Sustainable Practices in the Design Process in Civil Construction: A Delphi Study

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Abstract

Environmental issues have gained attention in discussions around the world. One of the areas that causes the most impacts on the planet is the area of civil construction, however, architecture can be thought of in a way that could help to slow down this process. In this context, this article aims to verify the adoption of sustainable practices and natural materials, within the civil construction design process in the city of Passo Fundo, used by architects and urban planners. This study was developed using the Delphi Method based on interviews with architects. As a result, it was found that there are still many possibilities for materials and practices to be incorporated into construction. Furthermore, it was found that many of the difficulties are a consequence of the lack of knowledge of professionals and clients regarding the area of sustainable construction, thus pointing to a weakness in relation to this topic.

Keywords: Sustainable Development; Sustainable Architecture; Sustainable Practices; Delphi.

1 Introduction

In the current global context, concerns about environmental issues and sustainable development processes are increasingly present, and these have been gaining strength since the last decades of the 20th century (GANHÃO, 2011). The Industrial Revolution was the starting point for major changes on the planet, it brought with it many improvements. However, in the search for productivity and growth, the quality of the environment was put aside. The consequences of this were the contamination of rivers, air pollution, emission of greenhouse gases, which lead to climate change, and a greater incidence of natural disasters, leakage of harmful chemicals and the loss of thousands of lives (POTT, ESTRELA, 2017).

The current scenario is a reflection of a series of mistakes and decisions that were made in the past. Never before have the effects of civilization's consumption patterns produced such consequences, even affecting future generations (TORGAL, JALALI, 2007). The environmental crisis is one of the fundamental issues facing humanity and requires a change of mentality, in search of new values and ethics in which nature is not only seen as a source of profit, but, above all, is recognized as a means of survival, for the species that inhabit the Planet (MARÇAL, 2005; PEREIRA and CURI, 2012). We are at a point where it is necessary to reduce the impacts of these errors, and work with a focus on preservation and precaution so that the same failures are not repeated (POTT, ESTRELA, 2017).

It was based on preservation thinking, the understanding that natural resources are finite, and the perception that it is necessary to rethink the man/nature relationship, that in the early 1970s, a strong current in defense of nature began to emerge, and the emergence of social awareness about the fragility of Planet Earth (MATEUS, 2004). In 1972, at the United Nations Conference held in Stockholm, environmental concerns gained international repercussion, but the concept of sustainability that we know today emerged in the 1980s, through the publication of the Report "Our Common Future", known as the Brundtland Report, and where for the first time the expression of sustainable development appears as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (BRUNDTLAND, 1987. p.41).

One of the biggest challenges of sustainable development is energy consumption, excessive consumption of resources and disorderly construction, due to the increase in the number of inhabitants (GANHÃO, 2011). In this context, the construction sector has a great effect on the environment. Therefore, it is possible to see that it is responsible for consuming a large part of the

world's natural resources (LUCAS, 2011; ROCHETA, FARINHA, 2007). The increase in the production and use of synthetic and toxic materials, the production of waste throughout the building's life cycle, combined with a lack of management, contributes significantly to environmental imbalance (CARAMELO, 2016). From this point onwards, environmental issues began to gain space in construction, where the concept of sustainable construction emerged, whose principle is to responsibly manage and create a healthy built environment, taking into account ecological principles and the efficient use of resources (GANHÃO, 2011).

To achieve a civil construction activity that is compatible with sustainable principles, it is necessary to realize that sustainable construction is not a model for solving specific problems, but a new way of thinking about construction itself and everything that surrounds it (ARAÚJO, 2008). With scientific evolution, there is the emergence of new technologies, appropriate for rationalizing available resources, for better use of labor, and reducing costs, in addition to the resurgence of technologies used thousands of years ago, which had been abandoned (MATEUS, 2004). In recent years, studies have demonstrated that vernacular architecture left in its legacy aspects in common with the principles of sustainability, and that this can be a useful contribution to sustainable development. However, it is important to make these practices compatible with the current reality, integrating them with new technologies available, in order to maximize their benefits (CARAMELO, 2016).

