



## Application of information technology for mass customization in the housing construction industry in Korea

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### ABSTRACT

In the Korean housing market, mass customization (MC) is an inevitable strategy for ensuring competitiveness. However, though customer needs have varied rapidly under the customer-oriented market conditions, the level of customization for houses has been restricted by economics of scale in the construction processes. With the rise of the level of customization, the cost of site management has increased because of additional labour. Therefore, this paper introduces the finishing information system (FIS), which can be used to minimize the additional commitment of manpower due to higher levels of MC. To illustrate and validate this system, a case study was performed in a real apartment complex project. The results showed that additional manpower for site management was decreased by quicker completion of the job, simplification of the management process, and efficiency of communication.

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### 1. Introduction

The Korean housing market, which accounts for 43.4% of the construction industry [1], is faced with a highly competitive environment due to various customer needs, the growth of the housing supply ratio, and changes in housing policies. These situations redirect the house-building environment from a supplier-oriented market to a customer-oriented one. Thus, housing suppliers need a new strategy to enhance their profit and ensure higher competitiveness.

In a customer-oriented environment, understanding the requirements of customers and providing them with products they need, reducing customer costs and improving customer value, and continually tracing the satisfaction of consumers are essential issues for an enterprise to march toward success [2]. Mass customization—building products to meet individual orders of the customers rather than for stock—has been a highly desirable goal for the manufacturing industry for many years [3]. In the house-building industry, house builders can employ mass customization (MC) to produce enough variety so that nearly everyone receives exactly what he or she wants at a reasonable price.

In the Korean house-building industry, MC has become a key marketing strategy since the late 1990s [1]. General contractors have

paid more attention to collaborative design and provide individually designed apartments to each customer. Customers can choose from large assortments and match house configurations to their exact preference. In particular, extra options for interior finishing materials and facilities have been offered, so that customers can customize their house individually. However, it seems that the level of customization provided by the housing supplier has not been enough to meet the various customer requirements. Customers are rebuilding their apartments themselves with the finishing materials they prefer, even though the apartment is newly built. This rebuilding causes great socio-economic issues because of the customer's additional cost, the resources waste and environmental pollution produced by the reconstruction wastes [4,5].

Although customers would like a wider range of designs [6], housing suppliers try to limit the range of customization options to achieve economics of scale in construction processes [7]. In contrast to the benefits of customization, such as increased customer satisfaction, increased market share, and increased profit, suppliers simultaneously have to endure the disadvantages, such as increased manufacturing cost, fewer on-time deliveries, low supplier delivery performance, and increased order response time, as well as increased material costs and reduction in product quality [8]. Therefore, to overcome these disadvantages, housing construction has to accept a supplementary commitment of manpower. Accordingly, to prompt a wider range of options for customized houses, MC must be carried out with minimized additional manpower.

To alleviate this conflict, information technology (IT) could be part of the solution. This technology can provide house builders with great advantages with respect to speed of operation, accessibility and

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exchange of information in the construction process. This paper presents the finishing information system (FIS), which can be used to minimize additional manpower in housing customization. It is developed by using computing and networking technology. First, this system uses a computing system to reduce the time and effort for information management at the construction site and to improve the efficiency of communication between the supplier and customer. In addition, the network environment enables efficient communication at the construction site among stakeholders who are geographically dispersed. In a customer-oriented market, the proposed hybrid system can be a strategy for increasing MC to achieve competitiveness.

## 2. The characteristics of the housing market in Korea

Recently, the Korean housing market has been undergoing a systematic environmental transition into a new phase in terms of the excess of the housing supply ratio and the policy transition of the housing supply method. Until the 1990s, in the Korean housing market, the mass supply method of apartment housing construction was employed to solve the problem of the housing shortage in Korea. To utilize the land most efficiently, apartment housing has spread to large cities, similar to the phenomenon of condominiums in North America, where multi-dwelling units share stairs, elevators, and some common structures, while each apartment unit is owned separately [9]. An apartment has been very preferred in Korea 48% over total residential building has been constructed for apartment housing until 2004 [10].

