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Analysis of the Perception of Users of Pre-hospital Architecture in Light Steel Frame: A Case Study in Minas Gerais, Brazil

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Abstract: The quality of many physical spaces can be achieved from the use of a flexible architecture. Understanding whether such a building has acceptable comfort conditions, adequate division of its internal spaces, efficiency of functionality, can be possible by consulting its own users/employees, analyzing and considering one of the basic concepts for architectural spatial design: people and environments are inseparable and cannot be thought out separately. Therefore, the purpose of this case study is to analyze the perception of users and managers of three USP (Unidades de Saúde Públicas) (Public Health Units), built in the LSF (Light Steel Framing) system, in relation to the built environment and thus contribute to a reflection on health care architecture based on identified gaps. These Public Health Units in LSF are located in 3 (three) different cities in the interior of the state of Minas Gerais, in the southeastern region of Brazil. To this end, the development of the work is carried out through on-site interviews with users and managers. The answers of the questionnaires are analyzed with the help of the software SPSS (Statistical Package for the Social Sciences), version 19.0. The results show that the buildings present project inadequacies related to the performance of self-supporting closures, extensive to the presence of cracks and infiltrations and to some aspects related to environmental comfort. However, the hospital architecture produced with the LSF can allow flexibility, modifications and probably possible solutions to these issues.

Key words: Hospital architecture, Public Health Units, LSF, flexibility of spaces.

1. Introduction

The need to optimize the use of buildings appears in all sectors of social life, such as: health, education, culture, among others [1]. In developed countries, the LSF (Light Steel Framing) constructive system is widely used in different architectural typologies. It consists of cold formed galvanized steel profiles, whose mechanical performance is satisfactory, besides presenting acceptable durability and aesthetic standard in the civil construction scenario; in terms of cost/benefit, in relation to the other structural systems designed in steel, it offers real advantages [2].

The LSF constructive system is characterized by being composed of lightweight profiles, disposed in a submultiple structural modulation of the dimensions of the plates that make the panels closures and in an integrated way produce self-supporting elements that support walls, floors and roofs. This construction system has the particularity of being formed, basically, by steel bars called (i-beams and columns), by thermal, acoustic and waterproofing insulation materials, as well as by closure plates of the external and internal walls of the building, electrical installations, hydro sanitaries, among others, which work together [3]. Considering a broader view of the concept, for Freitas and Crasto [4] and Mcleod [5], the LSF construction system is not just about the structural system of the building, but also consists of several components and

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varied subsystems. Its execution and assembly, stand out for using standardized products with technologies, which are submitted to a strict quality control to achieve rationalization in the construction.

Currently, the use of industrialized and rationalized constructions, such as the LSF, is increasingly present in North American countries, in such a way as to replace artisanal construction, in conventional masonry and concrete—traditionally used, which provides greater ease of production, with significant reduction of waste and labor, being able to use faster cycle times [6].

The use of LSF as a constructive system for public works has been growing in the national scenario, given the need to accelerate the execution of new public buildings, which comes to attend the various demands of civil society. Thus, in this research, the LSF, which begins to become popularized, is seen as one of the viable alternatives for solving these problems.

Public work is understood to be that building, destined to play a role in attending the needs of civil society. And the health care services are highlighted as one among this need. [7]. Regarding this aspect, the case study of this research, is the hospital architecture designed to attend these services.

In national public works, the use of LSF as a constructive method is primarily due to government investments. Examples of public works in the health system can be cited as the UBS (Unidades Básicas de Saúde) (Basic Health Units) and UPA (Unidades de Pronto Atendimento) (Emergency Care Units), object of this work. However, it is noted that specific information for the application of the LSF in the sanitary hospital architecture in the country is scarce, especially with the focus on the perception of the permanent user.

According to Lima [8] it is essential that, regardless of its technological complexity, the hospital building reflects concerns with all the essential values that define a work of architecture. When it comes to architecture for health care establishments, it is necessary that proposed spaces are flexible, extensive and manageable. This project need does not depend on the size of the sanitary building, as well as the complexity of the clinical cases that they are apt to receive.