The present work has as its theme “Constructive Design Practices” focusing on the analysis of some natural materials and some construction practices in the Southern Region of Brazil, with a focus on sustainability, to understand and test their possibilities and barriers in use within cities, more specifically, in the city of Passo Fundo, located in the northern region of the state of Rio Grande do Sul, in order to have more sustainable built environments. Thus, the objective of this article is to verify the adoption of sustainable practices and natural materials, within the civil construction design process in the city of Passo Fundo, used by architects and urban planners.

To achieve this objective, sustainable practices in civil construction will be analyzed through research with experts (Architects and Urban Planners) in order to understand which techniques are being used or not, evaluating potentialities and barriers in incorporating these solutions when building in urban areas.

This study is divided in 4 sections, the first of which was the introduction. As a second section, the methodological procedures are described. In the third section, the results are presented and analyzed and in the fourth section final considerations are made.

2 Methodology

The research with experts in the area of architecture and urbanism was carried out using the Delphi method. According to Facione (1990), among qualitative research methodologies, the Delphi method is a powerful investigation technique, as it allows the gathering of opinions from experts, who may be geographically separated, leading to dense results on complex topics. The Delphi method is defined as “a method for structuring a collective communication process so that it is effective in allowing a group of individuals, as a whole, to deal with a complex problem” (LINSTONE and TUROFF, 1975, p. 3).

It consists of a set of questionnaires that are answered, sequentially and individually by the participants (OSBORNE et al., 2003), which is repeated over and over again, until a consensus on the answers is obtained, which represents a consolidation of the group's judgment (ESTES and KUESPERT, 1976). Consensus for each statement will be reached when 2/3 of respondents agree or

disagree with it. Only statements that did not reach consensus will be passed on in subsequent questionnaires.

The interviews with the experts took place through closed questions, in a structured interview. The questions are specific to the topic of sustainable constructions and practices. The interview took place digitally, where it was sent by email and via social networks (WhatsApp and Instagram) to architects who are actively registered in the Architecture and Urban Planning Council (CAU) and who develop projects in the city of Passo Fundo/RS (Brazil). The results obtained in the rounds are presented in tables, for better analysis and comparison of responses, to obtain the desired consensus.

Currently in the city of Passo Fundo, according to data from CAU/RS, there are 572 active architects, however not all of them have complete registration on the website, which has made contact with all of them more complex. This number would be used to define the sample calculation, however, in contact with the architects and the CAU it was found that in the city, most architects do not work with design and construction, but rather with interior design or in other areas. Since the focus of the research is architects who construct built environments, the number of such architects are unknown by the Council, making it impossible for the sample calculation to be developed correctly. However, as research using the Delphi method is qualitative, the decision was to send the questionnaire to all active architects and hope for as many architects answer it. So, 280 questionnaires were sent by the end of 2020, 185 via email, 45 via Instagram and 50 via WhatsApp. This resulted in 64 architects participating in the research.

Before the questionnaire could be sent to participants, it was first sent to specialist professors in the area so that it could be validated and finalized. Once completed, it was necessary for it to be submitted to the Brazilian Research Ethics Committee, and could be sent only after being approved. To be evaluated by the Committee, it was necessary to submit the Research Project, the Free and Informed Consent Form (ICF), the Data Confidentiality Term, the schedule and the questionnaire.

