Analysis of self-building principles with respect to Pine (Pinus spp) kits available to low-income families in Florianópolis, Brazil

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ABSTRACT

Self-building may be considered a feasible solution to the housing shortage which many Brazilians face today. The discovery of a branch of activity in the Southern Brazilian city of Florianópolis, State of Santa Catarina, which produces and sells low-cost Pine (Pinus spp) housing kits for low-income families, prompted us to research the program's processes, systems and components with respect to their level of self-buildingness. Our methodology consisted of identifying the branch of activity and its developers, examining the instruction manual used by the companies and the selfbuilders, and analyzing the self-building principles with regard to a) community adoption; b) the use of unskilled labor; c) market supply; d) the non-requirement of machinery and tools; e) component design; f) ease of assembly; g) flexibility and modular coordination; and h) participation of family members. The information obtained demonstrate that the systems are competitive when compared to masonry, but pose problems from a self-building point of view.

INTRODUCTION

This work is part of a Master's thesis in architecture entitled, Parameters for the Architectonic and Technology Project for Community Built, Low-Income Pine (Pinus spp) Dwellings. The research project, which is currently underway at the Engineering School at São Carlos - EESC/USP, aims to establish the main parameters governing the principles of self-building systems in the production of low-income dwelling units made from pine (Pinus spp), a reforestation wood. The project also examines how houses are built with the help of homeowner (partner) families.

The growing housing shortage in Brazil continues to be one of the greatest problems the population faces and is a big challenge for municipal, state and federal governments. In most cases, government-financed housing programs do not reach the large part of the population which represents Brazil's true housing shortage. This part of the population, which earns the equivalent of roughly US$200 [R$390] per month and which is not included in the formal housing market, is responsible for developing the branch of activity we will analyze below.

REASONS AND CONTEXT

According to Cardoso (1993), the idea that the production process for self-building is fundamentally different from conventional means presents a series of questions regarding the development of solutions and construction systems. The use of reforestation wood, pine (Pinus spp) in this case, is another determinant aspect of the study since, because of pine's inherent properties, it assumes solutions which must respect pine's limitations.

We can justify the relevance of studying the Metropolitan Florianópolis region because no type of systemization or technological analysis had been done on these construction systems, on the way they are structured economically, the work they are generating, on producing housing on a large scale for the inhabitants of the region, and encouraging the use of pine (Pinus spp) as a construction material.

The EPAGRI – Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (1999) showed that the State of Santa Catarina has approximately 400,000 hectares of planted forests. It is calculated that there currently exist 25,000

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hectares of pine (*Pinus* spp) forests in the region. The trees which have already reached maturation, or cutting age (16 to 20 years), are mainly being used in the area of commercial and institutional construction.

Claro (1991) points out that Lumber Co. began using wood in the production process of housing units in the early 20th century, at which time, Lumber Co. exported most of its goods to the US. Beginning in the 1950s, part of its merchandise ended up staying in Santa Catarina.

The housing model which is currently being produced for the low-income population and which is used throughout most of the state, is quite similar to the original kits founded by Lumber Co. Today, that trend of construction system, sold as pine (*Pinus* spp) housing kits produced for self-building construction, is available in Florianópolis markets.

Our research in the greater Florianópolis region, which covers the cities of Florianópolis, São José, Palhoça and Biguaçu, revealed the existence of 113 lumber mills. Approximately 10% of these lumber mills sell pine (*Pinus* spp) housing kits. These kits consist of milled wood components which are sold to the low-income population in varying quantities, depending on the total area of the dwelling.

We estimate that the number of houses put together with these kits exceeds 100 houses per month; this figure does not include additions to built houses nor individual components in the case of long-term construction.

**OBJECTIVE**

Our analysis of the branch of activity which sells the pine kits aims to demonstrate the degree of self-buildingness, the suitability of the construction systems, as well as the proposed method of production. Furthermore, this work intends to identify the developers who oversee the production process, expose their interests and explain the low-income self-building project's lack of success.