Thus, Emamgholi [9] estimates that an environment, to be considered flexible, must enable the existence of a dynamic space that meets the needs of its users, creating conditions for a good level of satisfaction. The author believes that flexibility includes portable devices, easy displacement and multipurpose performance. Such flexibility can be given both by the internal and external components of the building structure. In both architecture and environmental design, flexibility can be described as the ability to change and reorganize the constructed environment in order to adapt it to new requirements [10].

Alkhansari [11] presents eight main elements that configure flexibility in architecture: 1—open plan, which considers only the structure as fixed, being mutable all other elements; 2—prefabricated modules, with industrial solutions that make the architecture portable; 3—similar spaces, which contain rooms with almost similar distribution and access; 4—extensible unit, possibility of expansion of the building horizontally or vertically; 5—attachment or separation of adjacent units, which usually occurs in residential apartments with removal or placement of partition walls; 6—common spaces between adjacent units, which allow the creation of free spaces that can be shared by two buildings; 7—portable walls that allow mixing or dividing spaces; and, finally, 8—retractable furniture in a multifunctional environment that increases the condition of diversity of possible functions of the space.

Kronenburg [12] in turn, describes flexible architecture as a fluid architecture that becomes complete when people inhabit and use it and establishes four key factors that characterize it: adaptation, mobility, transformation and interaction.

Adaptation in architecture indicates that change is inevitable, and that structure is the most important element for this change to happen. As for mobility, it refers to buildings that can be physically transferred from place. Transformation, as being an aspect of architecture in which a building has the capacity to interact with the external environment and respond to climatic situations and the interaction happen when the architecture is able to perform an interaction between building, people and furniture. Buildings interact when they respond to user requirements automatically or intuitively, and when people become participants instead of space observers.

On this path, for Anas, Safiullah and Nisar [13], the LSF adds other factors that have transformed the architecture into something mobile, adaptable and transformable. According to these authors, today with the availability of light steel, screwable elements etc., which help to provide steel structures easily mountable and demountable, and in a simplified way, help to stabilize the constructive system, contemporary architects are trying to adopt these existing constructive systems in their projects.

At another moment Kronenburg [12] defines flexible architecture as a term used to describe buildings designed to easily respond to changes throughout their useful lifetime. The benefits of flexible architecture are considerable: it remains in use for longer, fits better to its purpose, allows optimizing services using user's experience and intervention, takes advantage of technical innovation more promptly and is economically and ecologically more viable. It is common sense knowledge that the concept of flexibility in architecture is present in contemporary buildings, being well received in project proposals, of small, medium and large size [14].

According to Acharya [15], the flexible architecture aims to meet the needs of present time, with its specific reality of time, such as social, cultural, political and environmental issues. It also tries to boost architecture for the use of a more efficient and sustainable cultural product for a dynamic society. Buildings can remain in use for longer. By changing the activities offered by the adaptive space, they could best suit to its purpose.

Many have been and still are the policies developed to improve the public health system. The UPA (Emergency Care Units) are, by definition, government health establishments, created to receive clinical cases of intermediate complexity between the UBS (Basic Health Unities) and the hospital network, "[...] with which they must form an organized network of emergency care. These buildings were termed as pre-hospital" [16].

The idea of the Rede de Urgências (Emergency Network) comes from the intention of making health services available to the population, closer to where they live [17]. The UPAs operate over 24 hours, seven days a week. They offer a structure, where x-ray exams, electrocardiogram, pediatric care, some laboratory tests can be performed and they have observation beds [18]. Therefore, focusing on the flexibility of the LSF applied to the fluid architecture of the UPA (Emergency Care Units), object of this case study, the proposal of this study consists of the identification and analysis of the gaps presented by permanent users in the space, through applied questionnaires, as also considering the results of the descriptive statistical analysis, based on a methodological strategy that seeks to conciliate described approaches, taking into account the general objective of this work, which is to obtain information to propose qualification of the rational and industrialized construction system LSF as a possible source of applicability in hospital buildings.