After approval by the Ethics Committee, the questionnaires were sent to 5 architects and urban planners, so that a test could be carried out, regarding the time needed to answer it. Next, the research was forwarded to all the architects and urban planners mentioned above. The questionnaires were sent online, which allowed the responses to be automatically stored. The first page of the questionnaire referred to the ICF, which described all the information that the participant should know, in order to decide whether or not to participate in the research. After accepting the term, there is a field where the participant informs their email if they wish to participate in any other stage of the project. The questionnaire was developed in 2 stages, the first is to inform the interviewees, identify the sustainable techniques and materials the interviewed architects use in their projects. The second stage developed through the Delphi method is about the perception and vision of the future in relation to these materials and practices. The first stage has a total of 14 questions divided into 4 sections, 10 of which used the Likert scale, 2 closed multiple-choice questions, and 2 open questions. The first section is about sustainable buildings, the second one about the client's relationship with sustainability, the third about how to design and build in a more sustainable way and the fourth section about the future of buildings. This second stage has a total of 36 questions, all using the Likert scale (completely disagree, partially disagree, neither agree nor disagree, partially agree, completely agree).

After sending the questions, each architect had 30 days to answer it. With the completed questionnaire in hand, graphs were made to identify whether there was a consensus or not between the answers (agreement or disagreement of more than 2/3 of the sample), so that they could re-analyze their opinions, and there would be another 15 days to return them. As the questionnaire has

36 questions from the Delphi method, and among them only 6 did not reach consensus, the questionnaire was not sent back to the experts, as the data obtained from the answers that reached consensus were sufficient to carry out the analyzes and verify the results. The analyzes carried out were to understand the practices that architects use when building sustainably, which of them are most used, which are not developed by architects and understand why they are not used, and what are the difficulties in using them.

3 Results and Discussion

This section consists of an analysis of the questionnaire that was developed and sent to architects and urban planners in the city of Passo Fundo, with the aim of knowing and understanding what practices and materials they use in the design of their projects. In total, there were 64 respondents, but not all of them reached the end of the questionnaire, with 50 participants answering all the questions.

The first questions are related to the characteristics of the respondents, with the first question referring to age, in which 73% of participants answered they are between 26 and 35 years old. Next, the length of time working in the area was questioned, with 53.13% working for less than 5 years, followed by 37.5% working in the area for between 5 and 10 years. With these two data we can see that the majority of participating architects are from a younger generation, who are recently entering the field, and still have many years of career and learning ahead of them. The next question referred to the level of education, in which 60.9% of respondents have specialization and master's degrees, while 35% only have a bachelor's degree. When asked about the area of activity, the majority of respondents are working with residential projects, some commercial, and fewer with interior design, occupational safety, landscaping, industrial, public, hotels and teaching.

The following questions are still to characterize the participants, to find out what practices and materials they use in their projects. The first questions were about: “Sustainable Practices and Materials Used in Projects”, and within this section there were 9 statements where architects marked between totally disagree, partially disagree, neither agree nor disagree, partially agree and totally agree. The questions and the level of agreement between the architects are found in Table 1.

Table 1 - Sustainable Practices and Materials Used in Projects (n=50)

Questions	% Agree	% N. agree, N. disagree	% Disagree
1.1 I analyze the surroundings and take advantage of local natural conditions, solar orientation and winds, using bioclimatic techniques.	**100%**	0%	0%
1.2. I use the land in order to move as little earth as possible, using its natural topography.	**92%**	8%	0%
1.3. I propose techniques for collecting rainwater or reusing water.	**82%**	8%	10%
1.4. I propose techniques aimed at rationalizing the use of energy, such as using renewable energy.	**78%**	14%	8%
1.5. I use the energy labeling program, Procel Edifica[1].	51%	20%	29%
1.6. I propose using thermal performance standards (NBR 15220)[2] and general performance standards (NBR 15575)[3].	**67%**	26%	7%
1.7. I propose techniques to reduce material waste both in the design and execution of the project, such as modulation, flexibility, reusable materials or Life Cycle Analysis.	**76%**	14%	10%
1.8 I use technologies, such as software, energy-saving light bulbs, automation.	**76%**	15%	9%
1.9. I carry out detailed and integrated planning of the project, so that waste is avoided.	**82%**	8%	10%

Source: Authors.

