nature of construction	0.92	1.00	Very reliable
3	Exposure to liability	0.94	1.00	Very reliable
4	Fragmented nature	0.90	1.00	Very reliable
5	Lack of access to information	0.94	1.00	Very reliable
6	Dominance of small firms	0.90	1.00	Very reliable
7	High turnover of staff	0.83	1.00	Very reliable
8	Regulations and legal barriers	0.92	0.90	Very reliable
9	Entry restriction barriers	0.92	0.90	Very reliable
10	Language proximity barriers	0.92	0.90	Very reliable
11	Geographical/cultural barriers	0.94	0.90	Very reliable
12	Multinational business barriers	0.92	0.90	Very reliable
13	Financing expansion barriers	0.90	0.93	Very reliable
14	Business environment barriers	0.92	1.00	Very reliable
15	Insurance barriers	0.90	1.00	Very reliable
16	Trade barriers	0.92	1.00	Very reliable
17	Consumer awareness barriers	0.90	1.00	Very reliable
18	Management barriers	0.90	1.00	Very reliable
19	Distributor strength barriers	0.90	1.00	Very reliable

Stakeholders, actions, and decisions critical to the process

The literature indicates that certain organizational decision factors foster or hinder the process of international commercialization. Through the two survey versions employed, participants indicated that the variables related to the stakeholders, actions, and decisions critical to the process are very reliable. In the United States, the variables *ability to recover the cost of the innovation*, *difficulty of continued innovation use*, and *continued innovation cost* represent the lowest reliability scores at 0.89. In Saudi Arabia, all variables have the same reliability score at 0.94 (Table 5.7).

Table 5.6. Reliability of variables related to long-term barriers to international commercialization

	Variables (Long-Term Barriers)	Reliability Score: United States	Reliability Score: Saudi Arabia	Remarks
1	Competition by others	1.00	0.94	Very reliable
2	Energy costs	1.00	0.94	Very reliable
3	Land (cost, quality, and availability)	0.89	0.94	Very reliable
4	Labor (cost, quality, and availability)	1.00	1.00	Very reliable
5	Consumer awareness	1.00	0.94	Very reliable
6	Government regulations	1.00	1.00	Very reliable

Table 5.7. Reliability of variables related to organizational decision factors

	Variables (Organizational Decision Factors)	Reliability Score: United States	Reliability Score: Saudi Arabia	Remarks
1	Impact of the innovation on profitability	1.00	0.94	Very reliable
2	Labor savings derived from the innovation	1.00	0.94	Very reliable
3	Material savings derived from the innovation	1.00	0.94	Very reliable
4	Ability to recover the cost of the innovation	0.89	0.94	Very reliable
5	Streamlining the production process	0.95	0.94	Very reliable
6	Reduction in build time	1.00	0.94	Very reliable
7	Quality compared with traditional structural products	1.00	0.94	Very reliable
8	Consumers' preferences for the innovation	1.00	0.94	Very reliable
9	Reduction in cycle time	0.95	0.94	Very reliable
10	Manufacturer technical support	1.00	0.94	Very reliable
11	Subcontractor familiarity with the innovation	1.00	0.94	Very reliable

(*Continued*)

Table 5.7. (*Continued*)

	Variables (Organizational Decision Factors)	Reliability Score: United States	Reliability Score: Saudi Arabia	Remarks
12	Supplier technical support	1.00	0.94	Very reliable
13	Reduction in call backs	1.00	0.94	Very reliable
14	Innovation uncertainty/risk	1.00	0.94	Very reliable
15	Initial innovation cost	1.00	0.94	Very reliable
16	Continued innovation cost	0.89	0.94	Very reliable
17	Difficulty in first innovation use	0.95	0.94	Very reliable
18	Difficulty of continued innovation use	0.89	0.94	Very reliable
19	Acceptance by building inspectors/building codes	1.00	0.94	Very reliable
20	Acceptance by insurers	0.95	0.94	Very reliable
21	Acceptance by lenders	0.95	0.94	Very reliable

Market-based strategies to international commercialization

The literature indicates that many organizations tend to commercialize collaboratively with foreign stakeholders for a number of reasons, including access to *skilled/specialized workers*, *financing*, *partner's intellectual property or expertise*, and an *established distribution network*. Both survey versions indicated a very high reliability score for all variables. *Access to financing* and *access to partner's intellectual property* had the lowest reliability scores of 0.90 (Table 5.8).

Table 5.8. Reliability of variables related to collaboration reasons

	Variables (Reasons for Collaboration)	Reliability Score: United States	Reliability Score: Saudi Arabia	Remarks
1	Access to skilled/specialized workers	0.92	1.00	Very reliable
2	Access to financing	0.90	1.00	Very reliable
3	Access to partner's intellectual property	0.90	1.00	Very reliable
4	Access to partner's expertise	0.94	1.00	Very reliable
5	Access to established distribution network	0.94	1.00	Very reliable

SUMMARY AND CONCLUSION

In this chapter, we establish reliability for the instruments developed to evaluate the factors influencing the process of international commercialization. Reliability ensures an international understanding of 1) business terminology and modeling language used and 2) variables related to international commercialization. We used a split-halves method to establish instrument reliability, with separate versions of the survey created for each group. To determine consistency, we conducted correlation analysis between these two survey versions. This analysis estimates only the reliability of each test version. Both survey versions indicated high reliability for variables related to business terminology and modeling language used as well as high reliability for those related to international commercialization.

CHAPTER 6

PERCEIVED BARRIERS TO INTERNATIONAL COMMERCIALIZATION

While the previous chapter aimed to establish reliability among international survey instrument language, this chapter employs survey instruments to investigate barriers to commercializing innovative structural products across residential construction markets. Within this scope, we investigated six major objectives (directly related to the six research questions previously discussed for our book):

1. Existing international commercialization processes
2. Barriers to these international commercialization processes
3. Stakeholders, actions, and decisions critical to the process of international commercialization
4. Characteristics of innovative structural products considered appropriate for international commercialization (stakeholders in Saudi Arabia)
5. Characteristics of appropriate international markets for commercialization of innovative structural products (stakeholders in the United States)
6. Market-based strategies for international commercialization of innovative structural products in residential construction

SURVEY DESIGN

The study employed closed-ended surveys that included all variables from the previous step to ensure that participants had an equal opportunity to answer the questions, including all possible variables. The aim of the

open-ended questionnaire was to encourage full, meaningful answers and gather more information from participants about barriers to commercialization in their organizations. The second, closed-ended questionnaire was intended to additionally measure individual variables and select participants' subsequent qualitative interviews.

This study employed an unbiased sample of stakeholders with different attributes (from large to small) and thus, the survey instrument targeted participants working in positions ranging from corporate headquarters to those working in field operations or local offices. Because comparing the experience of stakeholders in both markets (local and international) with international commercialization within their organizations was critical, the surveys included three subcategories:

1. Part 1 (general questions) determined the attributes of organizations through which the research findings can be analyzed and classified (e.g., company size and experience).
2. Part 2 (targeting stakeholders who have international commercialization experience) determined actual information regarding the process, barriers, critical stakeholders and decisions, the innovative product, the host international market, and strategies.
3. Part 3 (targeting all stakeholders) addressed concepts regarding the process, barriers, critical stakeholders and decisions, the innovative product, the international host market, and strategies.

Two online questionnaires were administered using Survey Monkey to stakeholders in the United States and Saudi Arabia. Responses from each questionnaire were automatically collected to a separate spreadsheet. Each questionnaire included 22 questions, and response formats were standardized across both questionnaires for reliability (i.e., respondents were asked to check a box to indicate their response). The surveys included open-ended responses to encourage full and meaningful answers from the respondents' own knowledge. All respondents were also asked to provide an e-mail address to which a copy of the survey results would be sent.

DATA COLLECTION PROCEDURE

Data collection and analysis of the closed-ended surveys was conducted over a 6-week period. Surveys were conducted with the participants of the open-ended survey to establish instrument reliability and respondent data

validity. For example, the texts of the responses to the open questions in the first questionnaire were included numerically as closed-ended questions in the second round of the two group surveys to increase the study reliability. As previously discussed, the closed-ended questionnaires were embedded in the e-mail invitation sent to both SIP stakeholders and MCI members. After 2 weeks, a reminder e-mail was sent. A final reminder was sent after 3 weeks, giving respondents one more week to respond. Interview participants were chosen from these data based on the amount of information provided in the open-ended responses.

Consequently, the online tool captured all responses to each questionnaire automatically and merged them into a separate spreadsheet. During this process, the range of answers decreased (compared to those of the open-ended survey participants). Of 86 stakeholders the questionnaire was sent to in the United States, 48 responded for a response rate of 55.8%. Of 80 stakeholders the questionnaire was sent to in Saudi Arabia, 30 responded for a response rate of 37.5%.

FINDINGS

A frequency analysis was conducted based on the quantitative process to determine differences in the process and barriers to international commercialization between SIP stakeholders in the United States and innovative product stakeholders in Saudi Arabia. The Survey Monkey software captured responses to both questionnaires using a powerful and easy-to-use reporting platform. MS Excel was used to report the findings in visual tables, charts, and graphs for the frequency analysis. Frequencies were run separately for each research question subcategory within each of the two groups of stakeholders' responses. Analysis was also performed as cross-tabulation (two-way variable comparison tables) on selected variables representing perceived barriers to international commercialization.

ORGANIZATIONAL CHARACTERISTICS

Table 6.1 presents the characteristics of survey participants according to their role within the supply chain and organizational size. According to the sample, builders are stakeholders who report the highest level of adoption of innovative structural products in the international residential construction market. The sample indicates that builders are the dominant stake-

holders in both markets, representing about 55% of innovative structural product stakeholders in Saudi Arabia and about 33% of SIP stakeholders in the United States.

In addition, this study employed a representative sample of firms with varying characteristics, from large to small in size. The majority of these organizations are small, having less than 25 full-time employees, 50% in the United States and 40% in Saudi Arabia (Table 6.1).

Table 6.1. Percentage of stakeholders by their organizational sizes in the residential construction market in the United States and Saudi Arabia

		N	<25	25–49	50–99	100–249	250–499	500+	TOTAL (Excluding Multiple Roles)
US Stakeholders	Manufacturer	9	13%	4%	2%	0%	0%	0%	30%
	Builder	10	13%	4%	2%	2%	0%	0%	33%
	Supplier	7	15%	0%	0%	0%	0%	0%	23%
	Distributor	4	6%	2%	0%	0%	0%	0%	13%
	Architect	0	0%	0%	0%	0%	0%	0%	0%
	Multiple roles	18	4%	4%	4%	13%	6%	6%	N/A
	TOTAL	**48**	**50%**	**15%**	**8%**	**15%**	**6%**	**6%**	**100%**
Saudi Stakeholders	Manufacturer	4	10%	0%	3%	0%	0%	0%	18%
	Builder	12	17%	7%	3%	7%	7%	0%	54%
	Supplier	3	7%	3%	0%	0%	0%	0%	14%
	Distributor	2	3%	3%	0%	0%	0%	0%	9%
	Developers	1	0%	0%	3%	0%	0%	0%	5%
	Multiple roles	8	3%	0%	3%	0%	10%	10%	N/A
	TOTAL	**30**	**40%**	**13%**	**13%**	**7%**	**17%**	**10%**	**100%**

As the roles of the participants' jobs differ among organizations, the study gathered respondents from various levels and positions within organizations. Therefore, the researcher requested that organizations include all those influencing the decision-making process in the survey process. Table 6.2 presents the distribution of organizational positions that reported influencing the decision-making process in the United States and Saudi Arabia. This influence is somewhat similar in the two markets, which may indicate that organizational practices are similar in both residential construction markets in terms of decision-making.

While respondents may be representatives of large national or regional organizations, information reported from an operations office that serves

specific market areas is not necessarily representative of corporate-level responses. Survey respondents typically worked in corporate headquarters, field operations, and local offices. By frequency, *CEO/Owners*, *Presidents*, and *Sales Managers* represent 23%, 25%, and 21%, respectively, of subjects' corporate titles for US-based companies and 29%, 17%, and 20%, respectively, of those in Saudi Arabia. In both nations, major decisions to commercialize internationally occur primarily on the corporate level. Employees working on the corporate level represent about 69% of all participants in the United States and about 65% of those in Saudi Arabia (Table 6.2).

Table 6.2. Corporate titles of survey participants by organizational level in the United States and Saudi Arabia, in percent

	United States				**Saudi Arabia**			
Participant Job Title	**Corporate Level**	**Regional Level**	**Local Level**	**TOTAL**	**Corporate Level**	**Regional Level**	**Local Level**	**TOTAL**
Account Manager	1%	0%	0%	**2%**	0%	0%	0%	**0%**
Architect	3%	1%	1%	**4%**	2%	1%	0%	**3%**
Business Development Manager	3%	1%	1%	**4%**	2%	1%	0%	**3%**
CEO/Owner	16%	3%	4%	**23%**	18%	9%	2%	**29%**
Code Report Manager	1%	0%	0%	**2%**	0%	0%	0%	**0%**
Construction Manager	0%	0%	0%	**0%**	2%	1%	0%	**3%**
Director of Certification	1%	0%	0%	**2%**	0%	0%	0%	**0%**
Engineer	1%	0%	0%	**2%**	0%	0%	0%	**0%**
General Manager	1%	0%	0%	**2%**	2%	1%	0%	**3%**

(*Continued*)

Table 6.2. (*Continued*)

Participant Job Title	United States				Saudi Arabia			
	Corporate Level	Regional Level	Local Level	TOTAL	Corporate Level	Regional Level	Local Level	TOTAL
Operational Manager	3%	1%	1%	**4%**	2%	1%	0%	**3%**
President	17%	4%	4%	**25%**	11%	6%	0%	**17%**
Product Manager	1%	0%	0%	**2%**	0%	0%	0%	**0%**
Project Manager	3%	1%	1%	**4%**	2%	1%	0%	**3%**
Purchasing Manager	0%	0%	0%	**0%**	2%	1%	0%	**3%**
Regional Manager	0%	0%	0%	**0%**	9%	4%	0%	**13%**
Sales Manager	14%	3%	3%	**21%**	13%	7%	0%	**20%**
Technical Manager	1%	0%	0%	**2%**	0%	0%	0%	**0%**
Vice President	3%	1%	1%	**4%**	0%	0%	0%	**0%**
TOTAL	**69%**	**15%**	**16 %**	**100%**	**65%**	**33%**	**2%**	**100%**

FINDINGS SPECIFIC TO THE RESEARCH QUESTIONS

1. What commercialization processes exist for residential construction innovative products locally and internationally?

To date, global effects on diffusion are the least understood because of the lack of research on methods by which companies commercialize residential innovative products in new foreign markets. Unfortunately, for the residential construction industry, attention has been focused mainly on domestic diffusion patterns of consumer durables within a limited number of industrialized countries. The use of commercialization frameworks in the industry has also been limited. Based on the study, four participants in the US market indicated that they used a highly formalized process to

commercialize SIPs nationally or internationally. In Saudi Arabia, one organization indicated that it used a formal process to commercialize international innovations for the Saudi market (Figure 6.1). Based on this quantitative process, five participants were selected for qualitative interviews. There, visual and textual data about one commercialization process were collected from a willing participant. The findings are presented in the next chapter of this work.

