Method for assessing of sustainability of habitations of social interest (MASP-HIS)

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Abstract— **The main purpose of this work is to present for the first time the method entitled Method for Assessing the Sustainability of Habitations of Social Interest (MASP-HIS). This method has been developed in order to analyze the sustainability of habitations of social interest, applied to specifications of materials and components for vertical sealing subsystems. This method calculates indices of sustainability at the phase of the design of habitations of social interest, related to specifications of materials and components, when one refers to the environmental, economic and socio-cultural aspects. Through the method, it is possible to have partial indices, for each one of the aspects, or the index of design when the aspects are set together, for various combinations of materials and components of the analyzed subsystem. The partial indices can be used to detect and solve critical points of design, related to such specifications, once low partial indices indicate low sustainability. This can be verified at the end of this paper, by the results obtained from the application of the method to two designs developed in the Midwest region of Brazil.**

Index Term— **Sustainability, Specification of Materials and Components, Habitation of Social Interest.**

I. Introduction

The study of sustainability is justified due to the possibility that future generations of the world would face the impacts of continued exploitation of natural resources. In order to control this exploitation, various preventive actions are required, such as those related to the construction of habitations of social interest. Among such actions, one can include the solution for the housing deficit, using the principles of sustainable construction, and the development of guidelines and methodological basis for assessing the sustainable performance of design for habitations of social interest.

These, in turn, allow the creation of benchmarks for the push for more sustainable design and construction, and also allow one to encourage the specification of materials based on the generated impacts. Thus, it attempts to reduce burdens that impact and alter the quality of life on Earth at local, regional and global levels.

Other important sustainability preventive actions can be mentioned, such as analysis of the life cycle of the built environment, reform and replacement of components and subsystems of buildings, reduction of waste generated at construction sites, and reuse or recycling of construction, industrial and agricultural waste in the constructive process.

The design decisions related to these actions can improve the quality of the buildings, with direct implications for health, comfort, satisfaction and use of energy. In this way, it can increase the sustainability of habitations of social interest.

Thus, it is important that the design be environmentally friendly, socially effective, economically feasible and culturally accepted. In this context, it is necessary to specify the materials and components of the constructive elements, using various combinations of materials, such as different types of bricks, mortars and coatings, which are used in the habitations of social interest.

Through an assessing method, one can establish integrated practices for the developing of designs, promoting discussions among the involved agents. It is also possible to recognize sustainable initiatives in the construction industry, as well as to raise awareness among the consumers to the benefits of sustainable buildings. Moreover, a good method to assess sustainability allows one to identify sources of impacts and techniques to eliminate their causes or minimize them before they are generated. It also allows the choice of low-cost options, when the life cycle of the building is considered.

In this sense, and seeking to integrate the principles of sustainability in designs of habitations of social interest, the main purpose of this work is to present a new method (called "Method for Assessing the Sustainability of Habitations of Social Interest – MASP-HIS”) that, based on sustainability indicators and indices, provides results which indicate specifications of materials and components for habitations of social interest, when one refers to the environmental, socio-cultural and economic aspects.

The first element of design chosen to be analyzed by the proposed method is the vertical sealing subsystem. There are several reasons to choose this element [1]: it uses approximately 20% of the material (in mass) used in the habitation; it has potential to generate waste and large loss[1]; it is subject to frequent innovations and rationalization of the production processes; the materials and components used on it generate, in their production, environmental, socio-cultural and economical impacts; it impacts it the planning and scheduling of execution; it has great participations in the performance of the building, related to thermal and acoustic comfort, for instance; it has a deep relationship with the occurrence of pathological problems; it is, in many cases, the main structure of the building; and it represents, according to [2], around 20% of the total cost of a habitation of social interest.

[1] According to research in Brazil the losses are around 15%.

To validate the MASP-HIS method, it has been applied to two designs, by a computational tool called PROMASP-HIS, which has been developed in order to output indices of sustainability for constructive elements, from specifications of materials and components of designs of habitation of social interest, as it is foreseen in the conceptual framework of the method.

II. DISCUSSION

The method for assessing the sustainability of designs proposed herein (MASP-HIS) has special significance nowadays, like one can see in several works in the present literature, related to the same subject.

According to [3], measures taken in the design phase, related to the principles of sustainability, aiming to reduce environmental impact, can decrease costs, especially at the time of the use of the building.