In Table 1, the list of questions with the percentage of consensus obtained is shown. Even though this first stage is not part of the Delphi method, and consensus is not necessary to evaluate these set of questions, it was an interesting method to analyze which practices are being most used. Analyzing Table 1, it is possible to identify that these practices described in this section of questions are known and used by the architects who participated in the research. The greatest consensus is found when the subject is related to the conditions and understanding of the terrain. The least used practices and which consequently obtained the lowest consensus are related to performance standards, with question 1.5 referring to the Procel Edifica program, which despite presenting a majority of 51% agreement, did not obtain consensus (2/3 of respondents).

Next questions relate to the use of materials and techniques in their projects (Table 2). At this stage, the choice was made among the options “never used”, “few times”, “sometimes”, “most of the time”, “always use”. In this question, 11 natural materials and 7 techniques were selected.

[1] The National Program for Energy Efficiency in Buildings - PROCEL EDIFICA (our translation) is the Brazilian program that promotes the rational use of electrical energy in buildings with the aim of encouraging the conservation and efficient use of natural resources (water, light, ventilation, etc.) in buildings, reducing waste and impacts on the environment (PBE, 2023).

[2] The Brazilian Standard NBR 15.220 is entitled “Thermal Performance of Buildings” (our translation) and it presents recommendations regarding the thermal performance of single-family homes of social interest applicable in the design phase (ABNT, 2005).

[3] The Brazilian Standard NBR 15.575 is entitled “Performance standard” (our translation) and it presents requirements, criteria and evaluation methods that a residential building must have so that it achieves appropriate behavior during use (ABNT, 2021).

Table 2 – Results regarding materials and practices used (Question 1.10) (n=50)

	Never used	Few times	Sometimes	Most of the time	Always use
Adobe	37	7	3	1	2
SuperAdobe	42	4	4	0	0
Demolition wood	10	16	17	6	1
Reforested wood	5	12	13	14	6
Certified wood	5	5	12	19	9
Soil cement	21	17	7	5	0
Ferrocement	32	10	5	3	0
Recycled concrete	40	6	3	1	0
Straw	41	6	3	0	0
Bamboo	35	10	4	1	0
Taipa	41	5	4	0	0
Tetrapak Roof tiles	40	7	2	1	0
Green roof	18	17	12	2	1
Dry bathroom	43	2	5	0	0
Green wall	9	9	18	11	3
Photovoltaic panels	6	6	19	15	4
Cistern	7	7	19	10	7
Compost bin	28	9	10	3	0

Source: Authors.

Analyzing Table 2, it is possible to see that in the case of natural materials, the use is very small. The vast majority of selected materials have never been used by most architects. The materials that were most used were certified and reforested wood, with materials such as adobe, superadobe, ferrocement, recycled concrete and straw, in the vast majority of cases, never being used. As for the practices, some of them such as the green wall, photovoltaic panels and the cistern are the best known and are sometimes used in projects. The compost bin and green roof had a low rate of use. The dry bathroom and Tetrapak roof tiles were the two least used techniques, with the vast majority of respondents saying they had never used them.

After the interviewees responded about which materials they used or not, they were asked the reason for not using the techniques and materials described previously (Question 1.11), and according to the interviewees, what most influences the non-use is the cultural issue (31% of the interviewed), accompanied by the need for specific labor (26%). Subsequently, the economic factor (20%) and the difficulty of installing such materials and techniques (12%) were mentioned, followed by other reasons (11%). In the field “other reasons”, the answer that appeared the most was that they don't use it because customers do not want it, and because of a lack of technical knowledge.

The second closed multiple-choice question is intended for interviewees who indicated that they use one of the techniques to inform what advantages they find in using this material/technique (Question 1.12). The economic factor was highlighted as the biggest advantage (60% of respondents), followed by the issue of durability (21%), easily accessible labor (17%) and easy installation (15%), which presented similar percentages. In the item “Other Advantages”, what appeared most was the factor of sustainability and helping the environment.

