

Client Requirements Management in Social Housing: A Case Study on the Residential Leasing Program in Brazil

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Abstract: As in other developing countries, social housing programs in Brazil have endured major changes in the last two decades, such as decentralisation in decision making, growing participation by private developers, and decreasing participation by the government, which has traditionally been responsible for social housing product development in Brazil. This has increased the complexity of those projects and created new roles and relationships for the organisations involved in social housing projects. In this context, there is a need for improving the product development process of those projects and, more specifically, the manner in which client requirements are managed. The aim of this paper is to evaluate the Residential Leasing Program (PAR – *Programa de Arrendamento Residencial*), one of the most important programs for low-income families in Brazil, from the perspective of client requirements management. Two sets of case studies were carried out. The first set involved an analysis of the product development process and highlighted opportunities for improving client requirements management. The second set of case studies involved a post-occupancy evaluation, which noted some contradictions in the way the PAR Program was conceived. The results suggest that the adoption of mass customisation strategies, which have been successful in other industries, would be beneficial to the social housing sector.

Keywords: Client requirements management, Product development process, Social housing, Post-occupancy evaluation, Client satisfaction

INTRODUCTION

In Brazil, social housing needs are great; there is both a shortage of homes and the need to improve existing housing stock. Approximately 6.2 million families need new homes, and over 10 million existing homes have inadequate infrastructure in terms of water and sewage

services, public transportation, and waste management (Ministério das Cidades, 2007). As this problem is strongly related to the unequal distribution of wealth, most of the housing shortage is concentrated in the segments of society that have lower incomes and live on the outskirts of large urban areas. In fact, according to the Brazilian Cities Ministry (Ministério das Cidades, 2007), 96.9% of the total urban housing shortage in Brazil is related to families that earn up to five times the minimum wage per month. The Minimum wage in Brazil in December 2009 was approximately US\$270.00 a month or US\$3,240.00 a year. Those families are the ones that typically cannot afford

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to buy a house without some form of support from the government.

The role of the State in the provision of services and facilities has undergone major changes worldwide, especially in developing countries. In Brazil, there is a trend towards reducing the participation of the State as a direct developer or client in the construction industry, similar to what has happened in other countries (Barlow and Ozaki, 2000). In this country, the State has increasingly been assuming an enabling role, partly due to the lack of resources for investments (Keivani et al., 2004). This approach assumes that there should be a very close relationship between public and private organisations. Many existing social housing programs in Brazil have private developers, such as construction companies, cooperatives, and non-governmental organisations. This has increased the complexity of social housing projects, primarily because the promotion of those projects is now highly decentralised in Brazil (Keivani et al., 2004). Such changes have created new roles for the organisations involved and have resulted in innovative forms of the relationships between them. In this context, it is necessary to substantially improve the way such projects are managed, which depends on several changes in the social housing sector, including developing new competencies in public organisations, extending the role of general contractors in construction projects, and creating alternative forms of financing. Thus, there is a major need for identifying opportunities

for improvement in the product development process of social housing projects and, more specifically, in client requirements management.

Product development can be defined as the process by which a product is conceived, designed and launched, and includes also the feedback from both production and product use (Ulrich and Eppinger, 2000). Several authors argue that, due to the increasing complexity of product development in the construction industry, more effort should be dedicated to managing the clients' requirements, including capturing client requirements, making them explicitly available for the product development team, and controlling whether the requirements of different stakeholders have been properly balanced (Bailetti and Litva, 1995; Huovila and Serén, 1998; Barrett et al., 1999; Koskela, 2000; Kamara et al., 2002; Shen et al., 2004). In fact, research on client requirements management related to the building industry has mostly emphasised the brief-taking process or is focused on the use of specific tools, such as quality function deployment (QFD). Improving client requirements management is particularly important in social housing because of the need to maximise the value perceived by final users under existing cost constraints.

The purpose of this study is to evaluate the product development process of a specific housing program in Brazil from the perspective of client

requirements management. This investigation focused on the Residential Leasing Program (PAR – *Programa de Arrendamento Residencial*) because this program is currently one of the most important initiatives for low-income families in Brazil and is an example of the growing complexity that exists in social housing, as discussed above. This form of housing provision requires innovative roles for both public and private organisations and a new form of relationship between the State and the final user, which has never before existed in Brazil.