For [4],[5] and [6], the way in which buildings are designed, built and operated influences directly on the consumption of natural resources, comfort and health of the people which use them. In this sense, it appears to be possible to achieve sustainable construction if clear and objective parameters and criteria of performance of buildings are established, for design, construction, operation and maintenance. These performance parameters make it possible to have habitations of social interest that are capable of saving energy and water, to reduce waste at construction sites, to promote welfare of the users and to decrease the costs of the edification's cycle of life, among others [7].

In addition, the formalization of a method for assessing the sustainability of buildings from their designs enables that the sustainability measures be established for relevant requirements to the context of the region of interest. This makes the concept of sustainable buildings more objective, once it creates a set of standards to measure the characteristics related to the designs at specific places [8].

Following this way, the MASP-HIS method takes a step forward, once it takes into account, besides the environmental, economic and socio-cultural aspects of sustainability, the specifications and components of the constructive systems of a building.

At the stage presented in this article, only the vertical sealing subsystem has been implemented in the PROMASP-HIS computational program in order to perform the calculations of the sustainability of designs, according to the conceptual precepts of the MASP-HIS method. However, this method can be used to analyze other subsystems of a building, provided that the specificities of each one be implemented.

Unfortunately, it was not possible to locate at the present literature similar analysis to that presented herein, which take into account the specifications of materials and components of the constructive subsystems, in a sustainability analysis which includes environmental, economic and socio-cultural aspects. Hence, there are no comparative results to others methods in this work.

III. DESCRIPTION OF THE MASP –HIS METHOD

The MASP-HIS method has been developed to assist in specification of materials and components for constructive subsystems of buildings, seeking those materials that cause minor environmental, socio-cultural and economic impacts. The computer program PROMASP-HIS, based on conceptual framework of the method, provides indices of sustainability that take into account different combinations of materials and components of the constructive subsystems analyzed.

In this article, the vertical sealing subsystem, which is composed by blocks or bricks, seating and coating mortar, is analyzed specifically.

3.1 Index of Environmental Sustainability of the Vertical Sealing Subsystem

The index of environmental sustainability of the vertical sealing subsystem is obtained from the indices of sustainability of its components, which are: ceramic block, concrete block, brick soil-cement, seating mortar and coating mortar. First the indices are calculated for each component, and later the index of the most sustainable combination among five combinations of components established is obtained.

3.3.1 Energy Incorporated in Production (EI)

The partial index related to the energy incorporated (EI) in production of components of the masonry is obtained from the normalization between the component with lowest consumption of energy [9] (E_{min}) and the other i components with higher consumption of energy (E_i) in production, according to equation 1:

$$EI_i = \frac{E_{\min}}{E_i} 100 \quad (1)$$

It is assumed that the higher is the consumption of energy in production, the less sustainable is the material.

3.1.1.2 Energy Incorporated in Transport (EIt)

(1)

The partial index of the energy incorporated in transport takes into account the energetic index and the energy spent in the transport of the components, related directly to the distance traveled. This index is calculated like equation 1[2], adding the sub-index *t* to its variables. It is assumed that the higher is the consumption of energy in transport, the less sustainable is the material.

[2] From here forward the equations of the partial indices are not more presented, once they are very similar to the equation 1.

3.1.1.3 Emissions of CO_2 Generated in Producion (ECO_2)

This partial index is obtained by the normalization between the material with lowest emission of CO_2 and the other *i* materials with more emission of CO_2 generated in their production. It is assumed that the greater is the emission of CO_2 generated in production, the less sustainable is the material.

3.1.1.4 Emission of CO_2 Generated in transport (ECO_{2t})

Now, it is considered the amount of mass of the transported material, the amount of emission of CO_2 generated per kilometer and the distance traveled from its production to the site of construction. It is assumed that the higher is the emissions of CO_2 generated in transport, the less sustainable is the material.

3.1.1.5 Potential for Recyclability (PR)

Regarding to the potential for recyclability, this information for each material has been stored in the database of the PROMASP-HIS program, as YES or NO, if there is or there is not potential for recyclability, respectively. If there is not potential for recyclability, the index of sustainability is zero. If there is such potential, it is calculated by the normalization between the material with most quantity of mass and the other *i* materials with lesser mass. It is assumed that the greater is the amount of mass of the material used in a square meter of mansory, the greater is its potential for recyclability and the more sustainable is the material.

3.1.1.6 Incorporated Recycled Materials (MI)

The components of the vertical sealing subsystem can have recycled materials in their composition. This information shall be given to the program PROMASP-HIS, through the answers YES or NO. If there is not incorporated recycled material, the index of sustainability *MI* is zero. If there is such material, the percentage of it is automatically considered by the program, once that information is in database of the program.