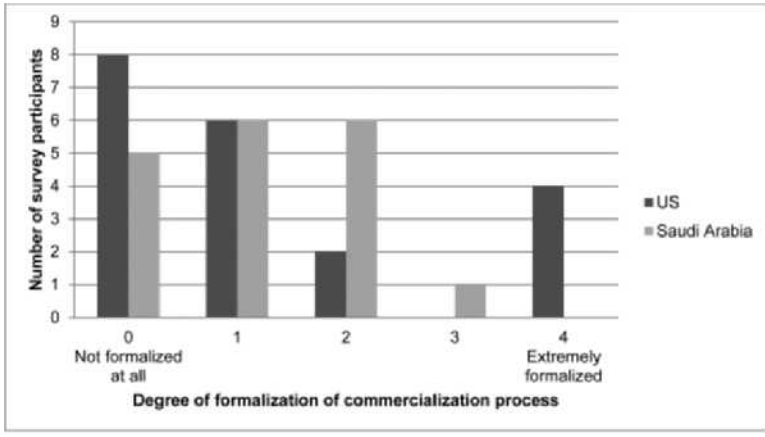

Figure 6.1. Formalization of international commercialization processes used by organizations in the United States and in Saudi Arabia

2. What are the local and international barriers to commercialization of innovative residential construction products?

The second research question requires information from stakeholders with and without experience in international commercialization. Thus, some survey questions targeted those with and without international commercialization experience to uncover barriers to the commercialization process.

a. Stakeholders who have experienced international commercialization

In both surveys, the number of participants with international commercialization experience is the same in the United States and Saudi Arabia at 19 each. Typically, these stakeholders set milestones that can be used to measure success. According to respondents, major milestones in the commercialization of new products include 1) *recovering investment costs*, 2) *increasing sales volume*, 3) *increasing market share*, 4) *becoming the market leader*, and 5) *developing strong demand for the product.*

Organizations in both markets report similar overall levels of success in achieving these milestones (Figure 6.2). In both surveys, most participants indicate that they have been or are able to 1) *recover the investment cost*, 2) *increase the sales volume*, and 3) *increase market share*. However, *becoming the market leader and developing strong product demand* have been challenging milestones for US stakeholders. The study found that 26% of organizations that commercialized innovations to the Saudi market are market leaders, whereas only 6% of US organizations were able to become market leaders. Similarly, 53% of organizations that have commercialized in the Saudi market indicated they are able to increase their market share compared to 39% of US organizations.

Furthermore, the commercialization period is considered a measure of success and is critical, and it differs among the countries. The majority of US organizations surveyed indicated that they achieved the following milestones: *recovering investment costs, increasing sales volume,* and *increasing market share* within *1–3 years*. However, they report that *becoming the market leader* and *developing strong product demand* are two milestones that can take up to 3–5 years to achieve, whereas most organizations in Saudi Arabia indicate they can achieve *all* milestones within 1–3 years (Table 6.3).

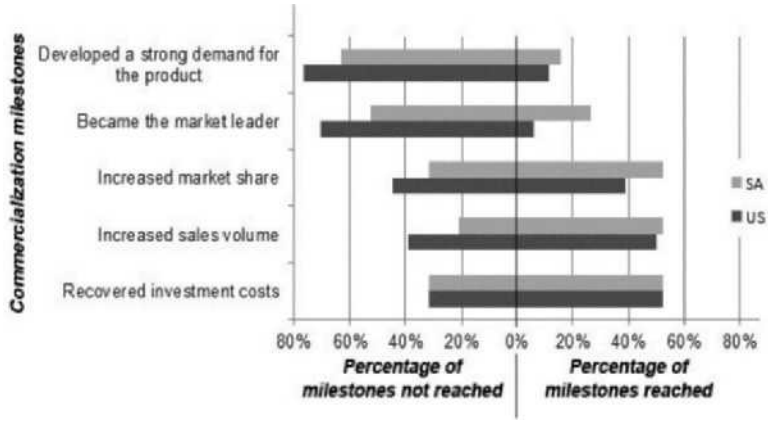

Figure 6.2. Milestones of international commercialization reached/not reached by stakeholders in the United States and Saudi Arabia

Inability to achieve these milestones may be caused by a number of factors, such as 1) lack of financial resources, 2) lack of specialized human resources, 3) low-quality or inefficient regulation, and 4) insufficient demand for the product. Overall, these factors have a higher influence on

US organizations than on Saudi ones (50% compared to 35%, respectively; Figure 6.3). Such factors may explain the slight differences between the two groups of stakeholders in terms of the success level to achieve these milestones.

Table 6.3. Time to achieve international commercialization milestones in the United States and Saudi Arabia

Organizational Milestones	1–3 Years		3–5 Years		5–10 Years		Over 10 Years		Won't Reach Milestone	
	US	SA	US	SA	US	SA	US	SA	US	SA
Recovered investment costs	**55%**	**50%**	18%	33%	9%	17%	0%	0%	18%	0%
Increased sales volume	**62%**	**43%**	15%	29%	8%	29%	0%	0%	15%	0%
Increased market share	**55%**	**50%**	9%	17%	18%	33%	0%	0%	18%	0%
Became market leader	21%	**50%**	**36%**	13%	21%	13%	7%	13%	14%	13%
Developed strong demand	27%	**33%**	**33%**	25%	13%	17%	13%	8%	13%	17%

* *Note:* Bold values represent the most-likely time that most participants believe it will take to achieve international commercialization milestones in the United States and Saudi Arabia.

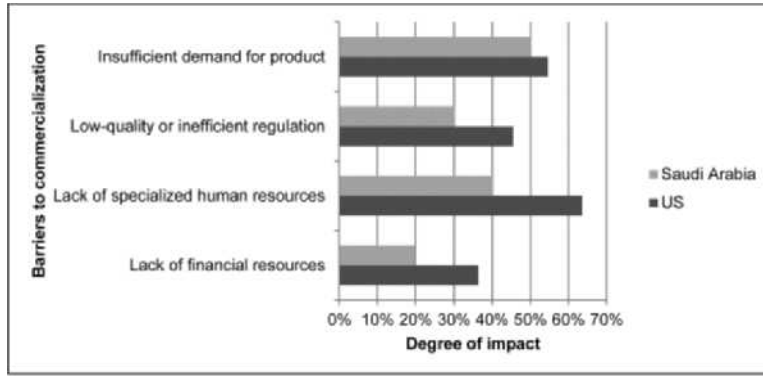

Figure 6.3. Factors influencing the success level of international commercialization of organizations in the United States and Saudi Arabia

In the United States, 64% of participants indicate that *lack of specialized human resources* is the factor most impacting the success level of SIP commercialization internationally, followed by *insufficient demand for the product*; *low-quality or inefficient regulation*; and *lack of financial resources* at 55%, 45%, and 36%, respectively. In Saudi Arabia, 50% of participants indicated that *insufficient product demand* is the factor most affecting adoption success of international innovation, followed by *lack of specialized human resources*, *low-quality or inefficient regulation*, and *lack of financial resources* at 40%, 30%, and 20%, respectively.

The level of innovation acceptance may change over time (Koebel and Cavell 2006). A number of factors have influenced adoption of innovative products, such as *competition from others*, *energy cost*, *land* (cost, quality, and availability), *labor* (cost, quality, and availability), consumer awareness of building technologies, and government regulations. Overall, 79% of US organizations have indicated that energy cost and consumer awareness of building technologies are factors that will highly influence its use over the next 10–20 years. Next, regulation and labor (cost, quality, and availability) are factors that may also influence the use of SIPs in the international market over the next 10–20 years at 61% and 53%, respectively (Figure 6.4). Similarly, 65% of organizations in the Saudi market have indicated that energy cost is the most concerning factor over the next 10–20 years. Government regulation, consumer awareness of building technologies, and labor (cost, quality, and availability) are other factors that concern the majority of these organizations, at 53%, 47%, and 35%, respectively (Figure 6.5).

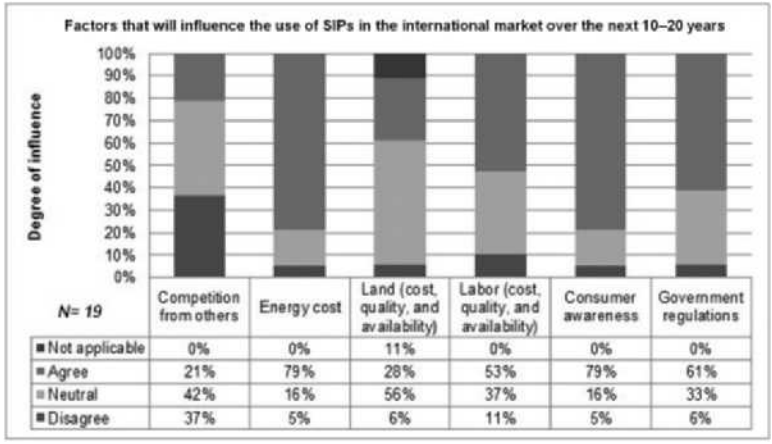

Figure 6.4. Factors that will influence the use of SIPs in the international market over the next 10–20 years

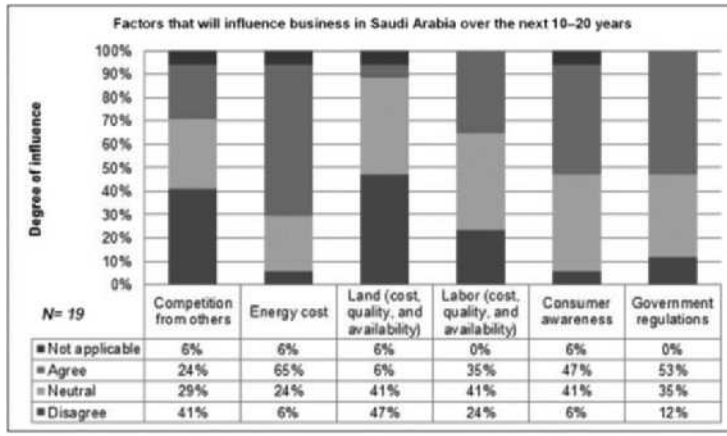

Figure 6.5. Factors that will influence business in Saudi Arabia over the next 10–20 years

b. All stakeholders in international commercialization, whether experienced or not

Many local organizations believe that a number of factors affect the success of international commercialization. Their perceptions of potential benefits and barriers to international commercialization either foster or hinder decision-making in their organizations to commercialize innovative products in foreign markets. Thus, the second research question aimed to identify the benefits and barriers that influence international commercialization and to measure their impact on the decision-making process in those organizations. Better allocation of risks and barriers leads to better development of market-based strategies, the ultimate objective of which is to endorse innovative international residential construction products successfully.

Table 6.4 shows the perceived benefits from international commercialization for firms in the United States and in Saudi Arabia. The overall effect of these benefits on the decision to commercialize is slightly higher in Saudi Arabia at an average of 37% compared to 25% in the United States. However, both groups agree on the importance of five potential benefits: *profitable market/product, increased demand over supply*, *met customer expectations*, *reduced build time*, and *reduced callbacks.* In the United States, 31% of the organizations believe that an *established image as a multinational innovator* is another factor that would foster international success. In Saudi Arabia, organizations identify two other factors critical for decision-making: *low cost of resources* (53%) and *increased competitiveness* (33%) (Table 6.4).

Table 6.4. Perceived benefits from international commercialization for firms in the United States and Saudi Arabia

Potential Benefits	United States				Saudi Arabia			
	Low	Average	High	N/A	Low	Average	High	N/A
Profitable market/product	6%	38%	**48%**	8%	3%	33%	**63%**	0%
Increased demand over supply	6%	38%	**50%**	6%	7%	40%	**53%**	0%
Low cost of resources	19%	48%	19%	15%	10%	37%	**53%**	0%
Simple negotiation framework	33%	48%	4%	15%	10%	53%	30%	7%
Ease of doing business	33%	44%	10%	13%	23%	47%	23%	7%
Ease of staff recruitment/retention	29%	44%	8%	19%	33%	37%	23%	7%
Ease of product modification	23%	54%	6%	17%	20%	50%	20%	10%
Better codes and regulations	25%	42%	19%	15%	23%	60%	10%	7%
Established image as a multinational innovator	15%	40%	31%	15%	20%	53%	20%	7%
Increased competitiveness	13%	54%	19%	15%	20%	40%	**33%**	7%
Met customers' expectations	10%	46%	**33%**	10%	17%	27%	**57%**	0%
Reduced build time	19%	25%	**42%**	15%	20%	27%	**53%**	0%
Reduced call-backs	19%	31%	**33%**	17%	23%	40%	**37%**	0%
AVERAGE	**19%**	**42%**	**25%**	**14%**	**18%**	**42%**	**37%**	**4%**

* *Note:* Bold values represent the most important benefits from international commercialization for firms in the United States and Saudi Arabia.

International commercialization is also associated with risk and uncertainty, as the process is associated with barriers that hinder stakeholders from exploring new products or markets. Table 6.5 shows the perceived barriers to international commercialization for firms in the United States and Saudi Arabia. The average reported effects of these barriers on

commercialization decisions are slightly higher in the United States than in Saudi Arabia at 24% compared to 20%, respectively. The common potential barriers for both groups are *lack of access to information*, *financing expansion barriers*, and *consumer awareness barriers*. Other major factors influencing US firms are related to the business environment of that international market, including *international regulations and legal barriers*, *entry restriction barriers*, and *language proximity barriers*. In contrast, factors reported to most hinder stakeholders in Saudi Arabia are related to management barriers, such as the *highly competitive nature among participants*, *trade barriers*, and *management barriers* (Table 6.5).