**METHODOLOGY**

According to Abiko et. al. (1996), we can define "self-building" as the characteristic of a project, component, construction process or system that qualifies it to be built by one's self. Self-building may be defined by a few basic principles. The more these principles are adhered to, the greater the degree of self-buildingness, that is to say, the easier it is to self-build.

We divided the methodology for analyzing the low-income housing pine kits sold in the greater Florianópolis region into two stages: 1.) Identifying the branch of activity and the developers involved in the housing production process and 2.) Analyzing the construction system with respect to its ease of assembly by collecting the necessary data from the companies furnishing the material and from the inhabitants building their own houses.

We collected the data through the use of questionnaires based on the Self-building Principles (Abico et. al. 1996). The author's eight principles are: 1) community adoption; 2) the use of unskilled labor; 3) market supply; 4) machinery and tools; 5) component design; 6) ease of assembly; 7) flexibility and modular coordination; and 8) participation of family members.

**RESULTS ACHIEVED AND STAGES DEVELOPED**

We collected data from 6 companies that sell the low-income housing pine kits and 12 inhabitants who built their own houses in the greater Florianópolis region using this system.

The construction systems the companies adopted for selling the pine kits are quite similar and can be understood in general aspects in Figure 1. The foundation is made on dense masonry piers (1) which support the first (2) and second joists (3). The floor (4) and the structural system, which is composed of studs (5) and beams (6), are attached to the joists. The outside walls are made from boards (7) which are also supported by an intermediary beam (8) and attached externally with battens (9). The doors (10) and windows (11) are placed in the open spaces in the boards.

The gable roof, made from ceramic tiles, consists of horizontal pieces which rest on the external walls through the use of upper beams, purlins, rafters and slats. When corrugated fiberglass is used, they are attached to the sloped rafteres (12) which rest directly on the upper beams and the interior partitions. When room panelling is installed, it is attached to the
Before the wood components, some companies deliver the kits with tiles for the bathroom (13) and with roofing materials. (For more details, see Figure 2 and Figure 3)

**Figure 1** - Perspective of constructive system adopted by companies for social housing in Pine (Pinus spp)

With respect to the principles of self-buildingness, we classified the kits in the following manner:

**Community Adoption by the Selfbuilders**
Community adoption of the construction system is important for the selfbuilder and his community to understand and accept it. Acceptance of the processes, systems and components aids in the apprenticeship, results in successful completion of the project and increases the system's dependability.
All of these aspects improve the quality of the finished product. Among the selfbuilders we interviewed, 83% had previously lived in wooden houses, 91% were already familiar with the construction system they chose to purchase and 100% trust in the system. Furthermore, 91% of the inhabitants believe they made no errors while assembling the kits.

Although the principle was adhered to, there is no direct influence of community adoption on the quality of the finished product.

**The Use of Unskilled Labor**

Most of the selfbuilders build their houses with skills they picked up by watching others build theirs. The selfbuilder builds his house during his free-time and has no time to receive training; repetition is the only training that exists.

Among the selfbuilders interviewed, none has family members with specific carpentry knowledge but 58% have some prior experience in wood construction. With regard to the sale of the kits, only 40% of the companies label the individual component pieces.

Only 33% of those interviewed hired skilled laborers for any type of activity. Two of the kits studied had the help of a non-paid carpenter, and only one kit buyer contracted an electrician and a plumber to make installations.

Despite the fact that the construction system does not require any difficult tasks, none of the companies has a assembly manual which gives step-by-step instructions for the kit. Because carpentry services were executed by skilled laborers, we consider that the principle was not adhered to.

**Market Supply**

The selfbuilder usually uses systems which are well-known in his area, not only because they have already been adopted by the community, but also because they are available on the market. Since one of the characteristics of self-building construction is its capacity to evolve, the market availability of the material must be guaranteed until the project has been completed.