For instance, if the cement used in the concrete block is of the type CP IV, then the program will consider the value of 50% of incorporated recycled material, according to the technical standard [10]

It is assumed that the higher is the amount of incorporated recycled materials, the greater is the sustainability of the component.

3.1.1.7 Toxicity (TX)

The information about if there is or there is not toxicity in the materials has been stored in the database of the PROMASP-HIS program, like YES or NO, respectively. If the answer is YES, the respective index of sustainability is the smallest possible value: zero. If the material is not toxic, this partial index is calculated by the normalization between the material with least amount of mass and the other *i* materials with more mass. It is assumed that the smaller is the amount of mass of the material used in a square meter of mansory, the less is its toxicity and the more sustainable is the material.

3.1.1.8 Abundance (A)

This item is related to the abundance in nature of the raw material used in the components of the vertical sealing subsystem. This information has been stored in the database of the PROMASP-HIS program, as YES or NO, as it is or it is not abundant in nature, respectively. The material is considered abundant if the distance from the deposits of raw material used in its production is lesser than 300 km to the site of production. If the material is not abundant, the respective index of sustainability is the smallest possible value: zero. When the component is abundant, this partial index is calculated by the normalization between the material with least amount of mass and the other *i* materials with more mass. It is assumed that the lower is the amount of mass of the material used in a square meter of mansory, the greater is its abundance and the grater is the sustainability of the material.

3.1.1.9 Indices of Environmental Sustainability of the Ceramic and Concrete blocks and Soil-cement Brick

The indices of sustainability of the ceramic and concrete blocks and soil-cement brick (ISA_{MAT}) are given by arithmetic mean of the partial indices EI, EI_t, ECO_2, ECO_{2t}, PR, MI, TX and A, for each one of that components.

In this stage, the index of environmental sustainability ISA_{MAT} is already normalized, and it will always present its values between 0 and 100, like the partial indices. This range allows a fast and easy visualization of the relative sustainability among the components involved in the analysis.

3.1.2 Index of Environment Sustainability of the Seating Mortar

The index of environment sustainability of the seating mortar (ISA_{SM}) encompasses the indices of the materials used in it, which are: cement, lime and sand. They are calculated in the same way as the calculations made for the blocks. However, there are some differences due to inherent particularities of the materials, such as:

a) the trace of the mortar (cement:lime:sand) is measured in mass and the comparative unit is the cubic meter;

b) the index of sustainability of the seating mortar is calculated in two steps: *i*) first each one of the variables EI, EI_t, ECO_2, ECO_{2t}, PR, MI, TX and A is calculated by the arithmetic mean relative to the cement, lime and sand, as it is the case of the energy incorporated in production (EI_{SM}), like equation 2.

$$EI_{SM} = \frac{EI_{cement} + EI_{\text{lime}} + EI_{sand}}{3} \tag{2}$$

ii) O finally it is calculated the index of sustainability of the seating mortar (ISA_{SM}) by equation 3;

$$ISA_{SM} = \frac{EI_{SM} + EI_{tSM} + ECO_{2SM} + ECO_{2tSM} + PR_{SM} + MI_{SM} + TX_{SM} + A_{SM}}{8} \tag{3}$$

c) the PROMASP-HIS program selects automatically the trace (cement:lime:sand) for the seating mortar, taking into account two types of blocks which can be used: ceramic block (1:2:8) and concrete block (1:0,5:8). However, the program is open for new materials and traces.

3.1.3 Index of Environmental Sustainability of the Coating Mortar

The MASP-HIS method has provision for two types of coating mortar: *i*) composed by spatterdash (cement;sand) and plaster (cement;lime;sand); and *ii*) composed only by plaster paste[3]. Hence, the index of environmental sustainability of the coating mortar is calculated by the arithmetic mean of the indices of the spatterdash and plaster, when these are the components of the coating mortar, or it is the index of the plaster paste, when this is the component of the coating mortar.

3.1.3.1 Index of Environmental Sustainability of the spatterdash

The index of sustainability of the spatterdash (ISA_S) is calculated in two steps: *i*) first each one of the variables EI, EI_t, ECO_2, ECO_{2t}, PR, MI, TX and A is calculated by the arithmetic mean relative to the cement and sand, as it is the case of the energy incorporated in production (EI_S), like equation 4.

$$EI_S = \frac{EI_{cement} + EI_{sand}}{2} \tag{4}$$

ii) finally it is calculated the index of sustainability of the spatterdash (ISA_S) by the arithmetic mean of those eight variables, in analogous way to the equation 3;

3.1.3.2 Index of Environmental Sustainability of the plaster

The index of environmental sustainability of the plaster is obtained in the same way as it has been done for the spatterdash. But, the materials now are cement, lime and sand, instead of only cement and sand.