2. Methodology

The development of the work encompasses a case study and uses the application of questionnaires with users to collect data. To do so, 3 (three) public health units were chosen, located in 3 (three) different cities: Pitangui, Divinópolis and Pará de Minas, in the

interior of the state of Minas Gerais, in the southeastern region of Brazil. It is worth noting that the location of the object of study, in municipalities of the interior, is a proposal of the Government of the State of Minas Gerais, therefore, does not contemplate the implementation of these in the Capital.

These pre-hospital units have different sizes, that is, varied square footage, but considering the same aspects: minimum physical-functional program, architectural typology and the construction system structure. The health units are identified as US1 located in the city of Pitangui with 518.89 m², US2 in Pará de Minas[1] with 1,650.00 m² and US3 located in Divinópolis with 1,231.00 m².

The research universe of this work included the users/employees of the health units under study, with special emphasis on those with a long stay in space, of all sectors, in addition to the managers of these units, positioning them, in this work, as able to evaluate the environment (Table 1). The units operate for twenty-four hours, seven days a week: therefore, the questionnaires were applied in alternate shifts, in order to cover all shifts.

The interviews were conducted personally by the author, with employees who develop activities in the most diverse areas and sectors of Public Health buildings, from November 2018 to February 2019, under the evaluation of the Ethics Council of the Federal University of Ouro Preto, complying with the criteria established by Plataforma Brasil.

The collected data, presented in the analysis of the results, are treated statistically, including the calculation of absolute and relative frequencies, with the aid of the SPSS (Statistical Package for the Social Sciences) software, version 19.0.

3. Analysis and Discussion of Results

The statistical analysis contemplated the calculation of absolute and relative frequencies with the help of the SPSS software, version 19.0. In the first analysis, the users/employees of the Health Units under study were asked about their direct contact with buildings that use the LSF as a construction system. Fig. 1 shows the analysis of the answers to this question, which allows noting that 66.3% of the employees/users reported that they do not know it. Of these, 26.6% reported to have had contact with hospital buildings, 8% with public buildings, 4% with commercial buildings, 4% with industrial buildings and 4% with institutional buildings.

As in Table 2, it is described the evaluation of employees regarding the aspects of comfort and building functionality. It can be noticed that most of the employees evaluated as good or great the divisions of their internal space, the size of their rooms, the natural lighting, the solar incidence and the noise level inside the building. In this analysis, the aspects of the building that obtained the best evaluation (good or great) were natural lighting 54.7% and 21.3% evaluated it as good or great, respectively, and the solar incidence 47.9% and 20.5% evaluated it as good or great, respectively. The aspects of the building with the highest proportion of negative evaluation (insufficient or regular) were the internal air circulation (36.0% and 17.3% assessed it as regular or insufficient, respectively) and thermal comfort conditions (28.8% and 23.2% assessed it as good or great, respectively).

The research also approached the acoustic comfort of the health units, in such a way that when the target audience was asked about which noise in the workplace bothered them most, 39.7% of the employees/users reported the absence of noise or the fact that they were not bothered by any type of noise, while 22.4% and 12.1% mentioned that they were bothered by the noise coming from the reception through exaggerated verbal communication between users, as well as the sound of some apparatus, or even the air conditioner and power generator, respectively.

The quality of the walls of the health care establishments was also an important factor to be analyzed in this study. Thus, in Figs. 2 and 3 it shows

[1] Available in Brasil, 2013. Accessed in December 2018.

Table 1 Sample.