Table 6.5. Perceived barriers to international commercialization for firms in the United States and Saudi Arabia

Barriers	United States				Saudi Arabia			
	Low	Average	High	N/A	Low	Average	High	N/A
Highly competitive industry	40%	42%	13%	6%	23%	43%	**33%**	0%
Cyclical nature of construction	29%	42%	21%	8%	30%	63%	7%	0%
Exposure to liability	25%	48%	21%	6%	33%	60%	7%	0%
Fragmented nature	21%	42%	27%	10%	33%	57%	10%	0%
Lack of access to information	15%	40%	**40%**	6%	30%	23%	**47%**	0%
Dominance of small firms	46%	44%	0%	10%	30%	60%	10%	0%
High turnover of staff	44%	33%	6%	17%	37%	57%	7%	0%
Regulations and legal barriers	10%	35%	**46%**	8%	**47%**	40%	3%	10%
Entry restriction barriers	15%	42%	**35%**	8%	**50%**	33%	7%	10%
Language proximity barriers	19%	38%	**35%**	8%	**53%**	30%	7%	10%
Geographic/cultural barriers	17%	50%	27%	6%	50%	33%	7%	10%
Multinational business barriers	13%	58%	21%	8%	47%	37%	7%	10%
Financing expansion barriers	19%	40%	31%	10%	23%	17%	**53%**	7%

(*Continued*)

Table 6.5. (*Continued*)

Barriers	United States				Saudi Arabia			
	Low	**Average**	**High**	**N/A**	**Low**	**Average**	**High**	**N/A**
Business environment barriers	21%	48%	23%	8%	40%	43%	17%	0%
Insurance barriers	38%	38%	15%	10%	40%	50%	10%	0%
Trade barriers	15%	48%	29%	8%	17%	50%	**33%**	0%
Consumer awareness barriers	6%	48%	**35%**	10%	17%	37%	**47%**	0%
Management barriers	19%	54%	17%	10%	23%	20%	**50%**	7%
Distributor strength barriers	13%	54%	23%	10%	20%	60%	20%	0%
AVERAGE	**22%**	**44%**	**24%**	**9%**	**34%**	**43%**	**20%**	**3%**

* *Note:* Bold values represent the most important barriers to international commercialization for firms in the United States and Saudi Arabia.

3. What are the stakeholders' actions and decisions that are critical to international commercialization of innovative structural products in residential construction?

A number of factors positively or negatively affect organizational decision-making in commercializing innovative products for foreign markets (Table 6.6). A better understanding of these factors helps organizations determine their needs and create strategies for international commercialization. The degree of similarity in these factors between the two markets is also likely to indicate similar needs and interests between both stakeholder groups, yielding better networking and collaboration between these stakeholders to achieve international commercialization success. Early collaboration with stakeholders in the new market leads to better market knowledge and improved commitment of all stakeholders. Moreover, collaboration enables firms to obtain needed skills or resources more quickly, reduce asset commitments and increase flexibility, learn from partners, share costs and risks, and build cooperation around a common standard (Mital 2007).

In the United States and Saudi Arabia, stakeholders share 18 common factors (14 positive and 4 negative) out of 21 possibilities. Organizations in the United States consider three factors to be barriers to international commercialization: *acceptance by building inspectors/building codes, acceptance by insurers*, and *acceptance by lenders*. However, Saudi stakeholders consider these positive factors. The 14 positive factors common to

both are *impact on profitability*, *labor savings derived*, *materials savings derived*, *ability to recover cost*, *streamlined production process*, *reduced build time*, *quality compared to traditional structural products*, *consumer preferences*, *reduction in cycle time*, *manufacturer technical support, supplier technical support, reduction in call-backs, continuing cost of the innovation, and difficulty of continuing use*. The four common negative factors are *subcontractor familiarity with the innovation*, *uncertainty/risk*, *initial cost*, and *difficulty of first use*.

Table 6.6. Decision factors affecting adoption of SIPs in international markets compared to other innovative structural products in Saudi Arabia

Decision Factors	United States				Saudi Arabia			
	No Impact	Negative	Positive	N/A	No Impact	Negative	Positive	N/A
Impact of the innovation on profitability	5%	11%	**84%**	0%	17%	11%	**67%**	6%
Labor savings derived from the innovation	16%	5%	**79%**	0%	11%	0%	**83%**	6%
Materials savings derived from the innovation	26%	11%	**63%**	0%	11%	0%	**83%**	6%
Ability to recover cost of the innovation	11%	11%	**68%**	11%	33%	0%	**61%**	6%
Streamlined production process	16%	0%	**79%**	5%	28%	0%	**67%**	6%
Reduction in build time	16%	0%	**84%**	0%	11%	0%	**83%**	6%
Quality compared to traditional structural products	5%	0%	**95%**	0%	6%	11%	**78%**	6%
Consumer preferences for the innovation	5%	26%	**68%**	0%	11%	22%	**61%**	6%
Reduction in cycle time	16%	5%	**74%**	5%	33%	6%	**56%**	6%

(*Continued*)

Table 6.6. (*Continued*)

Decision Factors	United States				Saudi Arabia			
	No Impact	Negative	Positive	N/A	No Impact	Negative	Positive	N/A
Manufacturer technical support	26%	5%	**68%**	0%	11%	11%	**72%**	6%
Subcontractor familiarity with the innovation	26%	**47%**	26%	0%	22%	**44%**	28%	6%
Supplier technical support	21%	11%	**68%**	0%	28%	11%	**56%**	6%
Reduction in call-backs	32%	11%	**58%**	0%	28%	17%	**50%**	6%
Uncertainty/risk of the innovation	32%	**58%**	11%	0%	17%	**44%**	33%	6%
Initial cost of the innovation	16%	**74%**	11%	0%	11%	**56%**	28%	6%
Continuing cost of the innovation	26%	16%	**47%**	11%	11%	28%	**56%**	6%
Difficulty of first use	26%	**63%**	5%	5%	6%	**61%**	28%	6%
Difficulty of continuing use	42%	16%	**32%**	11%	6%	28%	**61%**	6%
Acceptance by building inspectors/building codes	26%	**63%**	11%	0%	22%	6%	**67%**	6%
Acceptance by insurers	47%	**32%**	16%	5%	22%	6%	**67%**	6%
Acceptance by lenders	42%	**32%**	21%	5%	22%	6%	**67%**	6%
AVERAGE	**23%**	**24%**	**51%**	**3%**	**17%**	**17%**	**60%**	**6%**

* *Note:* Bold values represent the most important Decision factors affecting (positively or negatively) adoption of SIPs in international markets compared to other innovative structural products in Saudi Arabia.

As innovation offers a potential competitive advantage, many firms search for strategies and solutions that help them successfully promote innovation. These typically consider industry characteristics, accelerators, and barriers (Hassell et al. 2003, Koebel and Cavell 2006). As discussed in the literature review, the characteristics and soundness of innovation and its

host markets are a major factor affecting organizational decision-making for international commercialization. Most organizations in the United States and Saudi markets are willing to commercialize internationally if the market is promising for the product. Overall, 56% of SIP stakeholders in the United States have indicated that they are willing to explore international business opportunities in international markets compared to 50% of innovative product stakeholders in Saudi Arabia (Figure 6.6). Over a third of the participants are still hesitant to commercialize internationally even with a promising market/innovation, and these participants were interviewed.

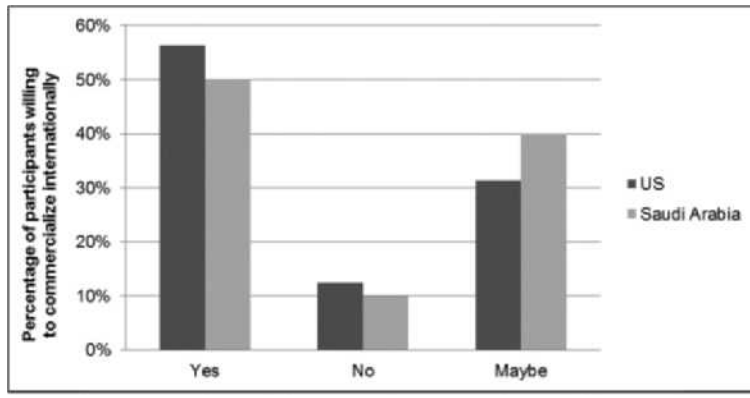

Figure 6.6. US and Saudi Arabian willingness to explore international business opportunities

CEOs, *presidents*, and *marketing/sales managers* are the organizational champions of international commercialization in both the United States and Saudi markets (Figure 6.7). However, international commercialization projects ultimately heavily rely on the involvement of other personnel who have influential inputs in the decision-making processes within these organizations. Table 6.7 presents the influential extent that some organizational positions have on the decision-making process in the United States and Saudi Arabia. This influence is clearly similar in the two markets, which may indicate that organizational practices are similar in terms of decision-making.

Using a Likert scale from 1 to 5, the survey further measured the importance of stakeholders' collaboration with others from the foreign markets they want to commercialize innovations in (Table 6.8). In the United States, *builders from foreign markets* are the most critical stakeholders that local SIP organizations want to collaborate with when commercializing internationally, for a 32% overall average importance rate. Most SIP manufacturers,

suppliers, and architects/designers favor collaboration with foreign builders over other stakeholders, with an importance rate of 36%, 41%, and 35%, respectively. However, SIP builders and distributors in the United States believe that suppliers from foreign markets are the most critical stakeholders for collaboration in international commercialization projects.

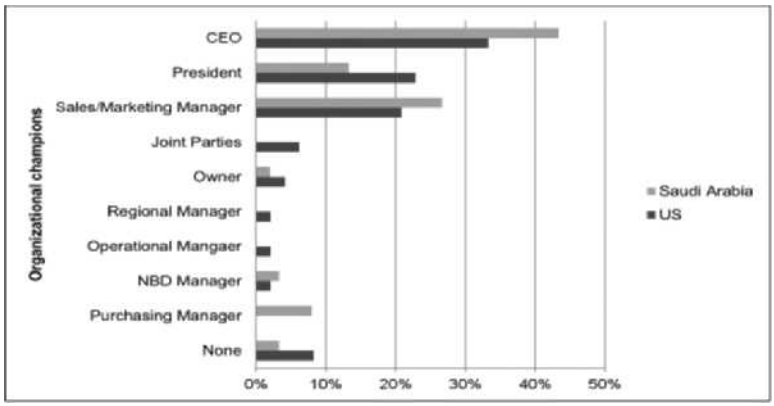

Figure 6.7. Influence of decision-makers on international commercialization

Table 6.7. Influential extent of organizational positions on the decision-making process in the United States and Saudi Arabia

Organizational Positions	United States	Saudi Arabia
Board Members	9%	4%
Chief Executive Officer	24%	44%
Chief Financial Officer	9%	0%
Head of Research Development	5%	2%
Head of Purchasing	4%	13%
Chief Designer/Architect	7%	0%
Chief Engineer	7%	4%
Head of Sales or Marketing	20%	27%
Regional Office Director	3%	4%
Regional Purchasing Manager	1%	2%
Regional Senior Project Manager	1%	0%
Regional Project Manager	1%	0%
Local Office Director	3%	2%
Local Purchasing Manager	2%	0%
Local Senior Project Manager	1%	0%
Local Project Manager	2%	0%

Table 6.8. Importance of collaboration with stakeholders in foreign markets for organizations in the United States and Saudi Arabia

			Foreign Market Stakeholders					
		N	**Manufacturer**	**Builder**	**Supplier**	**Distributor**	**Developer**	**Architect**
US Stakeholders	Manufacturer	19	21%	36%	19%	8%	11%	5%
	Builder	22	10%	23%	**26%**	7%	21%	13%
	Supplier	16	16%	**41%**	14%	10%	7%	12%
	Distributor	8	7%	23%	**52%**	10%	4%	4%
	Architect/Designer	1	8%	**35%**	29%	10%	11%	6%
	AVERAGE		**12%**	**32%**	**28%**	**9%**	**11%**	**8%**
Saudi Stakeholders	Manufacturer	9	**62%**	11%	8%	6%	4%	9%
	Builder	18	21%	**25%**	33%	4%	9%	8%
	Supplier	6	**41%**	**41%**	4%	6%	5%	3%
	Distributor	4	**44%**	18%	23%	7%	4%	4%
	Developer	1	10%	**32%**	29%	13%	9%	7%
	AVERAGE		**36%**	**25%**	**19%**	**7%**	**6%**	**6%**

* *Note:* Bold values represent the most important foreign market stakeholders to collaborate with.

On the other hand, organizations in Saudi Arabia indicated that *manufacturers from foreign markets* are the most important stakeholders for collaboration, averaging a 36% overall importance rate. Most manufacturers, suppliers, and distributors of innovative structural products favored collaboration with foreign manufacturers over other stakeholders at a rate of 62%, 41%, and 44%, respectively. However, the majority of builders in Saudi Arabia preferred to collaborate with foreign suppliers from foreign markets to adopt innovations from these foreign markets.

Many stakeholders exhibited a preference for collaborating with other stakeholders who have knowledge, expertise, or resources needed to enter new markets, whether or not they were part of a local market. Based on certain criteria (Table 6.9), respondents evaluated other stakeholders' qualifications and worked on matching "offers and needs" with theirs. Factors that encouraged firms to commercialize their product collaboratively with other organizations (locally or internationally) included *access to skilled/specialized workers, access to financing, access to partner*

intellectual property, access to partner expertise, and *access to established distribution networks*. Overall, 54% of US participants and 47% of Saudi ones indicated that *access to established distribution networks* is the most important factor fostering collaborative commercialization with other stakeholders. Next, *access to partner expertise* is critical for 35% of US stakeholders and 47% of Saudi Arabian ones (Table 6.9).