3.1.3.3 Index of Environmental Sustainability of the plaster paste

The index of environmental sustainability of the plaster paste is obtained through the arithmetic mean of the variables EI, El_t, ECO_2, ECO_{2t}, PR, MI, TX and A related to this material.

3.1.4 Analysis of Environmental Sustainability of the Vertical Sealing Subsystem for Five Combinations of Components and Materials

[3] Gypsum.

After calculated the indices of environmental sustainability for each component of the vertical sealing subsystem, the indices of sustainability for five combinations of its components are calculated, according to figure 1. The goal is to obtain the best combination of components and materials, which gives the highest index of sustainability.

Fig 1

Thus, the index of environmental sustainability for each i combination that composes the vertical sealing subsystem, is the arithmetic mean of the indices of the components which belong to such combination.

3.2 Indices of Socio-cultural Sustainability of the Vertical Sealing Subsystem

According to the method proposed in this paper, the socio-cultural aspects of the vertical sealing subsystem are divided into three categories (I, J and K). These categories are, in turn, divided into subcategories, as shown in Figure 2. The subcategories are the socio-cultural indicators of the vertical sealing subsystem.

Fig 2

Themes[4] (questions) have been defined herein for each subcategory (indicator), which are likely to be answered YES, NO or NOT APPLICABLE, if the design includes or not the criteria established in them, or if the theme does not apply to the design, respectively. Thus, the socio-cultural indicators have been established by equation QS/QT, according to table 1, where QS is the sum of the answers YES and QT is the sum of the answers YES and NO to the themes related to their respective indicators. If the answer is NOT APPLICABLE, the theme is not considered. The method assumes that the higher the values of the indicators, the greater is the sustainability of the design in relation to the socio-cultural aspects, once the themes, when they are contemplated in the design, can give more sustainability to them.

Table 1

From the socio-cultural indicators, the indices of socio-cultural sustainability for the five combinations of components of the vertical sealing subsystem presented in figure 1 are calculated. Thus, the index of socio-cultural sustainability of each *i* combination is the arithmetic mean of values of the socio-cultural indicators of the components which belong to such combination.

3.3 Index of Economic Sustainability of the Vertical Sealing Subsystem

The index of economic sustainability of the vertical sealing subsystem takes into account the economic aspects related to the life cycle cost (LCC) of the materials and components

[4] For the subcategory "Participation" one of the questions is: "*were the specifications for the vertical sealing subsystem obtained from the participation of the users of the inhabitants*?" The complete list of themes can be found in the doctorate thesis of the author [1]

which belong to this subsystem. In order to calculate the LCC of the materials and components, it has been used herein the Present Value Method [11],[12]for a lifetime of 40 years, according to the Brazilian technical standard [13].

In this way, the total (or global) life cycle costs for each combination *i* of the vertical sealing subsystem, according to figure 1, take into account three parcels, according to equation 4

$$LCC = C_I + C_M + C_D \quad (4)$$

where C_I is the initial cost, *CM* is the maintenance cost and *CD* is the o deconstruction cost of the subsystem.

Thus, the index of economic sustainability of each *i* combination is the arithmetic mean of values of the LCC of the components which belong to such combination.

3.4 Index of Sustainability of the Design

The index of sustainability of the design (IS_{Dcombi}) for the specifications of materials and components of the vertical sealing subsystem, for each combination *i*, according to figure 1, is obtained by the arithmetic mean of the environmental, socio-cultural and economic sustainability indices.

IV. APLICATION OF THE MASP-HIS METHOD TO TWO DESIGNS DEVELOPED IN THE MIDWEST OF BRAZIL

Two designs of habitations of social interest developed in the Midwest region of Brazil have been used herein in order to validate the MASP-HIS method and the PROMASP- HIS program, for specifications of materials and components of the vertical sealing subsystem. The descriptions of these designs and the results of the analysis are presented below.

