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Interlocking concrete paving blocks made with treated wastewater: an analysis of user acceptance

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ABSTRACT

Saving water of better quality for more important uses is critical in the context of preventing water scarcity. Prominent in this sense is the need to study not only the technical aspects involving environmentally conscious consumption, but also the acceptance of users, since appropriate technologies are of little value if they are not assimilated. Therefore, this work aimed to evaluate how well users accepted interlocking concrete paving blocks produced with treated wastewater rather than drinking water. To this end, questionnaires were administered to members of the faculty, student body and staff of a school of civil engineering, architecture and urban design in the city of Campinas (SP/Brazil), resulting in 238 answers. It was found that 79% of participants identified no visual differences between conventional paving blocks and those produced with treated wastewater, and that 96.6% were willing to use such blocks in outdoor areas of future construction work. On the other hand, there was a reduction in the acceptance of the paving blocks for use in indoor areas and the respondents' own homes. Hence, even though its results were largely positive, this survey raised a few points of attention regarding the acceptance of the technology in question.

KEYWORDS

Alternative sources. Concrete paving blocks. Environmentally conscious consumption. Innovation; reuse.

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1. Introduction

Water scarcity is a global reality that affects different regions of the world. The overall picture is quite bleak: about 25% of the world population lives in river basins with physical water scarcity (Cirilo, 2015). Mekonnen and Hoekstra (2016) estimate that around half a billion people face water scarcity all year round and that 4.3 billion people are subject to severe to moderate water shortage conditions for at least one month a year. The reasons for this situation are, among other factors, human consumption habits, population growth, improved living conditions, climate change and poor water management and pollution (Asahdollahfardi et al., 2016; Farhadkhani et al., 2018).

In 2015, the United Nations adopted the Sustainable Development Goals (SDGs) of the 2030 Agenda, whose focuses include protecting the planet against degradation. This involves encouraging sustainable consumption and production and sustainable management of natural resources, besides introducing urgent measures to fight climate change in order to meet the demands of present and future generations (ONU, 2015).

Regarding water, SDG number 6 states that it is critical to "ensure availability and sustainable management of water and sanitation for all" (ONU, 2015). To this end, Target 6.3 encourages increased recycling and safe water reuse worldwide (ONU, 2015).

In Brazil, the National Policy for Water Resources (PNRH), instituted by Law 9433/1997, provides that water is a common good and a limited natural resource of economic value. According to this policy, the availability of water and its rational use must be ensured for current and future generations, in line with UN guidelines. Brazil detains only 2.8% of world's population and possesses about 12% of the global freshwater availability (Augusto et al., 2012), but there are significant regional disparities that must be taken into account when analyzing water availability (Venancio et al., 2015).

Approximately 70% of the water resources within the Brazilian territory are concentrated in the northern states (in the Amazon basin), which have the lower population density, while at the northeastern states, where 30% of the population resides, possess merely 5% of the water reserves (Augusto et al., 2012). Furthermore, in the south and southeast regions, home to 60% of the population, only 12.5% of the water resources are accessible (Augusto et al., 2012). This situation, however, is not exclusive to Brazil, since several large regions share the same condition. A point in case is the African continent, which is estimated to have almost 9% of global freshwater resources. These resources are unevenly distributed, with six countries in Central and West Africa holding 54% of the continent's total freshwater while 27 others have only 7% (UN-Water, 2021).

In this context, the use of unconventional water sources is an important tool to tackle water scarcity. The search for alternative solutions to overcome water scarcity has increased globally, albeit erratically at first (UN-Water, 2020). Thus, previously rejected resources such as treated wastewater (domestic or industrial), desalinated sea water or rainwater have been used in activities that do not require potability as a means to reduce the demand for drinking water and save it for essential uses.

The building sector, for example, has great potential for water reuse in its production processes. Although water is an essential resource in various activities related to building and the production of building materials, in most cases it does not have to be of high quality. Al-Joulani (2015) estimates that globally, the concrete industry consumes over 1 trillion gallons of water per year, excluding curing and equipment washing operations. In addition, Miller et al. (2018) state that in 2012, this sector accounted for the consumption of 9% of total water used in industrial activities, approximately 1.7% of total water use worldwide.