	US1	US2	US3	Total
Users/employees	14	26	35	75
Managers	1	1	1	3

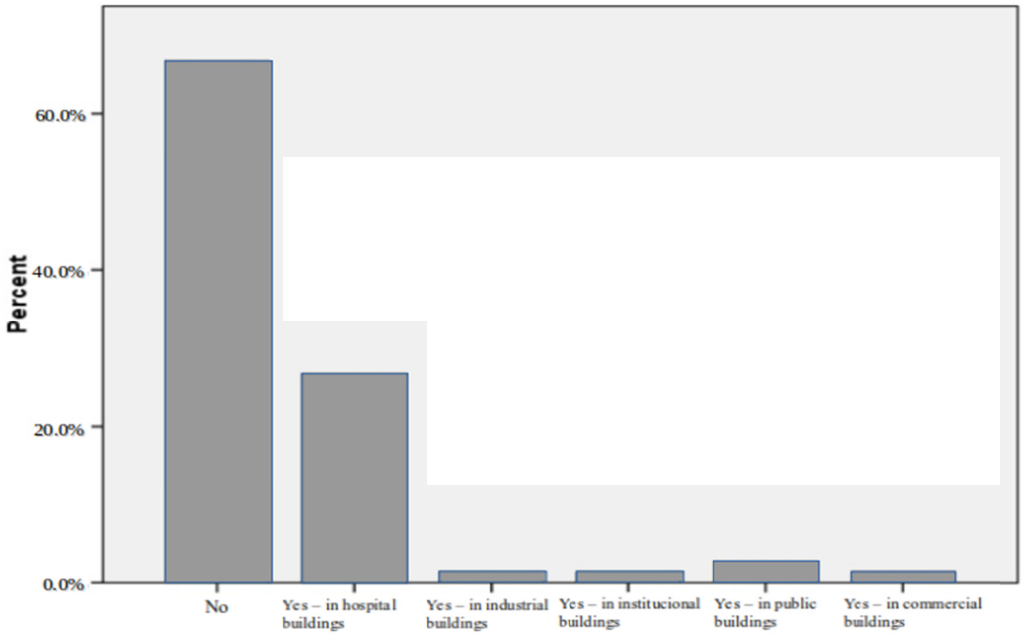

Fig. 1 Evaluation of employee contact with the LSF.

Table 2 Evaluation of employees as to the aspects of the building.

Building aspects	Evaluation (%)			
	Insufficient	Regular	Good	Great
Internal space divisions	16.0	33.3	32.0	18.7
Room size	20.0	25.3	32.0	22.7
Natural lighting	5.3	18.7	54.7	21.3
Internal air circulation	17.3	36.0	32.0	14.7
Solar incidence	12.3	19.3	47.9	20.5
Thermal comfort	28.8	23.2	32.9	15.1
Interior noise level	9.5	35.1	33.8	21.6

that the majority of employees 70.6% evaluated the quality of the walls of health units in relation to resistance as more or less 33.3% or very weak 37.3%. Regarding the perception of the ease of fixing light objects on the wall, 35.6% and 11.0% reported as difficult or with a certain degree of difficulty. As for the ease of fixing heavy objects on the wall, 42.7% and 12.0% evaluated it as difficult or with a certain degree of difficulty. Regarding participants perception of how they feel about the walls of the building, 40.0% and 17.3% reported to feel them as fragile and hollow, respectively.

Additionally, evaluations were carried out with the 3 (three) managers of the Health Units. This evaluation sought to cover the possibility of extensive and manageable sanitary spaces. In such a way that, the first factor to be analyzed was about the existence of reforms, all three managers claim that reforms have already been carried out in the hospital building; that most of the buildings environments do not have similar sizes; that there are cracks and infiltrations in the buildings. As for the safety of the building, they

mentioned that it is not safe against intrusion and theft and that the size of the rooms is compatible with the equipment used in the health units. In addition, they stated that they present different environmental perception of this physical space in relation to other health units in which they have worked. When approaching the need for preventive maintenance of these constructions, only managers of US3 and US1 stated that there is a need for a lot of maintenance in the unit, being the maintenance of the taps and doors as the most frequent. In the US3 unit the maintenance of plaster and infiltration is more frequent. On the other hand, the US1 unit manager states that the construction presents average maintenance problems, being that the maintenance workforce is specialized and that the size of the environments meets the needs of the patients. Only the manager of the US3 unit stated that there were expansions in the building and that there is preventive maintenance. As well, only the manager of the US1 unit reported that the conservation status of the hospital building and the closures (internal and external walls) is good. The other managers classified these items as regular.