4.1 Design 1: standard-design for habitations of social interest located in the City of Goiânia/GO/ Brazil

This Design 1 is a standard-design for habitation of social interest located in the city of Goiania/GO/Brazil. The general characteristics of the design 1 are: a) the habitations are placed on public lands; b) the design does not change depending on the climatic characteristics, topography and geographical orientation (inflexibility); c) the constructed area of each habitation is 40,80 m^2; d) the land size belonging to each habitation is not uinque and depends on each set of habitations; and e) the habitations have five rooms (living room, kitchen, two bedrooms and bathroom).

4.2 Design 2: standard-design for habitation of social interest developed by the Habitat Brazil non-governmental organization, in the metropolitan region of Goiânia/GO/Brazil

The design 2 is a standard-design for habitation of social interest developed by the Habitat Brazil non-governmental organization, in the metropolitan region of Goiânia/GO/Brasil. The general characteristics of the design 2 are: a) the habitations are placed on public lands; b) the design does not change depending on the climatic characteristics, topography and geographical orientation (inflexibility); c) the constructed area of each habitation is 50 m^2; d) the land size belonging to each habitation is not unique and depends on each set of habitations; and e) the habitations have six rooms (living room, kitchen, two bedrooms, bathroom and a laundry area).

4.3 Analysis of results

4.3.1 – Indices of Environmental sustainability

The partial indices of sustainability relating to environmental aspects of the vertical sealing subsystem are presented in table 2, which provides a comparative analysis between the results of designs 1 and 2. It presents the partial indices related to the blocks (ceramic and concrete), the soil-cement brick, the seating mortar (traces 1:2:8 and 1:0,5:8) and the coating mortar - spatterdash (trace 1:3), plaster (trace 1:2:11) and plaster paste. It also shows the indices for the five combinations foreseen by the method, as shown in Figure 1.
Table 2
According to Table 2, all block types had good sustainability in relation to environmental aspects, with rated above 50, except the concrete block of the design 2, which rated 42.96. The highest index was that of the ceramic block of designs 1 and 2, which reached a value of 67.93. The seating mortar tended to be more sustainable when the trace was 1:2:8, which gave environmental sustainability indices close to 50. The spatterdash also presented good sustainability, which rated close to 55. The plaster, however, had its indices indicating low sustainability, whose highest value was 35.16. The differences between the indices of designs 1 and 2 occurred mainly due to transport distances of materials[5].
Through the analysis of the different combinations of materials, it appears that the best was combination 1 (ceramic block, seating mortar - trace 1:2:8, plaster - trace 1:2:11) in both designs 1 and 2, with 51.61 and 51.06 rates, respectively. The worst combination was the 4 one (concrete block, seating mortar - trace 1:0,5:8, plaster paste), whose values were 42.76 and 39.92, respectively. The environmental sustainability of combination 4 was lower than that of combination 1, mainly for the following reasons: a) presence of plaster paste among the components of the combination 4, once this material has been carried from a long distance, it is not recyclable when in contact with other material and does not have incorporated recycled materials, b) the ceramic block had greater sustainability than the concrete block in relation to various indices (incorporated energy, transport, CO_2 emissions in the production and transport, toxicity and abundance). Its indices are minor only when related to the potential for recyclability and incorporated recycled materials.
The combination 5 (soil-cement bricks, seating mortar - trace 1:2:8, plaster - trace 1:2:11) had its values very close and

[5] Mainly because of the EI_t index (Energy incorporated in transport).

below to the ones of the combination 1, for both designs. The difference was due to the blocks: although the soil-cement bricks are made in the site of the work, the distance of transportation of cement which composes the soil-cement brick is larger than the distance of transportation of the ceramic block.

4.3.2 – Index of Socio-cultural Sustainability

The partial indices of sustainability related to socio-cultural aspects of the vertical sealing subsystem are shown in table 3, which provides a comparative analysis between the results of designs 1 and 2.

It is important to note that the materials reported in the category K are the same as those addressed in the environmental aspects. However, the focus is no longer related to the factors that directly impact on the environment, such as energy use, CO_2 emissions, toxicity, recyclability, etc. The emphasis is given to the factors related to income generation and social responsibility in the context of the manipulation of the materials involved on them. Now, elements like trace, amount of material and transport distance, among others, are not relevant.

Table 3

Table 3 shows that the indices of the designs 1 and 2 have are the same, for each category or subcategory. This happens mainly because that the socio-cultural factors, the income and the social responsibility are homogeneous characteristics in the analyzed region, so that the impact is the same in both designs.

Regarding Category I (Social), the analysis have shown that there is no concern about the participation of users in the specification of materials foreseen in the designs. In contrast, the cultural heritage - Category J (Cultural), is present in the specification of materials, because there is no new material specified in any of the designs. The fact makes it clear that there is use of existing materials in the region, which promotes sustainability.