Therefore, considering the great demand for water in concrete production and curing and the high volume of treated wastewater generated daily in wastewater treatment plants worldwide, some authors have conducted research on the use of treated wastewater in concrete production and its influences on physical and mechanical properties (Asadollahfardi et al., 2016; Duarte et al., 2019; Ghrair & Al-Mashaqbeh, 2016; Hassani et al., 2020; Meena & Luhar, 2019; Rao et al., 2014; Raza et al., 2020; Shekarchi et al., 2012; Tonetti et al., 2019; Tumediso et al., 2014).

Despite the well-known benefits of saving better quality water for more essential purposes, many people may oppose the idea of using treated wastewater as building material. Hence, it is also important to assess how well consumers accept goods produced with this material, since there is no point in developing a sustainable product if it is not accepted by potential users.

It is therefore necessary to understand how consumers behave. Consumer behavior is an area rooted in economics and social psychology (Vasseur, 2014). Three concepts explain how consumption practices in society change over time: cleanliness, comfort and convenience – CCC (Shove, 2003a).

The first aspect, cleanliness, is directly related to the feeling of well-being. It is evident that knowing that objects are clean makes people feel better. The second aspect, convenience, emerged in the 1960s and relates to arrangements or devices that save time. Since then, the term has been widely employed by companies that sell their products as convenient (Shove, 2003a).

The third point, comfort, relates strongly to physical aspects. Although feeling comfortable is an individual experience involving specific conditions and historical and cultural issues, there is an average range that can be determined by science as "comfort conditions" (Shove, 2003a).

Cleanliness-related traits can be noted in the increase in water consumption in recent decades due to more recurrent activities in some regions related to showering, household cleaning and laundry. Comfort, in turn, can be identified in the use of heating and cooling equipment, which accounts for most of the energy consumed in households in Western societies. Convenience, in turn, is seen in the consumption of frozen foods and cars (Shove, 2003a).

As with other forms of consumption, Shove (2003b) considers that "environmentally conscious consumption"[1] also comprises these three aspects. Therefore, consumption should be analyzed collectively rather than individually, which requires studying normal practices. Peattie (2010) believes it is necessary to understand the consumption process as a whole and various individual acts, which constitute a lifestyle, to analyze whether a behavior is more or less "conscious."

Given the above, this research aims to assess how well users accept different applications of interlocking concrete paving blocks produced with treated wastewater.

2. Methods

The physicochemical characteristics of treated effluents, as well as the physical and mechanical properties of specimens and concrete paving blocks made with effluents were evaluated in previous studies carried out by Duarte et al. (2019) and Tonetti et al. (2019).

The concrete paving blocks (hereinafter referred to only as "paving blocks") used as template and visual reference for the participants in this research (Figure 1) were the same produced and laid by Tonetti et al. (2019) in a parking lot of the School of Civil Engineering, Architecture and Urban Design of the University of Campinas (FEC/UNICAMP). The treated effluent used to manufacture them came from the wastewater treatment plant in Barão Geraldo (Campinas/SP), which uses a system of UASB (Upflow Anaerobic Sludge Blanket) reactors followed by a trickling filter process. This wastewater treatment plant system is widely used in Brazil and quite suitable for developing countries for its reduced operating and energy costs and higher efficiency in hot climates, typical of such regions.

Figure 1. Type of paving block used in the survey. Source: the authors (2019).

[1] Environmentally conscious consumption is consumption that takes into consideration its impacts (Roberts, 1996).

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Therefore, in addition to the previous studies, aiming to understand the acceptance and the perception of differences between conventional paving blocks and those produced with treated wastewater by users and potential consumers or encouragers of consumption, a questionnaire was designed. It was administered to a group of people familiar with the building sector, namely undergraduate and graduate students of civil engineering, architecture and urban design and staff (faculty and technicians) of FEC/UNICAMP.

The questionnaire was administered virtually via Google forms without the participants being identified in any way. After 15 days, 238 answers were collected: 51 from technicians, faculty and other staff and 187 from undergraduate and graduate students. This sample is part of a population of 2,945, of which 1,000 are undergraduate students (630 in civil engineering and 370 in architecture and urban design), 370 are graduate students, 450 are special students (students that are not regularly registered in the program but can join classes), 1,000 are students of outreach programs and 125 are university staff (60 faculty and 65 administration and lab technicians).