It is believed that, from the experience of these occupants and managers, an evaluation of the environment built in LSF can be obtained, considering its performance in this study in hospital architecture.

According to the presented documentary survey and based on the descriptive statistical analysis of the questions directed to users and managers, Health Units have characteristics that link them to the idea of a flexible architecture, such as portable walls. The buildings have the capacity to be adaptable to the needs of its users in terms of their production (design and calculation) in LSF. There is a smooth connection between spaces, identified by Alkhansari [11], as the constructive system allows the closures/partitions to be dismantled and transferred to another more suitable space, to expand or reduce environments.

Regarding the division of its internal space and natural lighting, aspects criticized by the interviewees, however, for being considered as a flexible architecture, its capacity for transformation and adaptation should be explored to improve aspects related to thermal comfort and air circulation. The quality of a flexible architecture is also directly linked

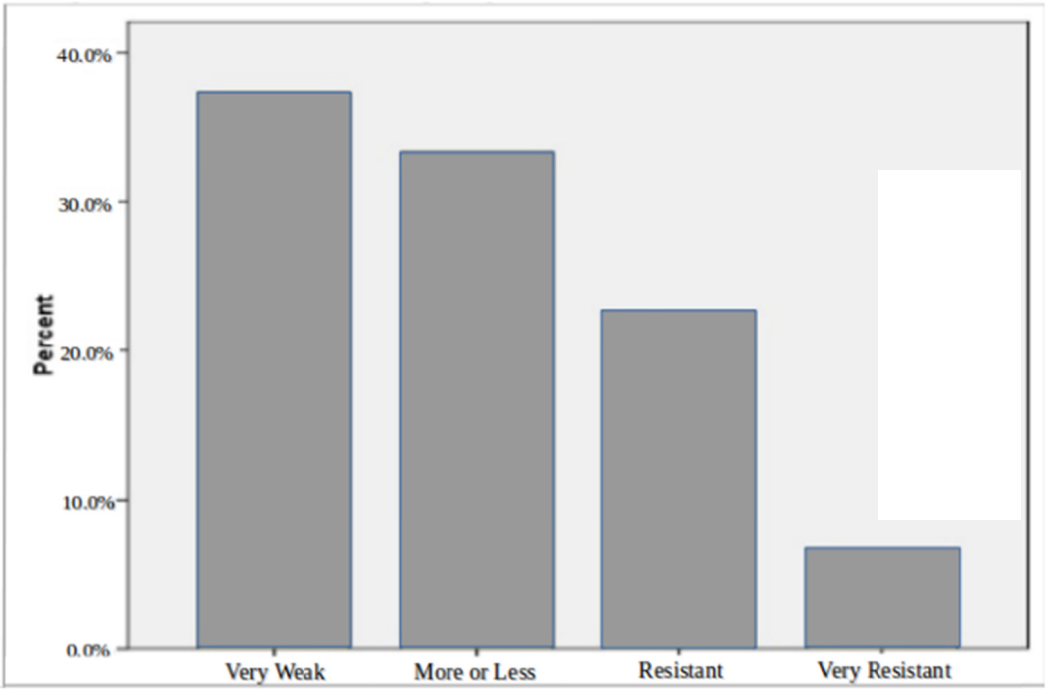

Fig. 2 Evaluation of the quality of the walls in relation to the resistance.