The PAR program was conceived and financed by the Brazilian Federal Government Cities Ministry (*Ministério das Cidades*) and is operated by the National Savings Bank (*Caixa Econômica Federal*). As both entities are part of the Federal Government and are partners in the PAR program, they are considered and referred to as 'owners' throughout this paper. Each project consists of the construction of new buildings or the renovation of existing buildings in highly populated urban areas, including state capitals and towns that have more than 100,000 inhabitants, for families that have a monthly income of three to six times the minimum wage (approximately US\$810 to US\$1,200 in December 2009). The Federal Government subsidises part of the project costs (usually between 50% and 70%) to keep the lease costs affordable for those families. The remaining costs are paid for by the lessees during a 15-year period, after which the lessees become the lawful owners of the property. These projects typically

consist of condominiums in the form of terraced houses or apartment buildings that are limited to 500 units. For new construction, all units have the same floor plan. For renovations, units vary in size and plan based on previous space distributions (e.g., renovation of office spaces to residential units). Condominiums are normally fenced and have communal areas such as parking lots, sports facilities, and a community centre. A cost yardstick has been established by the Federal Government for different types of projects. The National Savings Bank monitors construction and pays construction companies on a monthly basis based on percent completion of the project as compared to the schedule submitted at the start of construction. Around 266,000 units were delivered by this program between 2001 and 2008.

CLIENT REQUIREMENTS MANAGEMENT

In the construction industry, the term traditionally used for the capture of requirements at the beginning of a project is briefing, which refers to the process that generates the brief. The CIB Working Group 1 (1997) defines briefing as the process through which a client informs others of his or her needs, aspirations and desires for a project. Its main product is normally a document that contains the background, purpose, scope, content and desired outcomes of the project, the functions of the intended facility, cost and time targets and site and environmental conditions (Kamara et al., 2002). Barrett

et al. (1999) use a broader definition for the briefing process, assuming that this process should ensure that the client's requirements are initiated, developed, adapted, maintained and communicated throughout the project.

Despite its importance for the success of construction projects, the briefing process is often neglected. Most brief-takers rely on their own experience (Barrett et al., 1999) and do not usually base their work on any type of formal procedures (Kamara et al., 2002). This has also been observed in other industries, where requirements capture relies on key individuals thinking abstractly about the potential of an idea in terms of the market, technology and the likely impact on company resources (Bruce and Cooper, 2000).

Considering the increasing complexity of product development in social housing projects, along with increased value expectations and the need to manage multiple stakeholders and their expectations, the briefing process should not be carried out by a single professional, such as the architect. The quantity and complexity of project information, the need for designers to work simultaneously in several projects, and the fact that different actors participate in each of the product development phases make it practically impossible for a single project participant to know and recall all of the important requirements and the relationships amongst them (Kiviniemi and Fischer, 2004).

The absence of any objective or structured framework for supporting the briefing process in a complex project may lead to the following problems in product development: (a) clients' needs are not sufficiently studied and considered (Huovila and Serén, 1998); (b) the brief is biased by the perspective of the brief-taker (Barrett et al., 1999); (c) it may not be possible to properly balance the perspectives of different interest groups and to establish the relative importance of the various requirements (Kamara et al., 2002); and (d) the conformity of selected technical solutions is not managed systematically (Huovila and Serén, 1998). Moreover, requirements evolve over time. Hence, a flexible approach towards client requirements management is required, which would recognise changes and/or refinements in the requirements and adapt accordingly.

Both Kamara et al. (2002) and Bruce and Cooper (2000) argue that there is a need for processing client requirements in order to present information in a form that enhances the understanding of the product development team regarding precisely what the client desires. This is due to both the wide range of often conflicting interests from different stakeholders (Kamara et al., 2002) and to the nature of client requirements – some of them are not made explicit by the clients (Griffin and Hauser, 1991). The presentation of requirements should be neutral enough to allow different professionals to understand them in the same way, instead of adopting

an interpreted version from the perspective of a single professional (Kamara et al., 2002). Moreover, although most of the effort involved in capturing the requirements occurs at the front-end of product development, new requirements may be discovered and existing requirements ought to be refined throughout the development of the new product (Bruce and Cooper, 2000).

The above discussion indicates that a more systematic and comprehensive approach for client requirements management is required. In this paper, client requirements management is defined as the process of identifying and understanding clients, analysing their needs and expectations, processing the information in order to make client requirements accessible and to achieve a format that can be understood by professionals from the different disciplines involved, managing trade-offs by establishing priorities, and controlling the conformity of design solutions (Miron and Formoso, 2003).

RESEARCH METHODS

The aim of this paper is to evaluate the Residential Leasing Program (PAR – *Programa de Arrendamento Residencial*), one of the most important programs for low-income families in Brazil, from the perspective of

client requirements management. A case study was the research strategy used in this study. This strategy was chosen because we chose to conduct an in-depth investigation as opposed to developing a survey with a larger data set. This research was divided into two main stages: (a) development of a descriptive model of the product development process of the Residential Leasing Program based on seven PAR projects and (b) a post-occupancy evaluation of four PAR projects that had already been delivered within this program.

The descriptive model was developed between October 2003 and April 2004. The main product of this stage was an overview of the activities associated with the product development process. The process map is an as-is model based on the analysis of retrospective data from seven PAR projects and on interviews with representatives from different organisations involved in the PAR program, such as the National Savings Bank, construction companies and architectural firms. One construction company built five projects, and a second company built the remaining two projects.