The questionnaire was submitted to previous testing with volunteers for clarity and objectivity and then administered in three sessions. In the first session, besides indicating to which group within the college community they belonged, participants answered questions on their perception of the visual differences between the two paving block strips (A and B) shown in Figure 2, one with conventional blocks and the other with blocks produced with treated wastewater. Next, as the participants were not informed which kind of paving block was used in each strip, they were asked which of the two strips contained paving blocks made with treated wastewater and also whether they would use such blocks in future building work (indoor or general unspecified use) or at their own homes (indoor or general unspecified use).

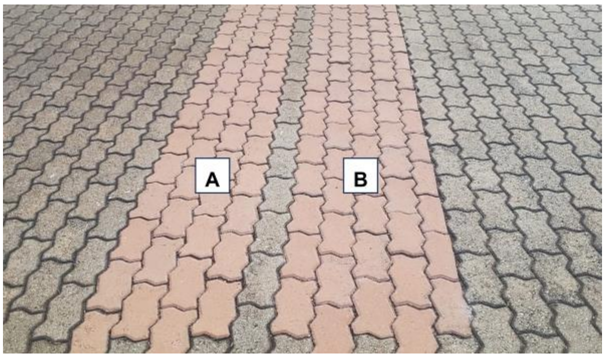

Figure 2. Area where the paving blocks made with drinking water (strip A) or treated wastewater (strip B) were laid.
Source: the authors (2019).

In the second session, participants indicated which option was closest to their reason for accepting or rejecting the use of the paving blocks. In the third session, which was optional, they could give their opinion on the use of treated wastewater in the manufacture of building and finishing materials.

3. Results and Discussion

The respondents were divided into three groups: students, staff and others, as shown in Table 1.

Table 1. Survey participants by group.

Group	Category		No. of answers	%
Student	Undegraduate	Civil Engineering	73	30.7%
		Architecture and Urban Design	16	6.7%
	Graduate	Civil Engineering (sanitation and environment)	20	8.4%
		Civil Engineering (other areas)	58	24.4%
		Architecture	20	8.4%
University Staff	Administration or lab technician		30	12.6%
	Faculty		17	7.1%
Other	-		4	1.7%

Source: the authors.

Graduate students in civil engineering were divided into "sanitation and environment" and "other areas" (structures and geotechnics; water, energy and environmental resources; construction and transport) in order to evaluate whether students doing research in sanitation and environment were more receptive to the use of treated wastewater in the production of the paving blocks compared to the others.

3.1. Results by category

The opinion of users about the paving blocks, in turn, was evaluated based on the analysis of the responses obtained for five questions, the first related to their perception of the difference between the strips shown in Figure 2 and the others regarding their acceptance or rejection of the use of interlocking paving blocks manufactured with treated wastewater in the different situations suggested: general and indoor use in future building work and general and indoor use in their own homes. Table 2 details by group and category the percentage of answers obtained for the main questions of the survey, offering an overview of the results obtained, as these will be presented and discussed in a categorized manner below.

Table 2. Answers by group.

Group		Answer	Difference between blocks	Future works	Indoor areas of future works	Own home	Indoor areas of own home
Student	Civil Engineering (undergraduate)	Yes	23.29%	98.63%	69.86%	87.67%	67.12%
		No	76.71%	1.37%	30.14%	12.33%	32.88%
	Architecture and Urban Design (undergraduate)	Yes	18.75%	93.75%	75.00%	100.00%	62.50%
		No	81.25%	6.25%	25.00%	0.00%	37.50%
	Civil Engineering (graduate – sanitation and environment)	Yes	30.00%	100.00%	70.00%	100.00%	65.00%
		No	70.00%	0.00%	30.00%	0.00%	35.00%
	Civil Engineering (graduate – other areas)	Yes	17.24%	96.55%	60.34%	87.93%	48.28%
		No	82.76%	3.45%	39.66%	12.07%	51.72%
	Architecture, Technology and Cities (graduate)	Yes	20.00%	95.00%	50.00%	85.00%	45.00%
		No	80.00%	5.00%	50.00%	15.00%	55.00%
Staff	Administration or lab technician	Yes	13.33%	100.00%	66.67%	90.00%	63.33%
		No	86.67%	0.00%	33.33%	10.00%	36.67%
	Faculty	Yes	29.41%	82.35%	52.94%	82.35%	47.06%
		No	70.59%	17.65%	47.06%	17.65%	52.94%
Other		Yes	25.00%	100.00%	75.00%	100.00%	50.00%
		No	75.00%	0.00%	25.00%	0.00%	50.00%

Source: the authors.