The open questions in this section concern the interest of using or not these techniques and materials. From the answers to question 1.13, it is possible to see that there is an interest in using such techniques and materials, where 32% of participants confirmed their interest in using them,

18% stated that they did not wish to use them, and 50% responded "Other". In the "Other" field (a field that was left for participants to give their opinion). Therefore, many of the respondents marked this field to comment something about it. Analyzing the responses, however, it appears that the majority of responses were very similar, as they mention the desire to use all the techniques presented and to use more natural materials in projects, with the motivation of causing less environmental impacts, for sustainability, saving energy water and energy.

Question 1.14 asked the reason for not using those materials or techniques, and the answers that most emerged were that the non-incorporation of these materials and practices is due to the reason that customers do not wish to use such techniques and materials, for economic reasons, for lack of knowledge, due to difficult access to them or the lack of specialized labor.

With the analysis of this first stage of the research, it is possible to verify that despite the lack of knowledge and non-use of many natural materials, there is the incorporation of several sustainable practices, showing that there is a search for sustainability, despite still existing many barriers for using them. However, despite of the barriers, there is already an understanding of the need to use more sustainable materials and techniques.

The questions in the next section are part of the Delphi methodology and were divided into 4 subgroups, related to their theme. The Subgroups are: **Sustainable Construction**, **Customer Relationship x Sustainability**, **Design and Build in a more sustainable way** and **Future – SDG 2030**. In total there are 36 statements, which were answered using the Likert scale, defined as "completely disagree", "partially disagree", "neither agree nor disagree", "partially agree", "completely agree", among them only 6 did not obtain the necessary 2/3 of the sample to reach consensus.

The first subgroup was developed with the aim of knowing and understanding the architects' perception in relation to sustainable construction and environmental crisis. Therefore, the questions and the respective percentages of answers' agreement and disagreement are presented in Table 3.

Table 3 - Questions on the Theme: Sustainable Construction (n=50)

Questions	% Agree	% N. agree, N. disagree	% Disagree
1.1. Concerns about environmental issues and sustainable development are increasingly present in the design process within civil construction.	**98%**	0%	2%
1.2. The environmental crisis is a consequence of the excessive use of resources and unplanned construction.	**82%**	14%	4%
1.3. The construction sector has a great effect on the environment; therefore, it is possible to see that the construction sector is responsible for consuming a large part of the world's natural resources.	**89%**	9%	2%
1.4. We are at a point where we need to reduce impacts and work with a focus on preserving the environment.	**86%**	8%	6%
1.5. Sustainable construction is not a model for solving specific problems, but a new way of thinking about construction itself and everything that surrounds it.	**94%**	6%	0%

Source: Authors.

According to Table 3, it is possible to see that in all statements on this topic there was consensus among the architects, with the majority of responses ranging between partially agree and completely agree. Thus, it is possible to notice how respondents view the current scenario, and how they understand the need for a new way of acting, regarding constructions, where it is necessary to reduce the impacts caused to the environment by focusing on greater sustainability. Furthermore, they agree that the civil construction sector is one of the major polluters today in relation to environmental impacts, but that it can show one of the ways to restructure and restore the environment.

The second subgroup Customer Relationship x Sustainability was developed with the aim of understanding the influence that customers have in making decisions whether or not to use some more sustainable techniques and materials. The statements and results are presented in Table 4.

Table 4 – Questions on the Theme: Customer Relationship x Sustainability (n=50)

Questions	% Agree	% N. agree, N. disagree	% Disagree
2.1. Most of my clients know what sustainable architecture is.	26%	31%	43%
2.2. Most of my clients look for projects that use sustainable architecture.	16%	18%	**66%**
2.3. Some clients sought out my office because they knew it offered sustainable techniques.	11%	22%	**67%**
2.4. Most clients understand that sustainable architecture can contribute to their quality of life.	51%	17%	32%
2.5. Most customers consider the use of sustainable techniques to be expensive.	**74%**	20%	6%
2.6. Most clients prefer to use conventional techniques.	**83%**	10%	7%

Source: Authors.