Initially, several documents were analysed for each project, including design drawings, contracts, and project plans. Based on those documents, the evolution of the architectural design was studied, and the duration of each stage of the project was traced. Then, a map of the product development process was produced and used as a support for conducting some of the interviews.

At the end of this stage, a product development process map was produced, emphasising activities that were potentially related to client requirements management. This process map was then refined through a series of individual discussions with different stakeholders involved in the process.

The post-occupancy evaluation had an exploratory character, with the aim of revealing contradictions between the objectives and results of the four projects from the point of view of the users. The survey involved the collection of both qualitative and quantitative data from the users, including their perception of the program and the degree of satisfaction with dwelling units, communal areas and facilities management. Data concerning the profile of the users were also obtained.

Moreover, this survey was used to develop a method for assessing the performance of PAR projects based on the users' perspective, which could be used in the future on a larger scale. The development of the survey included feedback from several project stakeholders: the National Savings Bank (representing the 'owner'), construction companies, designers, and facility management companies.

All projects were located in the State of Rio Grande do Sul, South of Brazil. As most PAR projects had been delivered fairly recently, one of the criteria for choosing the projects was the date of delivery of those projects. In this type of study, it is not recommended to interview users who have moved in very recently because they might not have sufficient experience to provide a comprehensive assessment. The need for an assessment

Table 1. Brief Description of the Projects

| Location | Project | Project Type | Building Type | Occupation Period | Number of Units |
|--------------|---------|------------------|--------------------------------------------------------------------------|-------------------|-----------------|
| Pelotas | A | New construction | Condominium of three terraced blocks of 3 to 4-story apartment buildings | 5 months | 132 |
| | B | New construction | Condominium of three terraced blocks of 4-story apartment buildings | 16 months | 160 |
| | C | New construction | Condominium of three terraced blocks of 4-story apartment buildings | 13 months | 160 |
| Porto Alegre | D | Renovation | 14-story apartment building | 17 months | 78 |

of different types of projects within the same program was also considered. Table 1 presents a brief description of the four projects that were chosen.

The four selected projects were developed by three different companies. Project H and I were the only ones developed by the same company. The sample was uniformly distributed within each project. For example, in a 160-unit project with three four-story buildings, 32 interviews were conducted (sample of 20%), of which approximately 10 interviews were conducted in each building, uniformly distributed by floors and by front and back-facing units in each floor. For renovation projects, the sample size was 50%, given the smaller number of units in those projects. The sample was randomly selected based on the aforementioned criteria. The interviewee was at all times a resident adult. Only one resident was interviewed per unit. The duration of each interview varied from 20 to 60 minutes and took place inside each unit so that the research team could take note of any spatial modifications users have made to their units.

Three new construction projects (A, B and C) were located in the town of Pelotas. They were selected because they were considered to be typical examples of this type of project in the State of Rio Grande do Sul. The dwelling units were the same for each project, and their size varied from 39.00 to 46.54m². Each unit has a kitchen, laundry room, living room, bathroom and two

bedrooms. The communal areas included a parking lot, community centre, playground and sports court. There was also a watch post at the entrance to the condominiums, with 24-hour security patrolling in each project. Figure 1(a) is a photograph of Project C, and Figure 2 presents an overview of Project A and the floor plan of the dwelling units.

Project D was located in downtown Porto Alegre, the state capital. This was the first renovation project completed by the Residential Leasing Program in the state of Rio Grande do Sul. The aim of this type of project was to bring people back to the city centres by renovating formerly abandoned high-rise buildings. There were two types of dwellings in this building, studios and one-bedroom apartments, ranging from 19.42 to 32.32m². They typically had a kitchen, laundry room, living room, bathroom and, except for the studios, one bedroom. In the building entrance hall, there was also 24-hour security patrolling. Unlike the new building projects, there were no parking lots or communal leisure areas in the building. Figure 1(b) shows a photograph of the façade of Project D.

Given that this study had an exploratory character, the sample size ranged from 20% of the units for the new construction projects up to 50% for the renovation projects because the latter were much smaller. These figures were considered to be adequate for qualitative data because sampling continued until data saturation



(a) Project C in Pelotas



(b) Project D in Downtown Porto Alegre

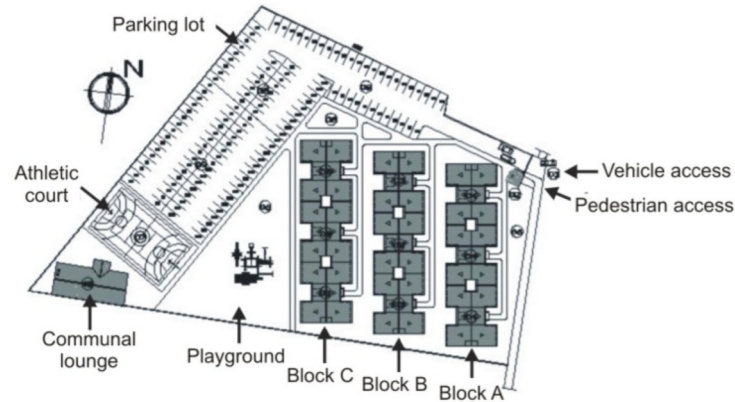
Figure 1. General View of PAR Projects

Source: Leite, 2005

was reached, which occurs when no new relevant data regarding a particular category seems to emerge from the interviews (Strauss and Corbin, 1998). Data collection was conducted individually with adult residents by two researchers, with interviews ranging from 15 to 80 minutes. While one researcher conducted the interview,

the other made direct observations of each unit. The data collection tool was divided into five main sections:

- (a) Profile of the dwelling group: position in the family, profession, age and sex of the interviewee, number



(a) Site Plan of Project A



(b) Project A Dwelling Unit

Figure 2. Overview of Project A

Source: Leite, 2005

of dwellers, number of children, location and type of previous home, etc.;

- (b) Critical incident technique: an adaptation of this technique, which has mostly been used for assessing service quality (Chell and Pittaway, 1998), was made by asking the users for the five most positive and the five most negative characteristics in each project. This technique provides a sense of the importance of different aspects of the projects;

- (c) Evaluation of the user's degree of satisfaction: a questionnaire was used, which was divided into three main sections - the performance of the facility management company, the quality of the communal areas, and the quality of the dwelling units; and
- (d) Use of the dwelling: a description of changes that had been made in the apartments and the position of the furniture in each dwelling unit were

documented by sketches and photographs. The dwellers were also asked if they intended to perform further changes to the apartment.

The data were analysed using descriptive statistical variables, histograms and Pareto graphs. A non-hierarchical cluster analysis was also performed for generating classes of users based on the principle of maximising intra-class similarity and minimising inter-class similarity (Han and Kamber, 2001). According to Malhotra (2004), in the non-hierarchical cluster analysis, also known as k-means, the number of clusters (k) is pre-determined by the researcher. In this research, $k = 4$, because that was the number of main dwelling groups initially identified by the researchers.

The results of both stages of this investigation were presented in eight seminars in different towns in Brazil. The aim of these events was to discuss the results with representatives from different organisations involved in PAR projects, including the National Savings Bank, construction companies, design offices, and facility management companies.

DESCRIPTIVE MODEL OF THE PRODUCT DEVELOPMENT PROCESS

Figure 3 presents a map of the product development process in PAR projects. It shows the main activities associated with the process, the precedence relationships between them, and project milestones. The process is initiated by a construction company, which is responsible for designing and building the project. This company finds a suitable land plot and proposes a scheme design that is submitted for an assessment by the National Savings Bank. This assessment is based on standards established by the Cities Ministry. If the project receives a preliminary approval from the Bank, the design is completed and submitted for an analysis by the municipal government, which is also responsible for enrolling potential dwellers and identifying whether there is demand for that type of project. Typically, a project begins if the demand is found to be four times the number of apartments to be built because a large percentage of families eventually do not comply with all of the requirements for becoming lessors. If the local government approves the project and there is a high potential demand for the project, a contract is signed between the National Savings Bank and the construction company.