Table 6.9. US and Saudi Arabian ranking of importance for commercialization collaboration criteria

	Criteria for Collaboration	Little Importance	Moderate Importance	Great Importance	Essential	Not Applicable
US Stakeholders	Access to skilled/specialized workers	4%	33%	**35%**	19%	8%
	Access to financing	8%	13%	**31%**	38%	10%
	Access to partner intellectual property	17%	38%	25%	10%	10%
	Access to partner expertise	4%	27%	**35%**	27%	6%
	Access to established distribution network	0%	19%	**54%**	21%	6%
Saudi Stakeholders	Access to skilled/specialized workers	10%	50%	33%	7%	0%
	Access to financing	7%	27%	**37%**	30%	0%
	Access to partner intellectual property	30%	33%	33%	3%	0%
	Access to partner expertise	7%	47%	**47%**	0%	0%
	Access to established distribution network	0%	17%	**47%**	37%	0%

**Note:* Bold values represent the most important criteria for collaboration for stakeholders in the United States and Saudi Arabia.

4. What innovative products are appropriate for international use? Are SIPs considered appropriate?
5. What residential construction markets are ideal for studying the barriers of product development and adoption?

Characteristics of innovation and the host market have a significant effect on the spread of innovations in residential construction (James Hickling Consultants 1989, Slaughter 1993). Building professionals and stakeholders are continually looking for products that meet needs and reduce risk, eliminating concerns. However, builders, owners, designers, and other construction team members have a low risk tolerance. Consequently, these stakeholders avoid adopting innovations that carry market risk, competitive risk, and, especially, financial risk (McCoy et al. 2008). Therefore, two questions aimed to quantify the characteristics of innovations and foreign markets critical to stakeholders. The study produced market-based strategies and incorporated them into the development of the final model for international commercialization.

In the United States and Saudi Arabia, the number of organizations attempting to commercialize innovative structural products internationally has increased in the last two decades (Figure 6.8). From the United States, 19 SIP stakeholders have commercialized SIPs in 24 international markets and 41 organizations worldwide. Of these 41 organizations, 23 were located within the two American continents (Figure 6.9). However, international commercialization of SIPs in some developing countries is still limited. For example, there were only two SIP organizations in the Middle East, a manufacturer in Dubai and a builder in Saudi Arabia.

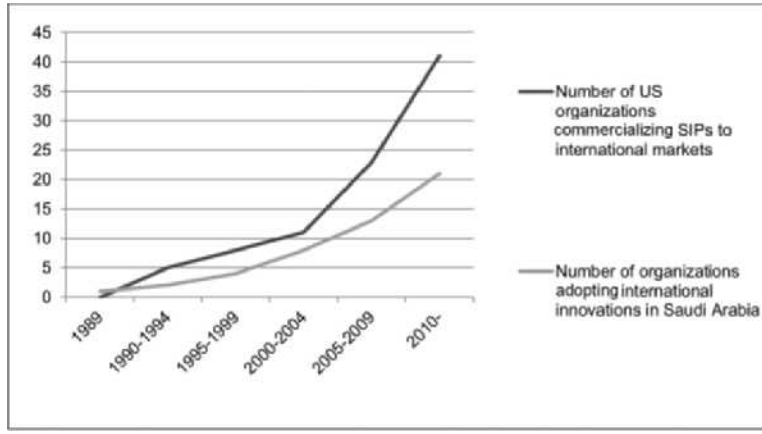

Figure 6.8. Growth of both US organizations commercializing SIPs in international markets and organizations adopting international innovations in Saudi Arabia

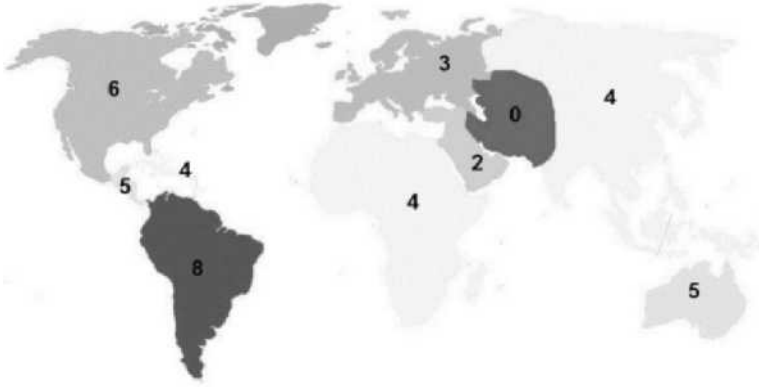

Figure 6.9. Presence of SIPs in international markets

In Saudi Arabia, some organizations have attempted to adopt a number of innovative structural products, such as metal building structures (pre-engineered building or racking systems), pre-cast concrete, insulated roofs and walls, composite panels (Siporex, Innovida, Dura wall), wooden walls, light structures, aluminum panels, seamless roofing systems, and steel decking. For these, 21 multinational enterprises attempted to adopt these products from other international markets. However, in the Saudi residential construction market, they mostly adopted innovations from China and the Middle East (14 out of 21). Few organizations indicated that this approach has affected consumer awareness and the adoption rate of these new products by end-users.

Most stakeholders in Saudi Arabia and the United States suggested that they prefer the *importing from/exporting to* new markets entry mode at 43% and 56%, respectively. Other stakeholders indicated they prefer to use a *strategic alliance* (14% in Saudi Arabia and 38% in the United States). Some participants in Saudi Arabia (21%) indicated they prefer to use the *JV* approach to adopting new products in the Saudi residential construction market (Figure 6.10). They suggested that JVs offer speed, access, risk-sharing, and the ability to combine local in-depth knowledge with foreign partner expertise in the technology or process, resource sharing, and leverage of underutilized resources, high profits, and back-end income. If the partners carefully map out in advance what they expect to achieve and how, they can overcome many issues associated with the process of international commercialization.

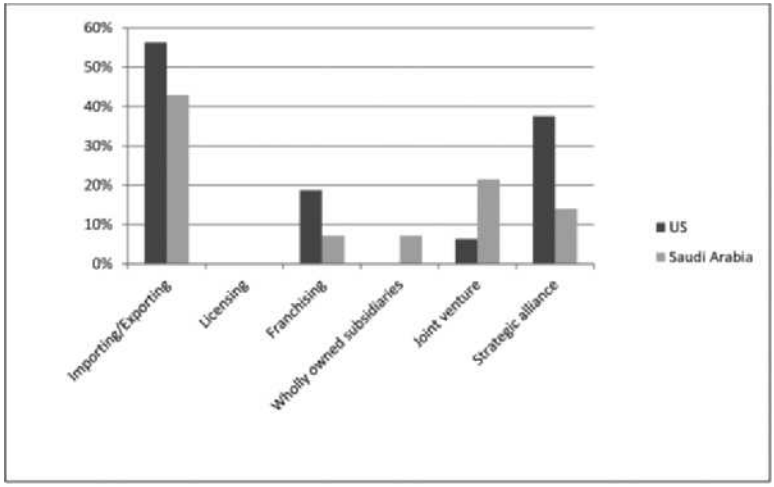

Figure 6.10. Foreign market entry modes used by SIP stakeholders in the United States and innovative products stakeholders in Saudi Arabia

6. What are the market-based strategies for overcoming barriers to international commercialization of innovative structural products in residential construction?

Firm characteristics (e.g., firm innovativeness) strongly affect the success of commercialization projects in residential construction, including those that are international in nature. In general, less-innovative and low-performing firms perceive higher barriers to the process of international commercialization compared to high-performing and more-innovative firms (Ylinenpaa 1997). However, Tourigny and Le (2004) argued that non-innovative firms in general do not have a strong perception of barriers compared to innovative firms. In these regards, this research question aimed to determine how organizations with different levels of innovativeness perceive risks and barriers to international commercialization.

Question 6 aims to determine the organizational orientation toward international commercialization of innovative structural products in the residential construction industry. Most participants (38% of US SIP stakeholders and 33% of Saudi Arabian innovative product stakeholders) indicated that they would *welcome opportunities for international commercialization*. In addition, 29% of US SIP stakeholders indicated that they would *encourage other stakeholders to collaborate internationally* with them in international commercialization projects, whereas 23% of Saudi stakeholders indicated that within the Saudi market, they are *the first to*

commercialize international innovations (Figure 6.11). Therefore, organizations from these two strategic domains can collaborate to commercialize SIPs in the Saudi market and benefit from partnerships.

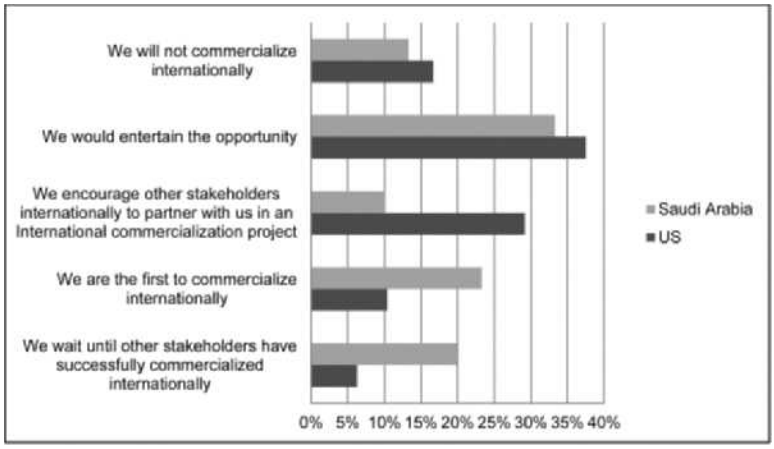

Figure 6.11. Organization approach to commercialization of innovative products for the international market

ANALYSIS

This section presents the findings of the second phase of the research design using a frequency analysis to determine the differences in the process and barriers to international commercialization of SIPs between US and Saudi stakeholders during product commercialization. This section provides a descriptive analysis of the model and findings concerning factors that affect the process of international commercialization. Then, the uncovered barriers are merged with this literature-based framework, resulting in a perceived view of barriers through the international commercialization framework of innovative structural products.

ORGANIZATIONAL CHARACTERISTICS

The survey indicated that builders are dominant stakeholders in both markets, representing about 60% of innovative products stakeholders in Saudi Arabia and about 45.8% of SIP stakeholders in the United States.

In both surveys, the majority of organizations were small, having less than 25 full-time employees (50% of US firms and 40% of Saudi Arabian ones). Although the market share of large domestic building firms in the United States is growing, the majority of organizations who adopt innovations in residential construction are small.

Regardless of their size, firms intending to enter a foreign market are required to assess this new market and ensure they have the required knowledge, skills, and resources to address the new environment. A firm's level of innovativeness has a significant degree of influence on commercialization success (Markusen 1984, Rugman 1981a). Therefore, early in the process, organizations that intend to reach firms with insufficient resources should consider a market entry mode that helps them reach the new environment. Collaboration with other organizations from the new market may expose firms to required markets through a network of skills and/or resources more quickly while reducing asset commitments and increasing flexibility through sharing of costs and risks. This learning from partners builds cooperation around a common standard (Burgel and Murray 2000, Mital 2007).

RESEARCH-SPECIFIC ANALYSIS

In the United States and Saudi Arabia, organizations report the same overall success level in achieving their milestones: 1) *recovering investment costs*, 2) *increasing sales volume*, and 3) *increasing market share within 1–3 years*. However, Saudi firms report a higher level than US ones in achieving the following: 4) *becoming the market leader* and 5) *developing a strong demand for the product*. Regarding timing, Saudi firms indicate that they take up to 3 years to achieve these two milestones, whereas US firms take up to 5 years. Participants in both markets also report that they could not reach some milestones because of factors such as 1) *lack of financial resources*, 2) *lack of specialized human resources*, 3) *low-quality or inefficient regulation*, and 4) *insufficient demand for the product*. Overall, each of these factors more strongly affects US organizations at an average of 50% compared to 35% in Saudi Arabia. Such factors explain the slight difference between the two groups of stakeholders in terms of success in achieving their milestones. Thus, organizations that want to commercialize internationally should consider sound markets that would help them to achieve their milestones according to their capability and resources. Organizations should consider this aspect during the *needs and*

offers matching phase. This finding supports McCoy et al. (2010), who indicated that proper market identification early in the commercialization process is integral for success.

In both markets, organizations indicate that *energy cost* and *consumer awareness of building technologies* are the most positive factors affecting long-term adoption of their products in the international market. *Regulation* and *labor (cost, quality,* and *availability)* are other factors that may influence the use of innovations in the international market over the next 10–20 years. Thus, organizations commercializing innovative products to other foreign markets should investigate the trend of these factors early in the process, as they seem to influence most businesses that operate in these markets.

Considering these factors early in the process (i.e., in the first phase of the proposed framework) would also better equip organizations to choose markets where networking is possible based on their capabilities and needs (i.e., in the second phase). Many organizations collaborate with foreign organizations that can provide the knowledge required to enter that foreign market and help in terms of networking with other stakeholders in the foreign supply chain.

The study found that most factors that either foster or hinder organizations from achieving their international commercialization goals within a reasonable time are related to the organizational environment and the characteristics of the new market/product. The success level is directly proportional to the extent of the best-practice similarity between the current market and the intended foreign market. However, some characteristics of the international market may reduce uncertainty in the commercialization process, such as *profitable market/product, increased demand over supply, meeting customer expectations, reduced build time*, and *reduced callbacks*. For instance, the reason to collaborate with a local organization may be a large demand–supply gap in a foreign market as long as the innovation meets consumers' needs and reduces risk. Therefore, a thorough investigation of such factors early in the process helps organizations choose the right market, collaborate with the right partners, and make mature decisions throughout the commercialization process.

In the United States and Saudi Arabia, stakeholders share 18 common factors (14 positive and 4 negative) out of 21 total factors.

The findings indicate that the success level of international commercialization largely depends on the level of similarity between an innovation's home and host market (Question 5). Moreover, the amount of common positive characteristics that both markets share is positively correlated with the

reported success level of international commercialization. For the markets studied here, stakeholder groups rely on the degree of similarity in factors as an indication of the likelihood of similar needs and interests, which is a basis for networking and collaboration that reduces uncertainty in international commercialization.

Concerning collaboration, some participants indicated that they use other stakeholders' expertise and resources in international commercialization projects. These stakeholders collaborated with those who had better knowledge and experience of the new market (whether local or international). Therefore, the use of an innovation champion who understands the foreign market remains important to success, as champions and key personnel can communicate with foreign markets to facilitate processes and collaboration opportunities.