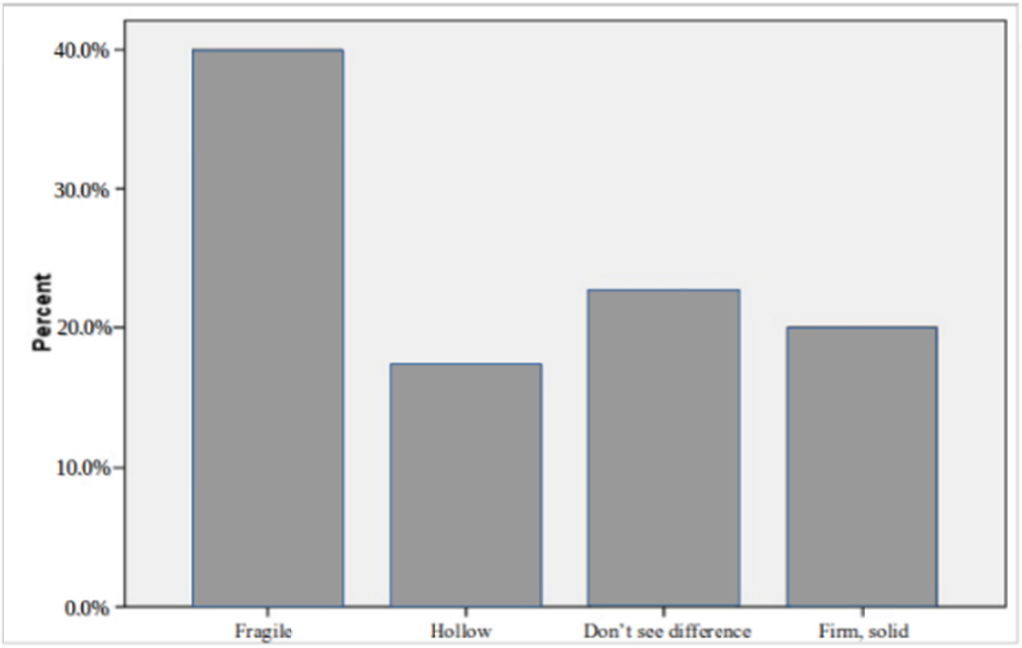

Fig. 3 Perception of users about how they feel in relation to the walls of the building.

to its adaptability capacity to better serve those who use it.

It is noted that, all of these issues are related to the spatial conception of the health units studied, end up saying, that they meet the needs of their users, taking into account the subject addressed so far.

In the case of public health buildings, they need to have a longer useful life and the construction in LSF seems quite pertinent because it allows flexibility in architecture and, with this, gains as many other uses as necessary: today, in hospital architecture, tomorrow in educational typologies, leisure, administration buildings etc. Only flexible architecture would enable such diversity of adaptation.

4. Conclusion

This case study on the analysis and perception of the permanent user of the pre-hospital architecture allowed us to observe that most of the interviewees consider that the partitions/closures in LSF of the Health Units are fragile, hollow and not resistant. It is believed that this gap can be solved from the strict specification of thermal acoustic blankets and hydrofuges in all of the closures of hospital architecture in Brazil, a practice seldom used by professionals of the sector today. Therefore, these materials can complete the performance of the LSF, providing environmental comfort, eliminating moisture at the closure, as well as causing a feeling of resistance of the walls, other faults are also identified in reports of the research participants.

Moreover, through this study it was possible to perceive a potential of flexible spaces, through the use of LSF, in order to enrich the solutions for the architecture of health environments with functional ideas and viability of using new constructive technologies in the country. Therefore, it is exactly the concept of portable walls that makes it possible to increase or reduce an environment as needed, which makes this architecture flexible.

However, the cracks presented as constructive pathologies by managers highlight the urgency of improving the quality of industrialized construction. In such a way, construction professionals, that is, architects, engineers and assemblers need to learn about the performance of the LSF, especially in aspect of the treatment of joints of the boards, considering the interference of the horizontal displacement of the

system.

Thus, it is believed that it is possible to conceive a more accurate hospital architecture in face of the primordial and inevitable values to which it proposes suggesting the use of the LSF.

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