Consequently, this supply method has made it possible to increase the housing supply ratio, defined as the ratio between the number of dwelling units and the number of households, from 70.1% to 100.6% between 1984 and 2002 [11]. In addition, the Korean government has been promoting the transition of the housing supply method from a pre-sale system to a post-sale one for public housing, and the government will prompt the private housing construction industry to participate in this promotion. The pre-sale system was a finance system to support housing construction and was adopted in some developing countries in Asia such as Korea and Taiwan [12,13]. In the pre-sale system, housing construction firms could sell houses before the commencement of construction and the customers had to pay about 80% of the housing price [12]. This way, firms had both benefits of sales and funding for the construction of housing units. However, in the post-sale system, construction firms would face more difficulty in selling the housing units and raising funds than in the pre-sale system. For instance, since firms can sell a housing unit after least 40% of the unit has been built, they have to procure money in advance before commencement of construction and bear the interest on the loan until the completed housing unit is sold out.

Consequently, these changes would bring about a transition in the housing market from a supplier-oriented environment to a customer-oriented one. Additionally, customers are already concerned about their various needs and the quality of their housing and are more informed about the building process than they were previously [14]. Housing customization is inevitable to meet the various needs of customers and for ensuring competitiveness in a customer-oriented housing market [5].

## 3. Mass customization in the house-building industry

Facing a competitive market, MC is an emerging concept in the industry, intended to provide customized products or services in high volumes and at reasonably low cost through flexible processes. In the MC environment, a company allows customers to choose from different optional accessories, colours, and forms of payment [15]. For example, Dell Computer provides a variety of specifications from which customers can choose. When a customer wants to buy a computer system, he/she can use a computer and the Internet to go online and place an order for a computer system. Then, the customer can

select from various options for the different aspects of the computer system according to his/her choice. Besides Dell, MC is used by major manufacturers, such as Motorola, Hewlett-Packard, General Motors, Chrysler and others.

In the new house-building industry, customization has been an important business strategy to promote the housing market [6]. A housing supplier provides a large range of interior fit-out options and various types of designs from which the customer can customize their dwelling unit [3]. Several standardized components, such as white goods, wallpaper, lighting and storage products, are offered to facilitate housing customization. In the provided standard range, customers can choose from options and can combine components to meet their needs. If customers are not satisfied with the standard range, they can order from other facility manufacturers.

After the mid-1990s, housing suppliers in Korea developed customized strategies in which customers could participate in the design of their dwelling units to reflect their needs [5,16]. These attempts were mainly classified by two methods. One is the 'plan select' type, in which a buyer can choose an interior design from among the completed designs proposed by the construction firms. However, the proposed interior styles had three or four quantitative restrictions. The other is the 'finishing option' type, in which the buyer can select interior finishing materials directly. However, the most of interior finishing materials were decided by the construction firm and only about 15–25% of all finishing materials were selected by the buyer.

In order to meet rapid diversification of customer needs, the level of customization had to increase. Unfortunately, as the level of customization increased, the workload on site also increased [4], and additional manpower had to be committed in order to accommodate the increased workload. As a result, the additional commitment had a bad influence on the construction cost. Therefore, the suppliers had to devise a way to construct an efficient environment in which additional manpower due to customization could be minimized. This pursuit has become a critical construction issue in the promotion of a higher level of customization in house building.

## 4. Finishing information system (FIS)

In housing construction, the available IT supports customers in the efficient customization of their houses. The web-based design system provides customers with an interactive program, which generates housing solutions, and rapid prototyping and virtual reality techniques for visualizing these solutions [17], and a decision-support system assists customers in making adequate choices among the various designs for customization [18]. However, a web-based system provides only a layout of the plan as a housing solution, excluding the options on finishing materials that allow the customers to express their personality and, thus, are the most influential components of customer satisfaction. A decision-support system also provides customers with several pre-assembled alternatives and offers no opportunity for customers to choose the options directly. Additionally, although both of these systems improve communication efficiency, their application is restricted between the supplier and customer only. Therefore, this study proposes the FIS, which improves the productivity in housing construction with customization by the customers themselves.

### 4.1. System architecture

FIS has been developed as a computing and networking system to provide a solution for efficient information management and good communication at the site. The system mainly consists of a PC for orders, a site-office server to manage information, and a mobile device on site, as shown in Fig. 1. In the finishing work, it supports information management about the order for finishing materials, the order in which individual aspects of the work are to be undertaken, and the process on site; as well, it supports data communication among the

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