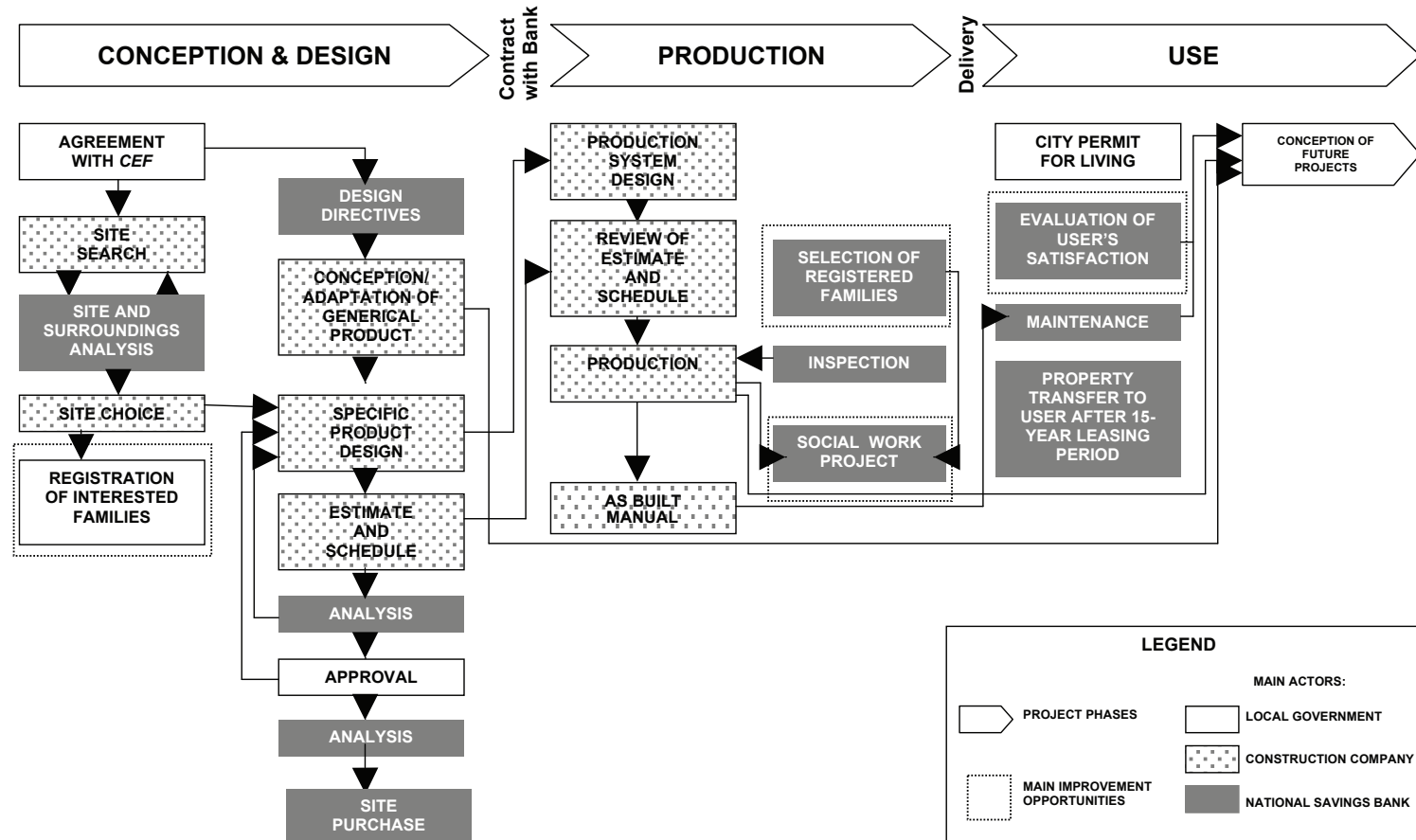


Figure 3. Product Development Process Map of PAR Projects (Adapted from Leite, 2005)

The duration of the production stage was 12 months for all projects in this study. Currently, there are larger PAR projects that have adjusted durations (e.g., 24 months for 500-unit projects). The construction company builds the project and the Bank technical staff inspects both the quality and the duration of the project, usually through weekly site visits. This project control tends to be fairly strict compared to other housing programs because the Bank is the owner. Towards the end of the project, the selection of users is conducted jointly by the local authority and the Bank – the former is responsible for establishing priority criteria for selecting lessors. Once the dwellers are selected, social work starts, which is intended to create a community attitude among the group of dwellers because they will live together (some for the first time) in a condominium complex.

At the end of the production stage, the project is initially delivered to the National Savings Bank. After final inspection, the dwelling units are finally delivered to lessors. After living in the housing development for 15 years, the lessors will become the owners of the units. During the 15-year leasing period, the National Savings Bank hires a facilities management company that is in charge of managing the operation and maintenance of the housing complex.

POST-OCCUPANCY EVALUATION

Causes of Satisfaction and Dissatisfaction

Table 2 presents a summary of the results of the post-occupancy evaluation: the overall satisfaction rate, positive and negative characteristics, the main sources of dissatisfaction and the main changes made by the dwellers. Redundancy in the findings was observed for several items because of the use of different sources of evidence for triangulation.

Even though the general degree of satisfaction with the projects was high, dwellers still made changes in their units, which indicate some type of dissatisfaction with the design intent. For example, the integrated kitchen and laundry area was one of the main sources of dissatisfaction for the users. This was observed in the critical incident technique, the questionnaire, and in the changes made in the units. Approximately 40% of the users wished to separate the kitchen from the living room or had already made such a change. Interestingly, this had been noted as a significant source of dissatisfaction in previous post-occupancy evaluations (Reis, 2003; Noguchi and Hernandez-Velasco, 2005).

Another example of a requirement that was somewhat neglected in the project design is the dwelling size (and the number of rooms). In Project D,