All of the construction systems produced by the companies are very similar; this makes it easy to obtain components from any company that sells these kits. All of the companies supply the necessary components for any type of change, addition or maintenance: planks, battens, purlins, rafters, slats and beams. Doors and windows are supplied by only 40% of the companies interviewed.

The selfbuilders’ choice of companies is divided in the following manner: 58% of the selfbuilders researched the market looking for the cheapest prices, 22% chose a particular company based on the ease of construction of the system, 10% based their decision on the location of the company and 4% made their choice based on word of mouth.

70% of the selfbuilders chose to build with wood because of the price, 12% because of how fast they could assemble the structure and the other 18% chose wood because they were looking for something temporary or because of cultural factors.

We consider the principle to have been adhered to.

**The Non-Requirement of Machinery and Tools**

The equipment necessary for self-building construction must be simple and readily available. The use of sophisticated machinery would make self-building construction more costly, and therefore unfeasible.

Assembling the kits does not require machinery or special tools. Among those interviewed, 100% used simple tools such as hammers, measuring tapes, squares, pencils and plumb bobs. To make the precision length cuts in the pieces, 58% used a hand-saw.

While assembling any wood construction system, one must verify that the components are level. In order to do this, 8% of the selfbuilders used an air (or spirit) level and 9% used a hose. In the rest of the buildings no tests were made to check how level the houses were.

To streamline the production, some of the interviewees used electric powered tools: 8% used a plane, 16% used a drill,
33% used a portable circular saw and 9% a jigsaw.

One-fourth of the selfbuilders used a screwdriver to drive the screws rather than using nails, since they thought that certain components, especially the beams used to attach the flooring, would be sturdier.

Despite the fact that no company supplied any type of information regarding what type of tool should be used, we consider the principle to have been adhered to.

**Component Design**
Because no special tools are used, all of the self-building construction is done manually. Thus, the components must be light-weight in order to make assembling the house easy. For the employed selfbuilder, completing his house means taking on a second job. Therefore, the components should be light-weight in order to make assembling the house easy, thereby saving time and effort.

For 91% of those interviewed, the weight and size of the components were easy to handle and 41% of the selfbuilders counted on the help of their wives and children to transport the pieces.

80% of the companies considered the weight and size of the components easy to handle and all of them believed that a two-person team (a carpenter and an assistant) is enough to put the house together.

We consider the principle to have been adhered to.

**Ease of Assembly**
The question of being over-worked coupled with lack of construction experience can material waste or delays in the work schedule. For these reasons, it is important that the construction system is easy to assemble, thereby avoiding errors and improving the quality of the finished product.

More than one-third of the selfbuilders encountered problems while assembling the kits. These difficulties are linked mainly to the location of the foundation, the placement of the beams and the roof structure. Although none of the companies deliver components that are pre-cut, 60% of the companies considered the kits easy to assemble.

Only 40% of the companies included a floor plan in the kit for its customers and none of the companies have completed details. All of the selfbuilders begin assembling the kit without the completed details of the house.

Among the selfbuilders, 91% said that they did not waste any materials while assembling the kit and they claimed not to have made any serious errors, in other words, did not waste any piece or component. 50% of them found it easy to assemble, 41% thought it was fairly difficult and 9% considered it difficult.

We consider that this principle was not adhered to since 60% of the companies admit that their kits were not intended to be self-built. Furthermore, many problems were encountered in the field during assembly and the productivity level was low among the selfbuilders who used conventional technology.

**Flexibility and Modular Coordination**
The flexibility of the systems for self-building construction is very important since most of the dwellings are made one room at a time and the spaces may be used for a variety of functions, depending on the demands the inhabitants face in their everyday lives. The modular coordination of the construction system allows the selfbuilder to build a house that is within his means, that is to say, one room at a time. Furthermore, the modular coordination streamlines the system, thereby avoiding material waste and making it easier to assemble.