In the United States, builders from foreign markets were reported to be the most important stakeholders with whom local SIP organizations collaborate. Similarly, SIP manufacturers, suppliers, and architects/designers reported similar preferences, favoring collaboration with foreign builders over other stakeholders. On the other hand, organizations in Saudi Arabia indicated that manufacturers from foreign markets are the most important stakeholders with whom to collaborate. Each could learn from the other's preference in this case.

As innovation offers the potential for a competitive advantage, many firms search for strategies and solutions that help them successfully promote innovation in residential construction and are willing to commercialize internationally with proper market conditions. There are other factors that may positively or negatively affect organizational decision-making to commercialize innovations internationally. Furthermore, firms gained both objective and experiential knowledge in the process of this research.

The residential construction markets in the United States and Saudi Arabia seem to successfully diffuse and adopt innovative structural products, respectively. However, despite the promising residential construction market in Saudi Arabia and the innovative market in the United States, only one SIP stakeholder from the United States has attempted to commercialize SIPs in the Saudi market. This organization also provides training and consulting in all areas of SIP construction. Furthermore, the director of the organization has been working with a Saudi organization to establish a market for SIPs by building a number of housing units in Saudi Arabia using imported SIPs (as SIPs are not currently available in the Saudi market).

When examining the markets for an innovation, it is essential to note major factors that foster stakeholders to commercialize internationally: *increased demand over current supply* and *profitable product/increased profit*. Other factors may play an important role in driving organizational decision-making processes, as each organization has different resources and capacity. Therefore, prior to actual execution, organizations should carefully investigate the market/product characteristics and the potential benefits they may offer for their business and the overall industry. A clear understanding of these elements would positively improve confidence and cooperation with the right partners in the commercialization of innovations to improve success.

The characteristics of the new markets/products also have a major impact on the selection of the market entry mode. Barriers associated with *resources and capacities* for a specific product or market may encourage organizations to participate in collaborative agreements to reduce risk. Here, organizations seek partnerships with foreign stakeholders that can meet their needs in regards to *resources and capacities*. Collaboration may also help both sides eliminate other barriers. For example, US companies can provide expertise regarding the competition, and Saudi stakeholders can reduce uncertainty associated with regulation, access to information, entry restriction, language proximity, and consumer awareness. All of these factors are related to early stages of innovation development.

Finally, as international commercialization projects are associated with risk and uncertainty, most organizations do not take the lead. They mainly entertain opportunities or encourage other stakeholders to collaborate. Such an approach can offer *access to skilled/specialized workers, access to financing, access to partner intellectual property, access to partner expertise*, and *access to an established distribution network*. If the partners carefully map out in advance what they expect to achieve and how, they can overcome many issues throughout the process.

SUMMARY AND CONCLUSION

This chapter provided a comprehensive analysis and findings on perceived barriers to an international commercialization framework for innovative residential construction products. The research first distilled literature findings into survey questionnaires for two groups of key stakeholders in the supply chain of innovative structural products: 1) SIP stakeholders in the United States and 2) stakeholders of innovative structural products in Saudi

Arabia. Then, data were collected using web-based surveys and analyzed through frequency analysis. Based on the results, the following market-based strategies need to be incorporated into the initial framework for international commercialization (framework areas are listed in parentheses).

MARKET-BASED STRATEGIES FOR INTERNATIONAL COMMERCIALIZATION

- In the United States and Saudi Arabia, most firms are builders who are risk-averse to innovations. Therefore, before commercializing internationally, organizations should investigate markets/products that would add significant value for their businesses and create a niche market for their services, such as energy-efficient builders (needs and offer matching).
- Regardless of their size, firms intending to enter a foreign market are required to assess this new market/product and ensure that they have the required knowledge, skills, and resources to address the new environment (needs and offer matching).
- Small organizations that may have insufficient resources should consider a market entry mode that reduces the uncertainty of the new environment (networking).
- Organizations from the innovation home-market should consider sound markets that help them achieve the following international milestones: 1) recovering investment costs, 2) increasing sales volume, 3) increasing market share, 4) becoming the market leader, and 5) developing strong demand for the product within less time (needs and offer matching).
- Organizations should also investigate the energy cost and consumer awareness of building technologies, as they seem to influence the ongoing operations of most businesses in new markets. Regulation and labor (cost, quality, and availability) are other factors that affect the use of innovations in the long-term (needs and offer matching).
- For organizations from the innovation host market, innovation characteristics that positively impact their decision-making include the impact of the innovation on profitability, labor savings derived, materials savings derived, ability to recover the innovation cost, a streamlined production process, reduced build time, quality compared to traditional structural products, consumer preferences for the innovation, reduction in cycle time, and manufacturer technical support (needs and offer matching).

- Prior to commercialization, organizations on both sides must ensure that the innovation is accepted by building inspectors/building codes, insurers, and lenders in the new market (needs and offer matching).
- Organizations indicated that the critical factors having a negative influence on their decision-making are subcontractor unfamiliarity with the innovation, uncertainty/risk of the innovation, high initial innovation cost, and difficulty of first use. Therefore, they should commercialize the innovation to the new market in a manner that will reduce or eliminate these factors whether individually or collaboratively (needs and offers matching + networking).
- The number of common positive characteristics between the groups is positively correlated with the success level of international commercialization. Organizations should attempt to find the perfect match between the product and the market need. They should ensure that innovation offers a substantial relative advantage and that it is relatively easy to integrate with existing technologies and practices, straightforward to learn and use, easy to try, and readily visible to those who might adopt it (needs and offer matching).
- After a period of selling innovative products solely in domestic markets, most firms begin internationally commercializing to/from markets that are similar to the local market, and approach more physically distant markets over time.
- Organizations should consider commercializing collaboratively with other stakeholders who have better knowledge and experience of the new market, which may lead to higher commercialization success (networking).
- Organizations collaborate with others for a number of reasons (ranked in order of importance): access to skilled/specialized workers, access to financing, access to partner intellectual property, access to partner expertise, and access to an established distribution network.
- Builders are the most significant stakeholders for home-market organizations seeking to collaborate in an international commercialization project, whereas manufacturers are the most important stakeholders for those in the innovation host market (networking).
- When seeking information about the innovation/foreign market or collaboration with foreign entities, organizations should approach

the appropriate agent or partner. CEOs, presidents, and marketing/sales managers are the most influential decision-makers in international commercialization (networking).

- To reach the right market with an innovative product, organizations should overcome the following barriers during the exploratory phase: *lack of relevant and visible research or tools to conduct such research* and *lack of potential partners*.

Notably, factors that either foster or hinder organizations to commercialize innovations internationally are mainly related to the organizational environment and characteristics of the new market and innovations. Given the multidisciplinary nature of international commercialization, it is necessary for firms to build a better understanding of barriers influencing overall success, beginning with the risk and uncertainty associated with adoption, diffusion, and commercialization of innovation. Failure to fully understand these factors can affect the firm's objectives for profit, market share, and long-term stability. Thus, consideration of such factors prior to actual execution of international commercialization is essential to decrease unnecessary risk and uncertainty associated with the process.

We therefore propose an adaptive international framework focusing on four phases: *needs and offers matching*, *networking*, *feasibility study*, and *actual execution* (Figure 6.12). The overall process is considered more agile by rethinking the abilities of needs and offers, avoiding duplicate efforts and unsolicited contacts. All of this can be done without the need to change behaviors (i.e., modify cultural variables) or fundamentally shift priorities. Instead, it can be accomplished simply by improving the discoverability of a suitable innovative product and international market as well as proactively matching current pools of needs with potential "partners" in the new market. The following is a brief illustration of the first two phases, where most barriers to the process of international commercialization can be addressed.

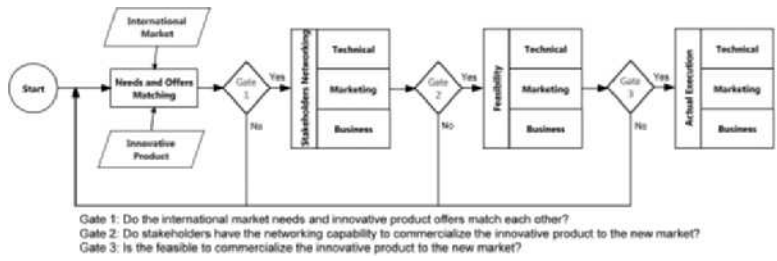

Figure 6.12. Initial framework

- Phase I: Needs and offers matching, where organizations have to find the perfect match between the product offered and the market needs. The organizations should ensure that innovation offers a substantial relative advantage and that it is relatively easy to integrate with existing technologies and practices in that foreign market.
- Phase II: Networking, where organizations work on the resources configuration (i.e., build, reconfigure, add, and delete). A firm approaches suitable stakeholders to commercialize an innovation in a foreign market. In the phase prior to networking, firm behavior and characteristics represent only a single firm. Subsequent phases represent activities, actions, and decisions that all involved stakeholders within the network can conduct.

CHAPTER 7

ACTUAL BARRIERS TO INTERNATIONAL COMMERCIALIZATION

Previous chapters reported on the quantitative data regarding perceived barriers to international commercialization for US and Saudi Arabian stakeholders in the commercialization of structural insulated panels (SIPs). In this chapter, we expand on previous work and detailed interviews of key stakeholders in the commercialization of SIPs across the two countries highlighted. We present findings and analysis of market-based strategies for honing the initial framework into a well-defined model for international commercialization of innovative structural products in residential construction.

PARTICIPANTS

Empirically, the literature contains little evidence that a particular stakeholder can commercialize innovative structural products across residential construction markets more successfully or has a stronger role than another stakeholder. Thus, the quantitative surveys employed unbiased sample participants. To augment the data collected through the online surveys, personal interviews were conducted with respondents from three groups:

a. Stakeholders who have experienced international commercialization
b. Stakeholders who would like to commercialize internationally, but do not have the ability to do so
c. Stakeholders who can commercialize internationally but do not desire to do so

This work collects data on barriers to international commercialization of SIPs for the Saudi residential construction market. On the basis of the survey results, 13 stakeholders from the United States and 17 stakeholders from Saudi Arabia were considered appropriate for interviews. However, some stakeholders, especially those in the United States, have more than one role within the supply chain. For instance, one firm produces SIPs, supplies them to other firms, and uses them to build homes. Table 7.1 presents the size of firms selected for interviews based on the number of employees.

Table 7.1. Number of stakeholders elected for interviews in the United States and Saudi Arabia

		N	<25	25–49	50–99	100–249	250–499	500+
US Stakeholders	Manufacturer	**5**	3	1	0	1	0	0
	Builder	**6**	4	1	0	1	0	0
	Suppliers	**5**	4	0	0	1	0	0
	Distributor	**2**	2	0	0	0	0	0
	Archi-tect/Designer	**0**	0	0	0	0	0	0
	TOTAL	**19**	**14**	**2**	**0**	**2**	**0**	**0**
Saudi Stakeholders	Manufacturer	**4**	3	0	0	1	0	0
	Builder	**8**	6	0	0	1	1	0
	Supplier	**3**	3	0	0	0	0	0
	Distributor	**2**	2	0	0	0	0	0
	Developers	**0**	0	0	0	0	0	0
	TOTAL	**17**	**12**	**1**	**1**	**3**	**0**	**0**

The second step involved e-mailing the prospective case study subjects to ensure their willingness to participate and to provide several potential dates for in-depth in-person or phone interviews depending on their location. Previous reliability measures ensured that all subjects were familiar with the study language. A final, follow-up phone call was placed 5 days later to make final arrangements for the interview dates and times. Of the selected sample, eight people in the United States and two in Saudi Arabia were willing to participate in the case study process. Case study principles often base a sample size on the concept of saturation—that is, when an analysis of barriers to international commercialization does not shed further light on the investigated issue. The findings indicate that four in-depth inter-

views in the United States and two in Saudi Arabia provided sufficient knowledge of the two markets. Table 7.2 shows the characteristics of the six interviewed individuals and their firms. Arguably, the interviews do not represent large firms, which exhibit different commercialization processes.

Table 7.2. Characteristics of participating firms

		Role	Position	Size	Subject
US Stakeholders	1	Manufacturer	CEO	<25	Case #1
	2	Manufacturer	President	<25	Case #2
	3	Builder, trainer	Director	<25	Case #3
	4	Builder, supplier, distributor	CEO	<25	Case #4
Saudi Stakeholders	1	Builder	CEO	250–499	Case #5
	2	Builder	President	<25	Case #6

INTERVIEW DESIGN

The case studies interviews were semi-structured following a guide based on a pilot practice interview conducted to increase fluency and set question order. First, background questions were conducted (e.g., interviewee's job title, responsibilities, and time with the organization) to "warm up" the interviewee and establish an interview mindset. Detailed questions that focused on the barriers to commercialization and strategies employed were broad, open-ended questions that allowed the interviewee latitude in constructing their answer. In addition to validating the first-phase survey responses, the aim of the qualitative interviews is to provide in-depth information pertaining to participants' experiences and viewpoints of the real barriers to international commercialization of SIPs into the Saudi residential construction market.

DATA COLLECTION PROCEDURE

In collecting data, identified stakeholders were contacted for in-person or phone interviews depending on the location. Each interview took about 45–90 minutes. All answers were recorded and notes on each interviewee were taken. Answers were then transcribed using the recordings to ensure

accuracy. To remove potential bias, the questions were not sent in advance unless the interviewee explicitly asked for them. The in-depth interviews ultimately provided a real view of barriers to international commercialization of SIPs to the Saudi market.

FINDINGS

The following section presents the interview findings based on each of the research questions, aiming to uncover details on the barriers to international commercialization of SIPs (innovative products) to the Saudi residential construction market (international market). It also broadly presents findings on commercialization frameworks and strategies employed by stakeholders, exploring best practices and barriers that are critical to the process of international commercialization.