Table 2. Summary of the Results of the Post-occupancy Satisfaction Survey

| Project | Overall Satisfaction | Positive Project Characteristics (Ordered from Most Cited to Least Cited) | Negative Project Characteristics (Ordered from Most Cited to Least Cited) | Main Sources of Dissatisfaction | Main Changes Made by the Dwellers |
|---------|----------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A | 80.85% | Condominium design, location, dwelling unit design, condominium life, security, PAR program, finishing | Condominium life, condominium design, building defects, finishing, lack of area for air drying clothes, facility management company, dwelling unit design, PAR program, condo maintenance tax, location | Uncovered parking lot, lack of shadowed green areas, kitchen and laundry area | Physical separation of kitchen and living room, physical separation of kitchen and laundry area, addition of finishing in kitchen, laundry area and bathroom, substitution of kitchen countertop |
| B | 96.88% | Dwelling unit design, security, condominium design, location, condominium life, PAR program, finishing | Condominium design, condominium life, location, dwelling unit design, lack of area for air drying clothes, facility management company, condo maintenance tax, finishing, the PAR program in general | Material used in sports court surface, kitchen and laundry area | Physical separation of kitchen and living room, physical separation of kitchen and laundry area, addition of finishing in kitchen, laundry area and bathroom, substitution of kitchen countertop |
| C | 81.26% | Location, condominium design, dwelling unit design, the PAR program, security, condominium life | Condominium life, condominium design, security, condo maintenance tax, facilities management company, finishing, lack of area to air dry clothes, dwelling unit design, location | Material used in sports court surface, security, kitchen and laundry area | Physical separation of kitchen and living room, physical separation of kitchen and laundry area, addition of finishing in kitchen, laundry area and bathroom, substitution of kitchen countertop |
| D | 71.80% | Location, the PAR program, dwelling unit design, condominium life, security | Outside noise, elevator issues, location, dwelling unit design, condominium design, lack of area to air dry clothes, finishing, condo maintenance tax, facilities management company, condominium life, building defects, security | Party room, building entrance, security, all rooms, but mainly laundry area | Substitution of floor tile, addition of finishing in kitchen, laundry area and bathroom, substitution of kitchen countertop |

approximately 25% of the dwelling units are studios, and most of them had been vacant for almost three years, although statistics indicate that significant demand exists for social housing. Moreover, in this same project, the lack of open areas for leisure activities, especially for children, has led to a smaller number of families with children (29%) that are interested in this project. By contrast, in projects A, B and C (two-bedroom apartments with communal leisure areas), 48.6% of the families have children. Thus, the occupancy in Project D could have been higher if the identification of the users' needs had been properly conducted during their initial registration, for example, by collecting information on the desired number of bedrooms, the number of dwellers and the age of the occupants.

Some of the results of this evaluation are specific to the needs and expectations of the population from the South of Brazil. If these same results were used in PAR projects in other regions of the country or in projects in other developing countries, the sources of satisfaction and dissatisfaction might differ substantially. Nonetheless, this evaluation indicates that it is necessary to introduce changes in the product development process in order to increase the value of those products for future dwellers. It is necessary to explore the existing opportunities for capturing client requirements, process this information and make it available to the decision makers (e.g., bank technical staff, designers, developers, etc.) in the early stages of product development.

Cluster Analysis

The profile of the dwellers was investigated by a k-means cluster analysis for the two types of projects: new construction (Projects A, B and C) and renovation (Project D).

The purpose of this analysis was to identify clusters of dwellers with similar requirements, providing information on the diversity of dwelling groups. Table 3 presents the distribution of four groups of dwellers for the two types of projects.

Although the PAR housing program has targeted traditional nuclear families consisting of a couple with two children, that category of dwelling groups corresponds to 37.80% of the units in the new building projects and only 15.38% in the refurbishment projects. The result of the k-means cluster analysis for Projects A, B and C is shown in Table 4.

Four clusters are described. Clusters 01 (adult with children) and 02 (couple with children) are the largest ones. Eleven out of 90 objects (interviewees) were too far from any of the cluster centres and were thus not classified. The result of the k-means cluster analysis for the refurbishment project is presented in Table 5.

Table 3. Categories of Dwelling Groups in New Construction and Renovation Projects

| Type of Project | Couple with Child(ren) | Couple without Children | Adult(s) without Children | Adult(s) with Child(ren) |
|---------------------------------------|------------------------|-------------------------|---------------------------|--------------------------|
| New construction (Project A, B and C) | 37.80% | 21.11% | 18.89% | 11.11% |
| Renovation (Project D) | 15.38% | 23.08% | 23.08% | 28.21% |

Table 4. Clusters in Projects A, B and C

| Cluster | Number of Objects | Cluster Centroid |
|------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adult with child(ren) | 27 | 39-year-old person, who completed High School, previously lived in a house, and is unsatisfied with the design of the common areas and satisfied with the design of the dwelling unit |
| Couple with child(ren) | 36 | 39-year-old person, who completed High School, previously lived in an apartment, and is satisfied with both the design of the common areas and the design of the dwelling unit |
| Young couple with child(ren) | 08 | 18-year-old person, who has not completed High School, previously lived in a house, and is unsatisfied with both the design of the common areas and the design of the dwelling unit |
| Middle-age couple without children | 08 | 56-year-old person, who completed Junior High School, previously lived in an apartment, and is unsatisfied with the design of the common areas and satisfied with the design of the dwelling unit |