According to Table 4, it is possible to verify that not all statements reached consensus. Questions 2.1 and 2.4 were the ones that received the most variations, and consequently did not obtain the desired consensus. Questions 2.2 and 2.3 are in consensus or disagreement, as they present the majority of responses in totally disagree and partially disagree. Questions 2.5 and 2.6 present a consensus of agreement, as the majority of answers fall between partially agree and completely agree. With this, it is possible to observe that in the view of the architects interviewed, people/clients still do not have knowledge about what sustainable architecture would be, and consequently, they are unaware of its advantages, believing that a sustainable project requires a high amount of investment, and because of this, they prefer to use conventional techniques.

Making a relationship between the questions of the first subgroup with the second, it is clear that there is an interest on the part of architects in using techniques and materials from sustainable architecture, with more natural practices and materials, and that they understand that designing in this way would be essential for the regeneration of the environment. However, due to a cultural issue and the clients' lack of knowledge of the possibilities, a barrier was created, causing architects to continue designing with conventional techniques, without being able to incorporate sustainable techniques into the majority of their projects.

The third subgroup is related to the fact of designing and building in a sustainable way. Questions 3.1 to 3.11 are about possible difficulties and barriers to designing or building in a sustainable way. From question 3.12 onwards, questions are directed to the benefits of using such techniques and materials. Table 5 presents the questions with their respective answers.

Table 5 – Questions on the Theme: Design and Build in a more sustainable way (n=50)

Questions	% Agree	% N. agree, N. disagree	% Disagree
3.1. Designing sustainably requires more effort than doing traditional designs.	**76%**	13%	11%
3.2. Designing sustainably requires more time spent on the project.	64%	20%	16%
3.3. Designing sustainably requires coordination and alignment between all parties to ensure compliance with guidelines.	**86%**	14%	0%
3.4. To design sustainably, you need a specialist in the field to guide the process.	**71%**	22%	7%
3.5. Designing in a sustainable way has a higher cost than traditional projects.	52%	30%	18%
3.6. Designing sustainably is more difficult as legislation imposes some barriers (e.g. laws, master plan, etc.).	43%	31%	26%
3.7. Designing sustainably is more difficult because of the materials used.	53%	29%	18%
3.8. Designing with alternative materials does not allow the project to be aesthetically pleasing.	25%	9%	**66%**
3.9. To build sustainably, the construction site must be adequate and there must be monitoring of the work.	**78%**	17%	5%
3.10. Sustainable building materials are typically more expensive.	**75%**	16%	9%
3.11. There are few suppliers of sustainable building materials on the market.	**69%**	24%	7%
3.12. The use of natural materials, such as soil, wood, among others, can contribute to the thermal comfort of buildings.	**84%**	13%	3%
3.13. Using sustainable techniques brings long-term financial benefits.	**91%**	9%	0%
3.14. The use of a green roof can bring advantages to construction, such as: improving thermal and acoustic insulation, reducing energy consumption, and helping to reduce internal temperatures.	**100%**	0%	0%
3.15. The use of cisterns is a good alternative for saving water.	**100%**	0%	0%
3.16. The use of photovoltaic panels is a good alternative to save energy.	**96%**	0%	4%
3.17. The use of solar energy is a good alternative to water heating.	**98%**	2%	0%
3.18. Using a compost bin is a good alternative for reducing waste.	**96%**	2%	2%

Source: Authors.

The third subgroup contains the most statements, 18 in total. Among all of them, 14 reached consensus and 4 did not reach consensus. Those that did not reach a consensus are questions 3.2,

3.5, 3.6 and 3.7, being part of the questions regarding the difficulties and barriers to designing in a sustainable way.

Analyzing the results, it is possible to state that when the subject is barriers, answers to questions 3.1, 3.2, 3.3, 3.9, 3.10 and 3.11 are mostly between partially agree and completely agree, demonstrating that for architects it is still It is complex to make sustainable projects. The responding architects state that it requires more effort, more time, greater alignment between projects, materials are often more expensive, and that it is difficult to find suppliers and labor for this type of construction.