All blocks have got the same index of socio-cultural sustainability: 16.67. It is a low rate, mainly because of the following factors: low formal employment, few actions aimed to promote health and safety at work and to promote fair trade, lack of certification of the production process, lack of knowledge of technical standards, lack of monitoring of the life cycle of products, processes and services and lack of technological advancement. The only factors in favor to the sustainability of the blocks were the on-time delivery and utilization of local labor in the production of these materials.

The plaster paste had an even lower index: 7.69. The analysis is the same as that one made for the blocks. In addition, the large distance to transport this material has contributed to its non on-time delivery and to this low index.

The mortars had better rates (59.69 and 49.04). They were calculated from the materials cement, lime and sand. The favorable factors to the sustainability of the sand were: use of local labor, on-time delivery and technological advance (modern extraction techniques). The cement and lime were pro-sustainability elements, except for the lack of fair trade certification.

In the case of combinations of materials according figure 1, no index reached at least 50.00, mainly because of the plaster paste and blocks, like explained before.

4.3.3 – Index of Economic Sustainability

The partial indices of sustainability for the economic aspects related to the elements of the vertical sealing subsystem are presented in table 4, which provides a comparative analysis between the results of designs 1 and 2.

Table 4

Following the data in table 4, it can be observed that the combination 2 (ceramic block, seating mortar - trace 1:2:8, coating mortar - plaster paste) is the most sustainable one, because it had the lower life cycle cost. This is true, because that combination had all costs (initial, maintenance and deconstruction) of its materials lower than the costs of the other combinations.

4.4 Index of Sustainability of Design

Table 5 below shows the index of sustainability of design for each combination of components of the vertical sealing subsystem foreseen in Figure 1. This index encompasses the environmental, socio-cultural and economic aspects. As one can see, the design 1 is more sustainable than the design 2 for all combinations. However, despite of the high variations of the indices of the materials, both designs had very similar values of the indices for all combinations, whose maximum difference was 1.37 on a 0 to 100 scale.

Also, the values of the indices of sustainability for all combinations of both designs varied very little, around the mean of 41.67 (the maximum variation was 2.03).

Table 5

Finally, the combination 2 was the best one for both designs, when the environmental, socio-cultural and economic sustainability aspects have been analyzed together. Hence, it is the best specification of materials and components in the studied cases herein.

It is interesting to observe that the specific problems of the designs have been identified through the partial indices of sustainability of the materials and components which have got values deep bellow from the indices of the combinations whose they are a part. Now, those problems can be solved, in order to achieve higher indices of sustainability. Such analysis is a powerful tool of the MASP-HIS method to be used in any design in further evaluations.

V. Conclusions

It has been proposed herein a method (MASP-HIS) for evaluation the sustainability of designs. According to the method, the evaluation is made through partial indices and index of the design, which includes the environment, socio-cultural and economic aspects.

The MASP-HIS method has been used herein to evaluate the sustainability of the vertical sealing subsystem, which has some of the most important and sensitive components of a building. But it can be used to analyze other subsystems of a building, provided that the specificities of each one being considered.

In order to validate the proposed method, two designs of habitations of social interest have been analyzed and the results related to the indices of sustainability were output through the PROMASP-HIS program, which has been implemented for this aim.

Although both designs have achieved indices of sustainability very close each other, when the environment, socio-cultural and economic aspects were considered together, their values did not reach even half the maximum value foreseen for such indices by the MASP-HIS method. However, it is possible for one to improve those indices, once the method allows a careful analysis of all partial indices to be made, in a feedback process, in order to identify the low ones, which are the critical points of the designs.

The PROMASP-HIS tool has been created to perform the calculations of the sustainability of designs, according to the conceptual precepts of the MASP-HIS method. This tool is open to be expanded or amended in accordance with specific needs of specific designs or in order to follow the development of the materials, components and construction methods.

In this way, the MASP-HIS method allows one to monitor the evolution of the sustainability of designs for buildings being constructed in the same locality, as changes and evolution in the environment, socio-cultural and economic aspects are going to happen over time.

There are not comparative results to others methods herein, once it was not possible to locate at the present literature similar analysis, when are set together the specifications of materials and components of the constructive systems for the environmental, socio-cultural and economic aspects.

It is intended to continue research into other building systems so as to allow combinations of different materials and systems to enable specification conscious aspect of sustainability. In addition to considering other aspects of joint projects as described in [14].

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