1. **What commercialization processes exist for innovative residential construction products, locally and internationally?**

Four US participants indicated in their responses that they used an extremely formalized process to commercialize SIPs in international markets. Only one organization in Saudi Arabia indicated that they used such a formalized process in the Saudi market. The researcher interviewed five participants to collect more information on the frameworks and procedures employed by their organizations. However, only Case #1 was willing to share information on the process the organization employed to commercialize SIPs internationally. He indicated that the organization has two franchises operating in two foreign markets, Venezuela and Honduras. In each market, a business arrangement was established by signing a contract with a local firm to sell SIPs under the organization's name and image. The international franchisee provided the time, capital, and motivation to produce SIPs in the new market. The process employed by the organization of Case #1 to commercialize SIPs internationally comprises five stages:

1. **Qualification**

   In this stage, the organization selects the perfect foreign market in which commercializing SIPs can add significant value for their business and create a niche market for their services. They look for a market that is economically stable and can offer a substantial

relative advantage, where it is relatively easy to integrate SIPs with existing technologies and practices, and easy to enter.

2. Level 1 Feasibility Analysis

The goal in this stage is to identify needs based on the data they gathered from studying market requirements and the SIPs offered based on the company's capacity and resources. Accordingly, they seek collaboration with someone from the new market in which they can create a real business opportunity—sharing knowledge, skills, and resources. In this stage, both partners must identify all operational goals for the project before they progress to the next stage.

3. Level 2 Feasibility Analysis

In this stage, both organizations (local and international) work together to analyze the economic and technical viability of producing SIPs in the new market—considering the return on investment, major customers, government regulations, and the new business environment. Then, they prepare a business plan that includes construction, operation, and maintenance pricing; calculations of final project economics with a simple payback schedule; and a lifecycle cost analysis of the total investment. At the end of this stage, all information required to make a decision about whether to proceed with the project should be available.

4. Procurement

Once the feasibility analysis is complete, both partners work to formalize their relationship—signing a letter of understanding (LOU) and a management of risk (MOR) document. Then, they build a new plant/factory according to specifications, on schedule and within budget, while navigating project development and implementing contract negotiations, project engineering, construction, and the final commissioning.

5. Operation and Maintenance

In this stage, the organization operates and maintains the business to keep the manufacturing plant operational.

2. What are the barriers to commercialization of residential construction innovative products, locally and internationally?

A majority of the organizations in the United States and Saudi Arabia indicated that they can achieve the following milestones within 1–3 years: *recovering investment costs*, *increasing sales volume*, and *increasing market share*. They also noted that they can reach the following two milestones within 3–5 years: *becoming the market leader* and *developing a strong demand for the product*. Identical results were obtained from the survey. However, they also believe they can achieve better results when commercializing SIPs to the Saudi market owing to the existing high demand for new housing units.

> *I think Saudi Arabia is a good market because they have a huge shortage of housing. They need houses very quickly and SIPs answer that problem by being able to deliver speed of construction. So, from that standpoint, I would say it is a very good market to look at.*
>
> (Case #3)

The US and Saudi residential construction markets seem to be compatible in terms of the building code requirements. SIP stakeholders indicated that SIPs, as other products approved in the United States, comply with code requirements in most international markets. In addition, Saudi stakeholders indicated that US products are accepted and ready for use in the Saudi market, whereas non-approved products could take up to 6 months of testing and approval to be adopted by stakeholders in the new market. There are additional engineering requirements that should be considered when commercializing innovative products to specific regions. For example, in Chile, building stakeholders have to consider earthquake survivability of materials, whereas in Florida, hurricane survivability is of more concern. Stakeholders early in the commercialization process must consider these variations in requirements.

> *…most of all of the markets we've been to accepted American testing.*
>
> (Case #4)

> *We now have within the ICC community a code which is internationally accepted by the vast majority of the countries in the world, which shows that if you want to buy a wood skin panel, there's a very clear standard by which it has to comply.*
>
> (Case #3)

SIP stakeholders prefer to commercialize SIPs to markets that have *governmental support* for social housing. Larger volumes of social housing required by many governments have assured many stakeholders *long-term stability*, *better market share*, and *higher profit* in the new markets. This seems to have a positive influence on their global competitiveness, knowledge transfer from "learning by doing," long-term survival in the economy, and allocative efficiency.

> *Our main market is South America, and the Caribbean has picked up in the last year, but the main market is South America right now. It has a large building program for social housing in Brazil, Venezuela, Columbia, and Bolivia. All those countries have money that the government is putting in social housing programs.*
>
> (Case #1)

> *Commercializing SIPs to other foreign markets has helped many US firms to compete with the best companies in the world and are therefore driven to be more innovative and use the most modern technology and management practices.*
>
> (Case #4)

The SIP stakeholders indicated that a few negative factors within the US market have fostered them to pursue better business opportunities outside the United States, including *tax rates*, *inflation*, *tax regulations*, *policy instability*, *inefficient government bureaucracy*, and *government instability*. However, they also believe that they face other barriers in commercializing SIPs to the Saudi market: *manual labor* (as the majority of labor is imported from other countries), *hot weather*, *concerns of timely payments*, and *being able to work in a business relationship with Saudis* (government contract or private client). However, these are cultural barriers and are not barriers associated with the quality or functionality of the SIPs.

3. What are the critical actions and decisions stakeholders must take for international commercialization of innovative structural products in residential construction?

SIP stakeholders have indicated they prefer to collaborate with others in the Saudi market to reduce risk and uncertainty associated with international commercialization. The foreign stakeholders must be well-connected in the market and have access to three things: financing, a builder or developer, and connections to an architectural/engineering group that would help pave the way for acceptance of the designs (both architecturally and structurally) to allow those projects to move forward. Many SIP stakeholders are looking for multitalented collaborations with others who are *well entrenched in a larger segment of the market*. Therefore, they can handle the infrastructure issues and understand the Saudi issues that accompany building in that area.

For manufacturers, *availability of raw materials* in or near a foreign market is a critical aspect they must look at before commercializing to the new market. Availability and continuous supply of raw materials have a significant effect on the production rate, transportation cost, and the overall cost of the project.

> *In the United States, all of the SIP raw materials are readily available in the local market, which helps lower the cost of manufacturing. It is very important that we look at it before going internationally. If the raw materials are readily available, starting the business is somewhat straightforward. If the raw materials are readily available, you can do everything you can to eliminate [oriented strand board] OSB agencies' MgO SIPs (Magnesium oxide SIPs). Therefore, I would say that you could have everything. You just need to buy the equipment to make the SIPs and you pretty much have all your all goods just like we do here in the United States. I believe that in Saudi Arabia, there is no issue with that.*
>
> (Case #1)

Adequate *labor force training* is crucial to the successful introduction of a new building product. Builders must take into consideration the cost and adequacy of the training when considering new products. SIP homebuilders indicated that general contractors and subcontractors have to understand that SIPs are different from the traditional structural products to which they are accustomed. Therefore, skilled and trained laborers are

required to assure successful and continuous adoption of SIPs. They also indicated that the quickest way to stop the introduction of SIPs or a new product like SIPs in a new foreign market would be an initial successful introduction but for the product to not meet durability expectations owing to improper installation. The product would then have a tarnished reputation creating a barrier that may never be overcome with the homebuilders and/or the consumer.

> *In Saudi Arabia, people build with bricks and blocks. It is all modern tiles. When I was there giving a presentation about SIPs, every contractor who came along would look and say, I do not know how to build with this. So, for somebody trying to introduce that technology, [it] is not just about educating the general contractor or the installation crew. You get to educate the roofer, the siders, the electricians, the plumbers, and everybody in between.*
>
> (Case #3)

Case #5 indicated that many homebuilders and trade contractors in Saudi Arabia avoid adopting innovations that may require *additional investment in equipment or training*, especially if either is expensive. They have become risk-averse to training, which can lock them into using standard materials and procedures, as the labor system is not familiar with such training. Furthermore, the *high turnover of staff* is likely to deter investment in training.

> *We try to adopt only new building materials that are similar to what we're using and do not require too much training, so the subcontractors would not have difficulty in using them. In fact, the construction industry in Saudi Arabia is moving very fast and thus, we cannot spend too much time and resources into training and other stuff to use a new material that consumers or homeowners may not accept at the end.*
>
> (Case #5)

4. **What innovative products are appropriate for international use? Should SIPs be considered appropriate?**

5. **What residential construction markets are ideal for studying the barriers of product development and adoption?**

In the United States, some SIP manufacturers indicated that they would like to have several plants worldwide where they can address many different markets. Clearly, they spend a large amount of money every year on engineering-related matters, product improvements, product certifications, and other regulatory requirements. Therefore, to avoid risk and uncertainty associated with the new market, they prefer to create a *JV* with stakeholders from the foreign markets in which each manufacturer wants to open a new plant. This approach is beneficial to stakeholders on both sides, as they can utilize assets, knowledge, and financial resources from both partners of the venture and thus combine the best features of each company without significant stress on the parent company.

> *We partnered (JV) with another company here in the US to export SIPs to the Japanese market—working with a marketing company in Japan. We sell a total package.*
>
> (Case #1)

Royalty programs are offered by many manufacturers that allow the foreign stakeholders that accept the programs to receive all engineering support they need. In addition, the manufacturers share all technical information needed with the foreign stakeholders, provide them with accounting programs that can help track costs of manufacturing and training, and provide all equipment. Such agreements may differ. For example, a foreign stakeholder can own a factory and license it to the manufacturer from the home market. Under this agreement, the manufacturer can maintain an agreed percentage of ownership (e.g., 20% ownership of the factory). Some manufacturers have franchise programs, which allow foreign stakeholders to open a factory despite not having the knowledgebase or skills required to start a new business. Under this situation, both parties benefit. The home manufacture provides the expertise for the product and production and the foreign stakeholders provide expertise in the local business environment. Both parties have a financial investment in the product, and both profit when the product is a success. Furthermore, both parties have a stake in the successful introduction of the product.

> *We are doing the technology, the engineering, and the R&D here in the United States and we are licensing [to] people in other markets, in which they are working through distributors. We went to Venezuela the first time, gave only 3 days [of] training, never been back, and they have done over 300 homes. So, staff is important*

> *but this is not a real complicated thing with SIPs. If we are franchising, we are giving others everything. They are just implementing it, and staff is not a big concern, because it is easy to find the people you need to build with SIPs.*
>
> (Case #2)

The SIP markets in Florida, Texas, and Louisiana may differ from other parts of the United States, as these areas must address variables unique to the region (e.g., environmental or building code differences). Wood is not a preferred building material in these markets, and thus, in these states, insurance companies charge more money for houses made out of wood than for those made out of concrete blocks. Accordingly, some US manufacturers have recently focused on cement fiber and magnesium oxide (MGO) to commercialize SIPs to *similar market environments*, such as the Caribbean and South America.

> *MgO is a very new product in the United States and currently, I don't know any single SIP manufacturer that had approved panels tested for MGO. We have been testing for the last year and we are about a month and a half away from having an approved State of Florida MgO SIP panel. I know of only one company in Canada and a few companies that are just starting to experiment with MGO. In the last 2 years, we have built about 400 homes with MgO in South America and the Caribbean, as we haven't yet received the US approvals.*
>
> (Case #1)

> *There are some companies in the last couple of years that have started using cement fiber in Texas and Louisiana, that is, mainly in the coastal regions, where they have high moisture problems and the wood is not a real good solution. I would say that less than 10% of the SIP manufacturers in the United States make cement fiber or MGO.*
>
> (Case #1)

MgO is readily available in Saudi Arabia, but manufacturers have not used it to produce SIPs. In the past, one company has imported MgO sandwich panels to build two-story housing units in Riyadh. However, this proved difficult, as MgO boards would crack at the joints and other places.

Participants in Saudi Arabia indicated that after consulting with technical engineers, they realized that these issues may be because of low-quality Chinese boards, and thus, they stopped the introduction of MgOs into the market. As mentioned earlier, previous failures to successfully introduce a product create barriers to later product introduction attempts.

> *China is doing much better than the United States in exporting large volume of manufacturing equipment to international markets, because of the low cost. However, the quality isn't that good as it is in the United States, and, therefore, other international companies prefer to buy their equipment from the United States. The shipping cost is one thing that drives the cost up as [the United States] is far away from other markets in the Middle East or even Europe.*
>
> (Case # 5)

> *I think that magnesium SIPs are a great product for the Saudi houses, because it's so hot there and the MgO has a lot of good characteristics: it doesn't burn, doesn't absorb moisture when it gets wet. However, I think it can provide benefits to that region that you may not get from conventional materials.*
>
> (Case # 6)

Governments should require new buildings to meet *energy standards* and *code requirements*. If the market is not required to build "green" or energy-efficient homes, it will not choose to do so. In the past, there were few opportunities to introduce innovative products. Now, governments worldwide are requiring social housing to be LEED-approved. These new requirements are opening up the markets for building professionals and companies with systems like SIPs.

> *We have a lot of interest in SIPs to put up a big plant to make the foam, magnesium board, and SIPs. However, this is really a big deal, in which the government input is needed to create [an] industry for SIPs in Saudi Arabia that would help to create jobs and benefit the market. We can have a program to help governments build housing units. It is very important to get the government support on the long-term that would recover the initial costs and would ensure long-term success.*
>
> (Case #6)

As indicated by a few of the participants, once building professionals and the public are required to meet the standards and code requirements, SIPs become as excellent solution for the Saudi market. SIPs can initially be more expensive but they provide substantial savings in the long-term. These savings are achieved through increased durability and significant contributions to overall energy savings on a daily basis. In addition, they are rapidly assembled, which significantly reduces labor costs.

> *It is hard for any system to compete with the efficiency of SIPs.*
>
> (Case #2)

Home markets worldwide are becoming very conscious of health concerns. Saudi Arabia is no exception. The Saudi government understands that future resources are limited, and thus, they have started doing things differently than in the past. Saudis are now looking at investments such as alternative energy, solar power, and plants to process liquefied natural gas. In the last decade, the government has established energy efficiency codes and standards to encourage the use of certified green building materials to build healthy houses that meet all green standards. Now, the Saudi market is *quality-driven*, and therefore, most homeowners look for energy-efficient building materials that may cost more upfront but save money in the long run.

> *SIPs can really help Saudis build healthy houses a lot easier than the conventional materials.*
>
> (Case #5)

Thus, the Saudi market is unlike other markets where building professionals and stakeholders aim to build homes that meet just the minimum standards, such as in Nicaragua and Colombia. In such markets, it is very difficult for SIPs to compete with the other traditional building materials.