Questions 3.4, 3.5, 3.6, 3.7 are between neither agree nor disagree, and partially agree, showing that these questions still generate doubts on the part of architects, and are related to the need for a specialist, high costs, and regulations. All statements related to the benefits of using sustainable architecture in projects reached consensus, with the vast majority of responses in complete agreement, thus being able to state that respondents know and confirm that there are many benefits to designing in a sustainable way.

The fourth and final subgroup is related to the future of sustainable construction, taking into account the SDGs developed by the 2030 Agenda. It contains statements about what architects believe civil construction will be like, whether sustainable construction will be more present, with fewer barriers, if there will be a requirement from the market and laws, and an obligation for projects to be sustainable. It was also questioned whether the client, which today is one of the main problems during construction, will relate quality of life with sustainable projects, and will choose projects that are developed in this way, and whether in the future these choices will influence the development of cities, making them smarter and more sustainable. Table 6 presents the questions and the respective results of this subgroup.

Table 6 – Questions on the Theme: Future – SDG 2030 (n=50)

Questions	% Agree	% N. agree, N. disagree	% Disagree
4.1 By 2030, sustainable buildings will be more present and accessible in civil construction.	**86%**	14%	2%
4.2 By 2030, the use of alternative materials for civil construction will be more natural.	**82%**	10%	8%
4.3 By 2030, we will be required by law to build more sustainable buildings.	**70%**	28%	2%
4.4 By 2030, we will be forced by the market to build more sustainable buildings.	**75%**	23%	2%
4.5 By 2030, the population will understand the relationship between sustainable buildings and quality of life.	**72%**	16%	12%
4.6 By 2030 we will have smarter and more sustainable cities.	**78%**	18%	4%

Source: Authors.

According to Table 6, all statements reached consensus, with most of the answers being between partially agree and completely agree, and the percentage of architects who disagreed with the statements were very low. With this, it is possible to affirm that the architects who answered believe that our future in relation to civil construction will be more sustainable. That this type of construction will be more present and more accessible; that there will be influence from the laws

and regulations that regulate projects; that the use of alternative materials will be more common; that the market and customers will be aware of this process and will request these types of projects; that the population will understand the relationship between sustainable projects and quality of life, in addition to being more aware of the need to regenerate the environment, and that as a consequence of this, we will have smarter and more sustainable cities.

With the analysis of subgroup 4, it is clear that the surveyed architects believe that sustainable buildings will be more present in cities in the future. However, it is necessary that in addition to believing, they begin to act, do and think in a more sustainable way, encouraging their clients, seeking information about these practices, so that the perception of the future that they have, is possible to become a reality. Currently, the barriers and difficulties encountered by architects and urban planners were more evident than the benefits, however, a change of vision and the desire for change are needed, so that in the year 2030, and if possible, even before, all these statements that experts believe, stop being just beliefs, and become reality.

4 Conclusions

The study presented here aimed to understand what designers think and how they develop their projects in relation to sustainability in the city of Passo Fundo. Furthermore, the aim was to find out what barriers architects encounter when designing in this way, and what potential and benefits this type of construction can bring to the city and its residents.

The Delphi methodology used to develop and apply the questionnaire was fundamental in achieving the expected results, allowing the current scenario to be known, the barriers and potential to be found, and the vision that the architects have for the future to be known.

Thus, it is possible to conclude that the methodology and questionnaire met the proposed objective. Knowing the city's scenario, it was found that there are still many possibilities for materials and practices to be incorporated into construction. And by understanding what barriers architects face, it is possible to propose strategies to overcome them. Furthermore, it was found that many of the difficulties are a consequence of the lack of knowledge of professionals and clients regarding the area of sustainable construction, thus pointing to a weakness in relation to this topic.

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