The construction system sold by the companies actually does offer many different floor plans, but the components don't fit together properly, thereby compromising the quality of the finished product. This is evident in the number of errors found in the interfaces between the exterior walls and the door frames and sashes, the exterior walls and the flooring, the exterior walls and the roof structures.

Since adding on to the houses built from the kits does not compromise the structure of the units, it is easy to make additions and improvements. The companies said that they are not concerned with the modulation of the system; this lack
of concern makes it difficult for the selfbuilders to use components that are already available on the market, particularly doors and windows. Because the components that are available on the market do not have standardized measurements, problems can occur when replacing parts or when making additions.

Upon completing the project, 41% of the selfbuilders said that the floor plan did not meet their needs because the rooms were too small and the lay out was inadequate for the type of furniture and household appliances, including gas stoves, that they have.

Thus, 83% made or intend to make changes in their houses by increasing the number of rooms and the size of the living room. To make these changes, 58% opted for wood. Other common changes which we noted are: walls in the kitchen and laundry room were replaced by brick walls; garages were built; and panelling was installed in the bedrooms and living rooms.

We consider that this principle was not adhered to.

Participation of Family Members

It is common for all family members to participate in most self-building construction projects. Thus the systems and the components must take into consideration the physical limitations of women, children and the elderly.

Most of the assembly tasks which do not require the use of tools were performed by women and children. As 83% of the selfbuilders said that the kit had no heavy components, we found that seniors (over the age of 60), women and children did in fact participate in assembling 75% of the houses studied. Although no women worked on the entire assembly of a kit, they did participate by carrying tools and components, painting the house and cleaning up in 33% of the work sites.

Furthermore, 100% of the selfbuilders relied on the help of friends or relatives who do not live in the house. The assembly teams are composed in the following manner: men, whose average age is 35 years, women, whose average age is 32 years, and with an average of 3.5 helpers.

We consider that this principle was adhered to.

CONCLUSION

The existence of this branch of activity in the region studied is due in large part to the large number of forest reserves in the State of Santa Catarina, as well as to the cultural acceptance on the part of the local population of using wood as a building material. As an alternative to paying rent and as a means of tackling the housing shortage problem in a quick and inexpensive manner, the population purchases the kits and builds its own houses.

Regarding the self-building principles, five of them were adhered to. However, the fact that the kits were judged to have a degree of self-buildingness does not express the poor quality of the finished product. The buildings are precarious from the point of view of how well reforestation wood is used, and the methods for producing housing through a self-building system are inadequate. All of the kits studied have construction problems which result not only from the way they are assembled, but also from the design of the system, which is not very well developed.

The companies which sell the kits are involved in the housing production process only for profit, with no concern for the quality of the finished product. The dwellings produced are of very poor quality due to the types of designs that are implemented, the level of processing of the components, pieces that are not weather-proofed or otherwise treated and the lack of technical support given during the construction process. All of these factors give the dwelling a temporary quality. Furthermore, they cause structural, acoustic and heating problems, make it difficult to create additions, lower the quality of the project and make the house less livable.

This attitude promotes a negative use of wood, depreciates its value and contributes to perpetuating the use of wood in alternative or temporary structures. Despite their knowledge of the quality of the dwellings, the companies claim to have only financial interests and promise to keep the product on the market as long as it is possible to sell other wood kits from the north of Brazil, particularly the Amazon. Although the price is higher, the wood from those kits does not need to be treated, since it is more resistant, and it is a good option for those who can afford to pay a bit more, according to the owners.
Despite the negative aspects, the development of local workmanship should be an encouraged practice for the growth of the local economy and for improving the technical skills of the community. In this sense, having universities work with these private wood manufacturing companies, and having the universities intervene during the construction process and the various stages of production, could improve the quality of the finished dwellings.

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*Figure 2* – Interior aspect of a house during self-building process

*Figure 3* – Outside view of a 30 m² house near completion