Table 5. Clusters in the Project D

| Cluster | Number of Objects | Cluster Centroid |
|------------------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adult with one child | 13 | 42-year-old person, who completed High School, previously lived in an apartment, and is unsatisfied with the design of the common areas and neutral with the design of the dwelling unit |
| Adult with two children | 05 | 28-year-old person, who hasn't completed High School, previously lived in a house, and is neutral with the design of the common areas and unsatisfied with the design of the dwelling unit |
| Young couple with one child | 04 | 23-year-old person, who completed High School, previously lived in a house, and is satisfied with both the design of the common areas and the design of the dwelling unit |
| Middle-age couple without children | 06 | 53-year-old person, who completed High School, previously lived in an apartment, and is neutral with the design of the common areas and unsatisfied with the design of the dwelling unit |

Clusters 01 (adult with one child) and 04 (middle-aged couple without children) are the largest ones. Eleven out of 39 objects were not considered part of any cluster. These 11 objects not classified by the k-means cluster algorithm for the refurbishment project were composed of single-person families, adults with children and couples with children. They were not classified because these objects were either unique or not similar enough to another object, which is the basic premise of k-means clustering (i.e., maximising intra-class similarity and minimising inter-class similarity).

This analysis highlights the source of major differences that exist in user requirements. For example, the users who belong to the adult with two children cluster in the refurbishment project are unsatisfied with the design of the dwelling unit, mostly because it has only one bedroom. Such division of user types may be used as a starting point for investigating specific requirements for different dwelling group categories. In fact, the use of clustering techniques could facilitate early design decisions for new projects by identifying potential groups of clients and their requirements.

DISCUSSION

This study provided evidence that, like most housing provision programs in Brazil, the conception of the PAR Program has implicitly adopted mass production ideas. In most projects, the design of all dwelling units are the same, based on the assumption that this reduces production costs and contributes to the simplification of contractual and financial procedures. However, this product development strategy ignores the fact that there is significant diversity amongst the requirements of various users – only a fairly small percentage of users represent the traditional nuclear families for whom the projects have been designed.

This strategy also ignores the possibility of using other cost reduction strategies, such as the following:

- (a) Reducing production lead time: this could reduce indirect project costs and increase capital turnover for the construction company, which is highly desirable in market segments where the profit margin is fairly low, such as social housing.
- (b) Reducing the design approval lead time: this period could be reduced by local and state governments through process improvement and by making the requirements more explicit for construction companies through an explicit and streamlined briefing process.

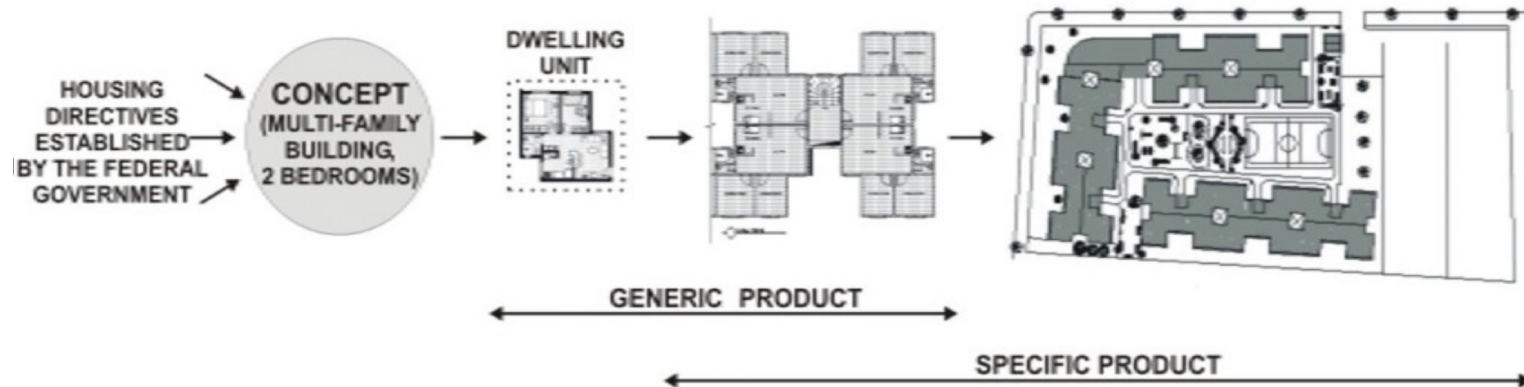


Figure 4. Illustration of the Generic Product Strategy Adopted by Construction Companies
(Adapted from Leite, 2005)

- (c) Project continuity: if it was possible for a company to develop a series of similar projects, cost reductions could be achieved through several factors, such as the learning effect, which is achieved by using the same crews continuously, and the use of the same infrastructure (e.g. site installations, pre-fabrication plants) for multiple projects.

In contrast, the principal strategy adopted by construction companies for reducing costs was the definition of a generic product: four to five-story apartment buildings, which may be combined in sets of terraced blocks (Figure 4), with a house plan that is

typically four units combined to form an H-shape. Again, this strategy is fairly restrictive in terms of fulfilling the needs and expectations of different dwelling groups.

