

# Residential Construction Diffusion Research for the NSF -PATH Program

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## Abstract

Housing technology development and deployment (or diffusion) into the housing market occurs in the complex social system of the home building industry. In order to achieve faster and more successful transfer of new technologies in this industry, research must address the conditions promoting or impeding diffusion. This paper identifies key gaps in our knowledge about diffusion in the home building industry and recommends research required to significantly advance technology transfer.

**Keywords:** diffusion in home building, housing industry

## Introduction

Studies of innovation or of diffusion of innovation in residential construction have focused on industry, product and consumer characteristics that might impede innovation. Many of these studies assume that construction is a “laggard industry” that has not developed and deployed new technology to improve the production process or product. Empirical evidence on the level of innovation and technology diffusion in residential construction is sparse and is complicated by cross-industry nature of the construction where products and materials are produced in other sectors (e.g. durable goods manufacturing). Having assumed that residential construction is laggard, analysts have looked for reasons to explain this condition. This search often starts with a review of the general characteristics of diffusion and then deduces the characteristics of residential construction that might impede diffusion. A few studies have surveyed builders (and more rarely consumers) to help identify barriers to diffusion. And a few studies have examined the process of diffusion of specific products, usually through retrospective studies comparing a few products that failed to gain the expected market acceptance with a few, more successful examples.

## Current State of the Art

Impediments studies (Dibner and Lemer, 1992; CERF, 1996a and 1996b; Jaffee and Stavins, 1995; NAHB Research Center, 1991; Koebel, 1999; Ball, 1999) have identified a list of suspects. These include:

- Cyclical nature of construction.
- Dominance of small firms in the industry.
- Problems with compatibility with the housing system.
- Lack of integration of the industry, particularly the heavy reliance on subcontractors.
- Inadequacy of skills in the residential labor force.
- Poor communication between practitioners and manufacturers.

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- Lack of a “systems integrator” (typically either an architect or engineer) in single-family construction.
- Diverse building codes with local peculiarities in details and administration.
- Lack of product approval systems that establish and certify to well-recognized performance criteria.
- Lack of access to information about new products.
- Inadequate education and training on products and materials, installation techniques, and methods of operation and maintenance.
- Exposure to liability.
- Required acceptance by the finance and insurance industries.
- Limited funding for research.
- Lack of clear means for moving new technology from government and university research labs to field-testing.
- Poorly developed links between universities and the construction industry.
- Low levels of government support for technology development.
- Changes in ownership over the long service lifetimes of buildings.
- Inadequate flow of information within the industry and between the industry and manufacturers.
- Adversarial relations in design and construction related to fixed-price contracts.
- Inadequate capital for deployment.
- The high cost of deployment.
- Lack of management ingenuity.
- Resistance to innovations from homebuyers.
- High discount rates among consumers.
- Low impact of technology on profit.

Another potential impediment that strangely has been ignored is the relationship between the cost of housing and the contribution of housing to wealth accumulation among homeowners, and the relationship between the price of new housing and existing housing. If the cost of producing new housing (*ceteris paribus*) was significantly reduced, real depreciation in the value of the existing housing stock (and hence the wealth of many homeowners) could be expected. In this perspective, homeowners (and local governments) would not push for improved efficiency through innovation in residential construction.

Given the ease with which analysts find impediments to innovation in residential construction, it might be more appropriate to ask, “why innovate” rather than “why not”. Either question is valid. In sum, our understanding of diffusion of residential building products and processes is in its infancy and only a few empirical studies have been conducted. From the few empirical studies that have been done, we know that diffusion in residential construction is very complex, likely to vary between different classes of products, be subject to regional differences, and follow different patterns for early and subsequent adopters.

Unfortunately, little is known about the communications and social networks builders use to learn about innovations or influence their adoption practices. Similarly, questions abound about how builders assess relative advantage; how they estimate the consumer’s reaction; information gaps of builders and consumers; information brokers for each; the importance of industry sources and of independent sources of information; and the importance of word-of-mouth among builders.

## **Future Research Directions**

NSF-PATH should emphasize diffusion research that builds on previous studies on diffusion and that exploit existing data bases, when possible. Research should address specific characteristics of the adopting firm, industry, information channels and social networks, technical attributes of the innovation, economic attributes of the innovation, and supplier/vendor characteristics that have been established in the literature as important to diffusion. Research focusing on modular builders, multifamily builders, and national building firms might be particularly fruitful, as past research (Koebel, et al, 2003) found these groups to be more innovative than others.

Research on builders should target innovators and early adopters, and should model the building technology adoption process and outcomes. Previous research has focused on innovators, about which much remains to be learned. But we are completely ignorant of the characteristics and behaviors of second stage adopters. Research on this group should identify the particular information sources and processes that influence the more rapid diffusion of innovation.

Research should target technology transfer programs, including PATH, Toolbase, the Regulatory Barriers Clearinghouse, and university research programs. As pointed out in the National Academies critique of PATH, a more refined model of diffusion is required before technology transfer programs can be improved.

Priority should also be given to:

- Research on the role of technology advocates and a corporate culture of innovation.
- Research on homebuyers' awareness of and demand for new products and materials, including the role played by builders in educating homebuyers.
- Research on information asymmetries between manufacturers, underwriters, builders and consumers, particularly the importance of established manufacturers in facilitating diffusion.
- Research on evaluation services and the importance of certifications to code officials and to consumers.
- Research on the impact of finance and insurance industries on diffusion.