> *In the United States, people have no problem paying more for a home if it is green or energy-efficient. We have, for example, LEED and green building certifications. When you go to Latin America (e.g., Argentina or Venezuela), they do not pay for the power (it is free). Therefore, they could care less about how energy-efficient or how green the house is. They only care about one thing: how much the house costs. So, that market is 100% price-driven, whereas in the United States, it is not the case. It is driven*

> *by quality: people look at buying a home and being in that home for 10–15–20 years. They look at the cost for the home they are living in, they look at energy efficiency, they look at their insurance and how much it costs, and they look at hurricane ratings. They look at all of this stuff.*
>
> (Case #3)

6. What are the market-based strategies that will help overcome barriers to international commercialization of innovative structural products in residential construction?

According to many SIP stakeholders in the United States, FDI plays a critical role in either fostering or hindering international expansion. It is directly proportional to the distance between the innovation home market and the foreign one. SIP stakeholders have indicated that they favor commercializing their products to nearby markets, such as the Caribbean and South America, as this would lower costs, favor communication, reduce risk, and increase the relative advantage.

> *Generally, we are pretty much focusing our time on Latin American, [the] Caribbean, and Florida. [For] any of these other markets (i.e., far overseas), we rely on people to come to us. We do not have a lot of money to go into those markets, because we have such a big market area here in the United States and on the islands. So, we basically are looking for people who may want to put up money, license the technology, and open a factory that they predominantly own and operate.*
>
> (Case #1)

However, some SIP stakeholders have indicated that they would commercialize SIPs to other foreign markets in Africa, Europe, Asia, and Australia as long as other stakeholders from the foreign markets made the first contact. This supports the survey finding from the first phase of this research that most SIP stakeholders favor entertaining the opportunity to commercialize SIPs internationally over taking the lead and becoming the first to commercialize SIPs internationally. The few stakeholders who would be the first to commercialize internationally indicated that they would actively commercialize in nearby markets in South America and the Caribbean while passively entertaining opportunities for distant markets.

Most international markets find us instead of us finding them. So, the process is one where we typically entertain an introduction that leads us to determine what that foreign market is and how we can best handle their needs. If it becomes specifically a SIP opportunity in terms of sales of SIPs, then I have to be concerned with the relationship of everything, from transportation to international relations, duties, taxes, and fees to ship as well as how I ensure that the product get shipped and installed properly. Once the door opens, the difficult part and challenges happen, because now somebody like myself who might be selling a panel has to deal with the local bureaucracy, the shipping issues, the training issues, the training of the entire construction process.

(Case #2)

ANALYSIS

This section presents the findings of a content analysis of the six interviews to show the actual barriers to international commercialization of SIPs to the Saudi market and possible strategies within the commercialization framework that can be employed for this case. Few SIP manufacturers commercialize internationally, and one manufacturer described the proprietary process considered by his firm.

This process provides a general view of international commercialization and not thorough and detailed information about processes between and within stages. As shown in Figure 7.1, according to the U. S. Congress. (1995), such a linear process can also contain limitations:

1. Many innovations are derived not from advances in science but from exploiting existing scientific knowledge and from recognizing potential new markets for certain types of products, processes, or services.
2. Science nevertheless plays an important role throughout the innovation process by providing information with which to solve problems identified in design, manufacturing, or other stages of the innovation process.
3. Innovation does not always follow a linear pathway from research to marketing. Often, technological developments precede scientific research, and lessons learned from manufacturing and marketing operations feed back into the product development process.

4. Innovation is usually an iterative process in which designs must be continually tested, evaluated, and reworked before an invention achieves market success.

One US manufacturer used this process as a general guide. However, the five stages are neither discrete nor conducted in a strictly linear fashion. Rather, subtasks within each stage seem to occur concurrently and with significant feedback between stages. The nature of commercialization projects in residential construction involves interactions and iterations owing to the advancement in technological capabilities, consumer preferences, markets, and other factors. The commercialization process may be circuitous and indirect, and thus, an invention's ultimate application and market may be substantially different from that originally conceived (Hassell et al. 2003). For this reason, a 1997 presidential advisory body on science and technology stated that the linear model

> *no longer works well and can even be seriously counterproductive. Rather than a pipeline, a more realistic image today might be a complex tapestry, with the various stages—basic science, applied research, development, demonstration, commercialization—all strongly entangled and inseparable throughout the process.*

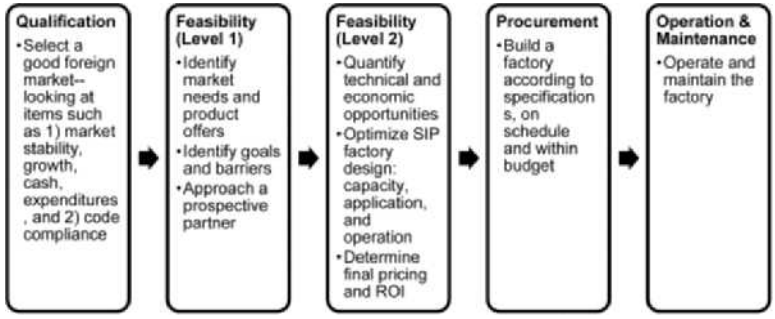

Figure 7.1. Process of international commercialization considered by one SIP manufacturer

Stakeholders in the United States and Saudi Arabia indicated that various characteristics associated with their local market foster organizations to commercialize internationally. For instance, some barriers within the US market foster stakeholders to pursue business opportunities in foreign markets, including *tax rates*, *inflation*, *tax regulations*, *policy instability*, *inefficient government bureaucracy*, and *government instability*. Similarly,

some factors that foster building professionals in Saudi Arabia to adopt innovative products from other markets are products that can create *better competitive advantage*, *increase performance*, and *reduce design and development times*. These stakeholders set milestones that they want to achieve from international commercialization, such as *recovering investment costs*, *increasing sales volume*, *increasing market share*, *becoming the market leader*, and *developing strong demand for the product*. The success level of multicultural organizations in achieving their objectives of international commercialization is directly proportional to a number of factors, including *increased demand over supply*, *code compliance*, *government support*, and *high energy standards and regulation*.

- **Increased demand over supply**

  Demand for innovation is a key driving factor that fosters many building professionals to commercialize internationally (Dow 2005). In residential construction, innovation is particularly relevant to the world's growing demand for affordable and sustainable housing. Innovations that successfully diffuse between established and emerging residential markets could offer significant benefits to all, especially those developing the technology.

- **Code compliance**

  Variation in code requirements may impede innovation adoption in different markets (Blackley and Shepard 1996, Cantrell 2006). However, regulations that guarantee markets might spur innovation (Miozzo and Dewick 2002). According to many US building professionals, products approved in the United States comply with code requirements in most international markets, including Saudi Arabia. Saudi stakeholders indicated that US products are accepted and ready for use in the Saudi market, whereas non-approved products could take up to 6 months of testing and approval in order to be adopted by stakeholders in the market.

- **Government support**

  Government support was found to be a key factor that stakeholders from the innovation home market highly consider when searching for a foreign market in which they can commercialize their innovations. Residential construction is a highly competitive, cyclical,

and fragmented industry, but it is also well-known for its resistance to adopting innovation (Koebel 2003). It has characteristics that significantly affect the acceptance level of innovation among stakeholders. Therefore, government support is essential for many stakeholders who want to commercialize internationally. They believe that a greater volume of social housing is needed to ensure long-term stability, better market share, and higher profits in the new markets. They also believe that government support has a positive influence on their global competitiveness, knowledge transfer from "learning by doing," long-term survival in the economy, and allocative efficiency.

- **High-energy standards and regulation**

  High-energy standards requirements are suggested to help building professionals promote innovations in new markets, as today's innovations have better energy properties than traditional products. Hassell et al. (2003) indicate that many builders are willing to adopt innovations to create a niche market for their services (e.g., energy-efficient builders). Therefore, stakeholders should consider markets in which governments require the public to build new buildings that meet energy standards and code requirements. If the markets are not set up to build green or energy-efficient homes, most stakeholders will not do so themselves.

Therefore, building professionals wanting to commercialize an innovation to a foreign market should investigate four aspects early in the process: *increased demand over supply*, *code compliance*, *government support*, and *high energy standards and regulation*. Such an investigation should occur early in the process, that is, when searching for a suitable market/innovation. In the context of this work, this investigation can happen in the first stage of the proposed framework (i.e., matching market needs with the innovation offering).

Other factors that should be considered by the organization early in the process to assure long-term success include *cost*, *quality*, *availability of labor*, and *location of the organization in the new market*. Organizations should consider these factors early as they have a direct impact on the organization's decision-making, strategies, and mode of entry into international markets.

Characteristics of stakeholders commercializing internationally differ according to factors mainly related to the characteristics of the new product/market and the organization's capacity and resources. The residential construction industry is fraught with large uncertainties. Therefore, when wanting to commercialize internationally, many stakeholders must first consider nearby markets rather than distant ones, as the cost of commercialization is lower, communication is easier, risk is lower, and the relative advantage is accordingly higher. However, other distant markets can provide a better relative advantage than nearby markets, as they might have higher demand over supply, higher government support, and better energy standards and code requirements. Therefore, early in the process, stakeholders should evaluate market needs and product offerings to make wise decisions and select the right market/product.

At a global level, an increasing number of construction firms enter foreign markets as stakeholders such as manufacturers, builders, distributors, and suppliers. Based on their capacity and resources, they choose to commercialize individually or collaboratively with other stakeholders who might have the required knowledge, skills, and resources. All stakeholders participating in this study indicated that they would choose to commercialize individually if the foreign market is nearby. Otherwise, they prefer to commercialize collaboratively with other stakeholders from the foreign market. Stakeholders from the innovation home market are mainly concerned with *networking with others from the foreign market*, *resource quality and availability*, and *financing expansion*. On the other hand, stakeholders from the innovation host market are mainly concerned with *technical knowledge*, *skilled laborers*, and *management skills*. Thus, firms intending to commercialize internationally are required to assess the new market/product and to ensure that they have the required knowledge, skills, and resources to address the new environment.

As mentioned previously, collaboration among stakeholders decreases the risk and uncertainty associated with the adoption of a new product in a foreign market. Moreover, collaboration enables firms to obtain the needed skills or resources more quickly, reduce asset commitments and increase flexibility, learn from partners, share costs and risks, and build cooperation around a common standard (Mital 2007). Therefore, ensuring that each stakeholder is selecting the right partner is critical to minimizing the chances of a future split by considering a set of criteria such as meeting resource needs, appropriate strategic objectives and styles, degree of rivalry, threat of entry of substitutes, effects on internal strengths and weaknesses, and effects on strategic direction.

As part of current globalization, many innovations have gained an adequate national and international presence. After a period of selling solely in the domestic market, most organizations begin their international activity in markets similar to the innovation home market and over time enter markets that are physically more distant. Throughout this process, the organization gains both objective and experiential knowledge. Essentially, as an organization enters a market and gains an understanding of the market, the perceived risk is lowered and the commitment to the market increases. Markets that are easier to understand and are therefore culturally, economically, and politically closer are entered first.

In addition, organizations seem to commercialize first in foreign markets that are similar to the home market. Because of differences in culture, climate, consumer preferences, building codes and regulations, and product characteristics vary within and across nations. For instance, in Florida, Texas, and Louisiana, wood is not a preferred building material owing to moisture, termites, molds, and hurricanes. Therefore, a few US manufacturers in these states have recently focused on cement fiber and MgO to commercialize SIPs within these areas and to markets that have a similar environment (e.g., the Caribbean and South America).

Studies have indicated that building codes and regulations are known factors that can impede the diffusion of innovation (Blackley and Shepard 1996, Slaughter 2000). However, building codes and regulations may guarantee the market and possibly spur innovation. For instance, building professionals and stakeholders in some markets (e.g., Nicaragua and Colombia) build homes that just meet the minimum standards. In such markets, it is very difficult for SIPs to compete with other traditional products.

Therefore, home-market firms must select foreign markets in which regulations can guarantee the market for their innovation. Similarly, the host-market organizations must select an innovative product that complies with the code and regulation requirements in the market. However, both groups of stakeholders should also ensure that innovation offers a substantial relative advantage and that it is relatively easy to integrate with existing technologies and practices, straightforward to learn and use, easy to try, and readily visible to those who might adopt it.

The method by which organizations enter foreign markets depends on a number of factors that are affected by risk. Firms entering markets that they perceive to be riskier tend to select a model that requires less commitment. For some firms, the mode is considered a tradeoff between the managerial risk of using an agent over whom they have no direct control and the greater financial risk of engaging in FDI (Child and Rodrigues

2008). The lack of management control over an agent enables the agent to pirate products and become a competitor or to neglect to develop the market for the product, thereby lowering the potential returns in that market (Chetty and Campbell-Hunt 2003). Therefore, choosing the right entry mode significantly boosts the potential for successful commercialization of international products.

Depending on the resources and capacity of the organization wanting to enter the foreign market, a number of market entry modes may be appropriate. Standalone businesses may do well if the organizations have the required knowledge, skills, and resources to address the new environment. If they lack access to proper knowledge, they can engage someone with the appropriate education to demonstrate the correct manufacturing and installation processes of SIPs.

Another approach to consider is a strategic alliance or JV, where organizations can collaborate with foreign stakeholders who might have the required knowledge, skills, and resources. A manufacturer from the home market can collaborate with a builder from the host market using the expertise of the manufacturer to produce high-quality panels and ship them to the host market. However, this adds the additional layer of shipping costs from overseas. Therefore, some organizations approach setting up a subsidiary in the host market to maintain supplies. This mode benefits firms in reducing the risk associated with higher transport costs, tariffs, or non-tariff barriers (Helpman et al. 2004).

As some manufacturers from the innovation home markets spend large amounts of money every year on engineering and approval aspects, they approach other markets seeking to spread the cost and increase profits. However, commercialization in international markets involves more risk and uncertainty; therefore, they prefer to collaborate with foreign investors, combining the best features of both companies without altering the parent companies. This approach offers speed, risk-sharing, and the ability to combine local in-depth knowledge with the foreign partner's expertise in the technology or process to leverage underutilized resources, high profits, and backend income.