One possible strategy for increasing product value but achieving production efficiency is the adoption of mass customisation ideas, which have been very successful in other sectors such as the automobile industry. In mass customisation, each product is unique and is produced according to the individual requirements of the consumer but in an efficient manner that is similar to mass production (Pine II, 1999). In construction projects, this would mean using a combination of components

to produce customised products that satisfy the needs of different dwelling groups, rather than using restrictive spatial solutions to achieve efficiency. Noguchi and Hernandez-Velasco (2005) emphasise the use of standardised components, which could be produced on a large scale, to increase the construction companies' bargaining power while reducing costs. For example, the construction companies that develop PAR projects often use pre-cast slabs and ready-made components to reduce the number of construction activities that must be performed on-site.

Furthermore, to customise products the professionals responsible for developing the product must have more information about the final clients, which is currently not possible in PAR projects because the final clients are selected close to the end of the production phase (in some cases, a few days before delivering the project).

As mentioned in page 56, four main opportunities for capturing client requirements during the project delivery process of PAR projects were identified:

(a) Enrolment of candidates: this task is the first opportunity for capturing the requirements of potential dwellers. An open announcement is usually made by the local government housing department, which is usually in charge of profiling the demand. This effort tends to be very time consuming because

of the large number of candidates and because it is performed manually, often resulting in long queues. Data collection is usually limited to contact information (address, phone number, etc.) and the income level of each applicant, primarily because of a lack of competence in local government. Hence, suitable briefs specifying the specific needs of the enrolled candidates are not delivered to the developer and, consequently, their needs are not monitored during the approval process to ensure that they are reflected in the design. The interviews also indicated that similar procedures are usually adopted in other housing programs.

(b) Selection of lessors: this is carried out too late in the product development process, only after the design has been completed and approved by the Bank. Completing this task earlier presents another improvement opportunity because it would then be possible to capture user requirements early enough in the process for them to be considered during product conception and design.

(c) Social work project: social workers are hired to promote the development of a sense of community amongst dwellers. They would begin this task immediately after the lessors are selected and work for up to one year after the delivery of the project. This step is necessary because most of the lessors have not had previous experience living in this type

of housing complex and are not used to having to comply with condominium rules and restrictions. Social workers are usually familiar with characteristics of the dwellers, including their lifestyle, complaints, and expectations. However, this knowledge is not made available in a systematic way for the professionals involved in the conception and design of new projects.

- (d) Post-occupancy evaluation: these have not been systematically conducted for PAR projects after they are delivered. There is, in fact, a specific procedure with the Bank for evaluations that are to be conducted by social workers, but data collection is inconsistent and very little data processing is undertaken.

CONCLUSIONS

This paper presented an evaluation of the Residential Leasing Program, which is currently one of the most important housing programs in Brazil, from the perspective of client requirements management. An analysis of the product development process for housing projects has indicated that value generation could be improved by increasing the direct participation of the final users in the early stages of the product development process. Currently, this is not possible because the families are

only selected at the end of the production phase when the design has already been completed. However, even if no radical changes are introduced in the Program, there are several points in the development process where opportunities for client requirements capture have previously been missed: (a) enrolment of potential lessors in the Program; (b) selection of the families; (c) social work project; and (d) evaluation of the users' satisfaction, including an analysis of the changes made to their units.

The post-occupancy evaluation revealed a fairly high degree of satisfaction in the Residential Leasing Program; between 75% and 100% of the users stated that they are generally satisfied with their homes. Moreover, the primary causes of dissatisfaction, such as the integration of the kitchen and living room areas, could have been easily avoided if the user requirements were properly captured, processed and made available to designers. Additionally, several contradictions that are strongly related to the lack of concern with client requirements management seem to exist in the PAR Program. For example, although the dwelling units are designed for traditional families, a wide diversity of family types has actually been living in those projects; only between 15% and 37% of the lessors correspond to the traditional family model of a couple and children.

The results indicate that the opportunities for capturing client requirements that were identified in this study could be used for profiling families to devise products that are more suitable for their needs and expectations. Clustering of future dwellers could also be used for grouping families and assigning them to projects with characteristics that suit their needs.

The problem of designing for a single type of family is also caused by the fact that the PAR Program, similar to other low-cost housing programs in developing countries, was conceived according to mass production principles; to reduce costs, the projects are usually designed to have identical dwelling units. Such a strategy ignores the fact that these projects do not fit the requirements of a large percentage of users, which has a negative effect on the value of the units. This strategy also fails to recognise that there are much more effective mechanisms for reducing construction costs, such as promoting the continuity of construction work and reducing project lead times. The capability for reducing construction costs is fairly evident in other industries that have adopted the concept of mass customisation, which could potentially increase the benefits perceived by the user in social housing projects in spite of the existing cost constraints.

One key issue that requires further investigation is the development of mechanisms for balancing the requirements of different clients, such as the final user (dweller), the owner (the Government), and the

developer (construction company). In addition to the systematic capture, processing and analysis of users' requirements, such requirements balancing will demand the collection and processing of a wider range of information and tools for comparing and weighing the needs and expectations of different stakeholders.

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