SUMMARY AND CONCLUSION

This chapter reports on the data collection and analysis of interview findings related to actual barriers of international commercialization of SIPs to

the Saudi residential construction market. On the basis of previous survey findings, the authors conducted in-depth interviews from three stakeholder groups:

a. Stakeholders who have experienced international commercialization
b. Stakeholders who would like to commercialize internationally, but do not have the ability to do so
c. Stakeholders who can commercialize internationally, but do not have the desire to do so

All interviews aimed to extend the authors' surveyed knowledge of barriers to international commercialization through a saturation of personal information on the topic. These in-depth interviews ultimately resulted in a real view of barriers to international commercialization. The resulting market-based strategies will be incorporated into the initial framework for a final international commercialization model for innovative products in residential construction.

CHAPTER 8

A NEW BUSINESS FRAMEWORK FOR INTERNATIONAL COMMERCIALIZATION

Until this point, we have described steps in developing a framework for international commercialization of innovative structural products in the residential construction industry. The framework is intended to be a conceptual and operational roadmap to commercializing innovative products that have been successfully developed but not yet launched in new international markets. It describes the significant decisions and actions of the innovation decision process.

By establishing research questions, implementing open-ended questionnaires, and conducting in-depth interviews of real processes in an international setting, we arrived at a focused set of barriers to international commercialization.

The initial findings indicate perceived versus actual risks and barriers to the commercialization process for an integral structural product in the residential construction process. Now, we need to incorporate these market-based strategies into a combined framework for commercializing innovative structural products across residential construction markets. As both the United States and Saudi Arabia have recently seen growth in the housing industry, the final results highlight areas within commercialization for stimulating innovation with important economic ramifications.

A NEW FRAMEWORK

In order to incorporate existing market-based strategies into one framework, we combined the findings from our literature-based framework and

two empirical frameworks. This process led to the development of the final framework shown here (Figure 8.1). The framework consists of four main stages: *needs and offers matching*, *stakeholders networking*, *feasibility study*, and *actual execution*. Sub-processes for each main stage are given in Appendix.

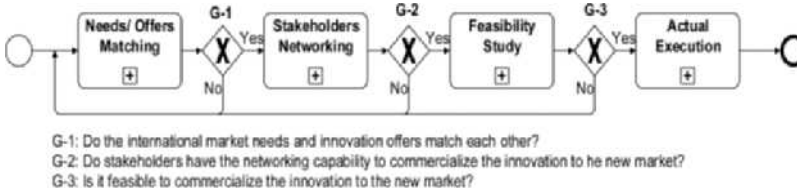

Figure 8.1. A framework for international commercialization in residential construction

STAGE 1: NEEDS AND OFFER MATCHING

The aim of this stage is to rethink the flows of market needs and innovation offerings and to avoid duplicate efforts and unsolicited contacts. This can be done without changing behaviors (i.e., modifying cultural variables) or fundamentally shifting the priorities but just by improving the discoverability of a suitable innovative product and an international market as well as pro-actively matching current pools of needs with potential "partners" in the new market. Figure 8.2 shows the sub-process of *needs and offers matching* to help the stakeholder select the right market/innovation.

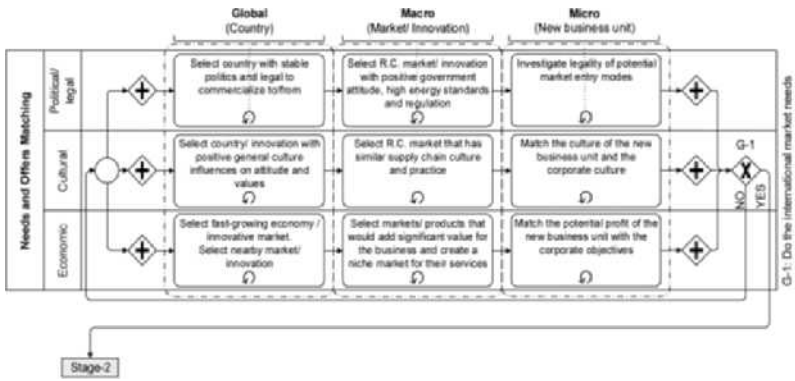

Figure 8.2. Sub-stage of needs and offer matching

STAGE 2: STAKEHOLDER NETWORKING

A range of factors generally affecting selection of entry mode and risk appear to be a common influence. Firms entering markets that they perceive to be riskier tend to select a mode that requires less commitment.

A collaborative arrangement between manufacturers of the innovative product in the home country with the homebuilding firm in the host country would be a better entry mode choice. As mentioned previously, collaboration among stakeholders decreases the risk and uncertainty associated with international commercialization. Moreover, collaboration enables firms to obtain needed skills or resources more quickly, reduce asset commitments and increase flexibility, learn from partners, share costs and risks, and build cooperation around a common standard (Mital 2007).

Once the innovation offers and market needs are matched, the stakeholders can start the international commercialization planning process. Some of the difficulties for stakeholders within the supply chain are to recognize, create, or act on business opportunities in an international market as well as collaborate efficiently and effectively to create value that no single firm could create alone. These issues can be resolved through stakeholder networking between all interested stakeholders within the supply chain. In this framework, early collaboration between stakeholders on both sides is required, as they can utilize assets, knowledge, and financial resources from both partners of the venture; thus, they can combine the best features of each company without significant stress on the parent company. However, ensuring that each stakeholder is selecting the right partner is critical to minimize the chances of a future split. This can be accomplished through meeting resource needs; selecting appropriate strategic objectives and styles; assessing the degree of rivalry and threats of entry of substitutes; and determining the effects on internal strengths, weaknesses, and strategic direction. Figure 8.3 shows the sub-process of stakeholder networking to help the stakeholder select the right partner.

STAGE 3: FEASIBILITY STUDY

Once stakeholder networking is complete, local and international stakeholders work together to analyze the economic and technical viability of producing the innovation in the new market considering the return on investment, prime consumers, government regulations, and the new business environment. Then, they prepare a business plan that includes

construction, operation, and maintenance pricing; calculations of final project economics with a simple payback schedule; and a lifecycle cost analysis of the total investment. At the end of this stage, all information needed to decide whether to proceed with the project should be available. Figure 8.4 shows the feasibility study sub-process.

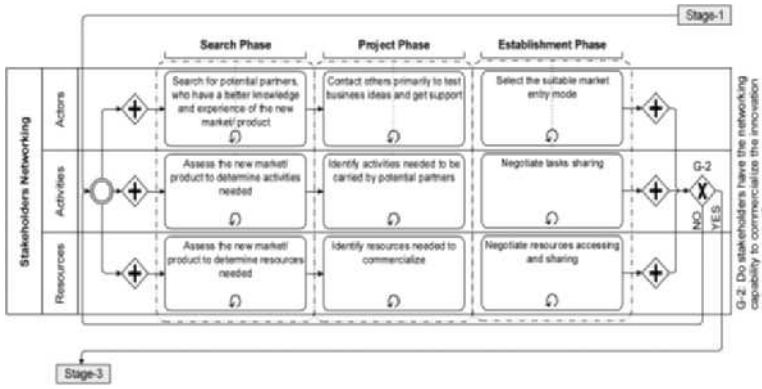

Figure 8.3. Sub-stage of stakeholder networking

STAGE 4: ACTUAL EXECUTION

Once all the stages of *needs/offers matching*, *stakeholder networking*, and *feasibility study* are performed well, it is easier to decide whether to proceed to the actual execution or stop before being exposed to significant risk. The decision is based on the information readily available, including the business case, risk analysis, and availability of necessary resources (e.g., money and competent people). The actual execution indicates the sub-process for technical, marketing, and business decision practices (and resulting actions) required for successful implementation of a new product or service from the planning stages to an introduction into the new foreign market (Figure 8.5).

FRAMEWORK VALIDATION

The proposed framework is primarily focused on the private sector with a particular emphasis on residential construction firms, as it includes a proposed roadmap to translate innovative products between markets. To obtain independent feedback as to how well the framework meets the objectives of such

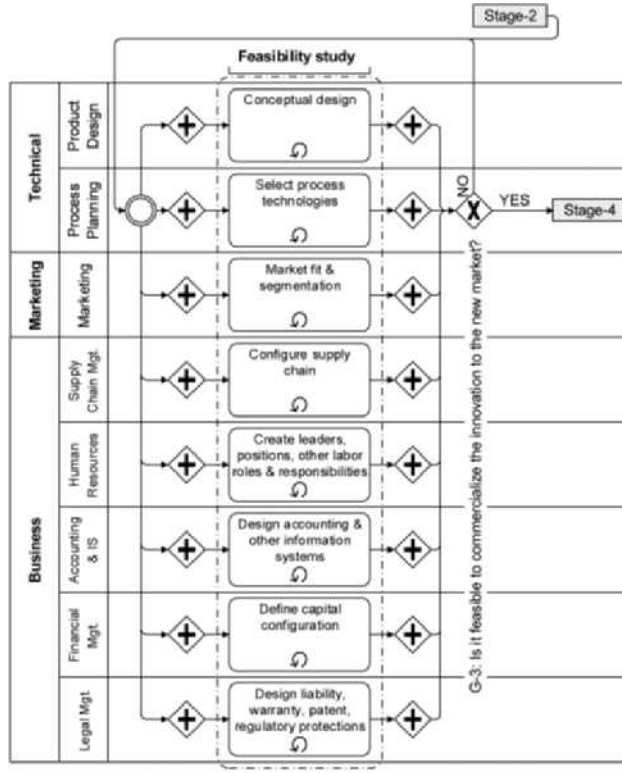

Figure 8.4. Feasibility study sub-stage

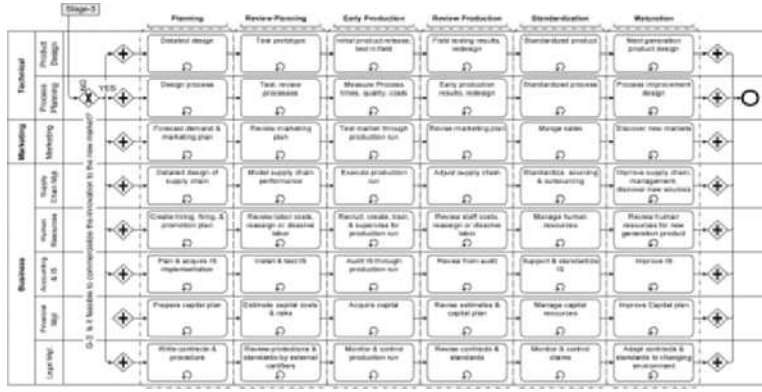

Figure 8.5. Actual execution sub-stage

firms, validation was conducted with two experts from the US residential construction industry. This validation step proved very helpful in highlighting

some of the framework's potential strengths and weaknesses. The general attitude of the experts toward the model was supportive, with only one point of criticism. One expert mentioned that the framework does not provide sources that can help stakeholders select the right market/innovation in the first stage.

THEORETICAL IMPLICATIONS

Few studies have been conducted on barriers to international commercialization of innovative products in residential construction. Although several researchers have begun exploring commercialization processes of new residential construction products or services (see, e.g., Koebel et al. 2004, McCoy et al. 2008), attention has been focused mainly on the development of domestic commercialization frameworks.

Recent work also suggests that commercialization processes are central to successful diffusion of technology. To date, global effects on diffusion are the least understood because of a lack of research on the methods by which companies commercialize residential innovative products in new foreign markets; that is, there is relatively little understanding of the risks and barriers they must overcome in the process.

Our main contribution is the development of a framework for international commercialization of innovative structural products in residential construction. This model was developed by triangulating three models that were developed throughout three stages of this work: 1) the literature-based framework, 2) the initial framework developed using survey findings and resulting market-based strategies, and 3) the final framework.

The framework provides a conceptual and operational roadmap to commercializing innovative products that have been developed successfully for launch in new international markets. We describe significant decisions and actions of the innovation decision process (i.e., horizontally across associated time and vertically along functional areas). This is an important distinction because of flaws in existing development methods and in the application of market diffusion. Then, this work aims to provide a better understanding of successful commercialization processes that facilitate the adoption and diffusion of such innovations.

This book provides a significant contribution to the integrated topic of globalization studies and commercialization of construction innovation concepts. It contributes to the current theoretical field on construction innovation commercialization by expanding the field using a global perspective of this process.

LIMITATIONS

There are some limitations in this study that are common to mixed-method studies. Chapter 4 describes the samples used in the current research and indicates that these were convenience samples accessed with the endorsement of two organizations: SIPA in the United States and MCI in Saudi Arabia. Because of this, they may not be representative of the populations under study (i.e., stakeholders of innovative products in residential construction). Readers should therefore approach the current findings and conclusions with caution.

In addition, this research has some limitations owing to the lack of response from participants. In Saudi Arabia, only two participants were willing to participate in the interview phase of the study, which may have affected the validity of the current research outcomes. However, some methodological tools were used to increase the quality and value of the research (discussed previously).

FURTHER RESEARCH

Testing the proposed framework on a large number of companies with a more diverse spectrum of interviewed experts is suggested. In such a manner, the proposed framework can be confirmed, modified, or rejected. While only companies based in the United States and Saudi Arabia were investigated under this study, similar research in other parts of the world should be conducted to test the results of this research on the companies operating in other environments.

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A Business Framework for International Commercialization of Innovative Construction Products

Ali Albassami • Andrew Patton McCoy

Businesses, consumers, industry groups, and governments understand the importance of innovation for continued economic success and improvements in quality of life. However, innovation remains an opaque topic. A paradox exists in the construction industry at-large; using innovation is vital yet challenges the value to individual organizations. This paradox is supported by a landscape that includes a sizeable graveyard of failed attempts at innovation on grand and small scales. As a result, *A Business Framework for International Commercialization of Innovative Construction Products* is the next book in a series looking at solutions to innovation adoption in a resistant industry.

The study in this book relies on sequential explanatory mixed-method research design. Such methodologies utilize distinct phases in order to gain insight into the commercialization processes. Findings suggest perceived versus actual risks and barriers to the international commercialization process for an integral product to the construction process. Based on the identified barriers, the researchers develop market-based strategies that are incorporated into common business practices for residential construction innovation.

Dr. Ali Albassami is working as a consultant for Investment and Business Development at King Abdullah City for Atomic and Renewable Energy. Dr. Ali has a PhD degree in environmental design and planning and a master's degree in building construction, both at Viginia Tech. His passion for helping organizations in all aspects of creating sustainable built environment flows through in the expert industry coverage he provides.

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