Analyzing Figure 3, one notes that acceptance of the paving blocks by "undergraduate students in civil engineering" is quite high when considering general use in future works and own home. However, a change of opinion is observed in 28.7% and 20.7% of those participants regarding their use in indoor areas of future works and own homes, respectively. This significant difference between general and indoor use may be associated with factors such as longer hours spent indoors, less air circulation or even the use of better finishing materials in such areas.

Comparing the results of "undergraduate students in civil engineering" with those of "undergraduate students in architecture and urban design" (Figure 3), one notes that the latter are more receptive to indoor use in future works and general use in their home. However, as with "undergraduate students in civil engineering," when comparing acceptance of general and indoor use, there are similar reductions. It is also noticed that, considering the two categories, perception of the difference between the paving blocks was low, standing around 21% on average.

Regarding graduate students, it was found in Figure 4 that the average obtained for perception of difference was quite similar, around 22%, with the highest percentage obtained for "graduate students in civil engineering in the area of "sanitation and environment". Nevertheless, that result had no influence on the acceptance of the paving blocks by this group, which actually had the highest acceptance rates among graduate students for all proposed situations. It is worth noting that this category was unanimous in approving the blocks for general use in future works and their homes, and despite a reduction regarding application in indoor areas, acceptance can still be considered good and comparable to that of undergraduate students.

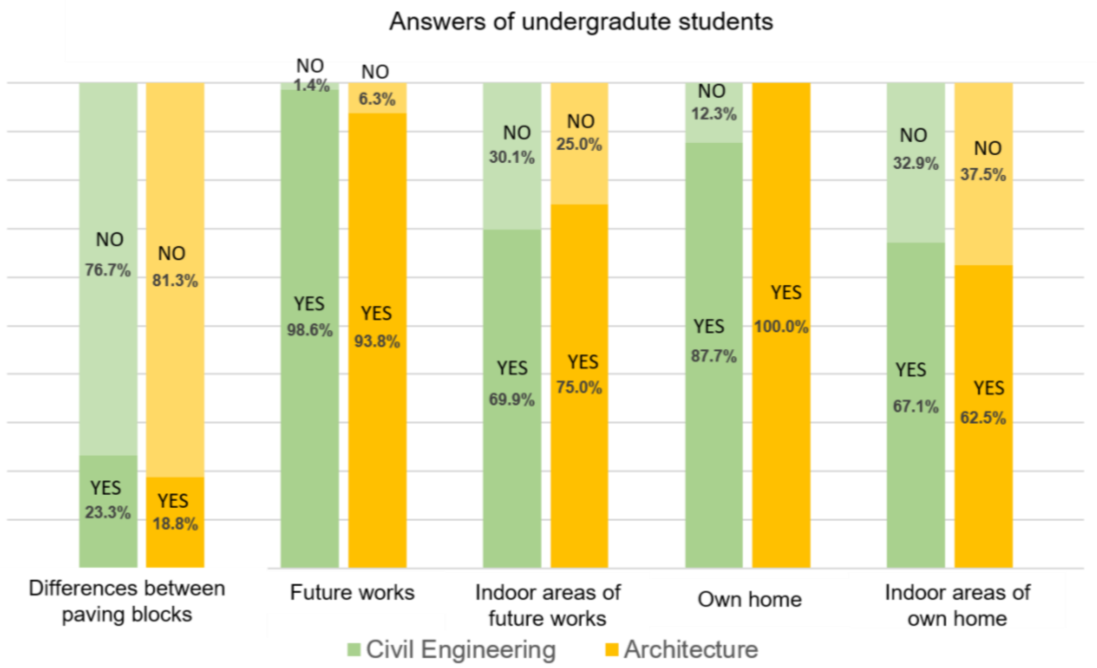

Figure 3. Answers of undergraduate students. Source: the authors.

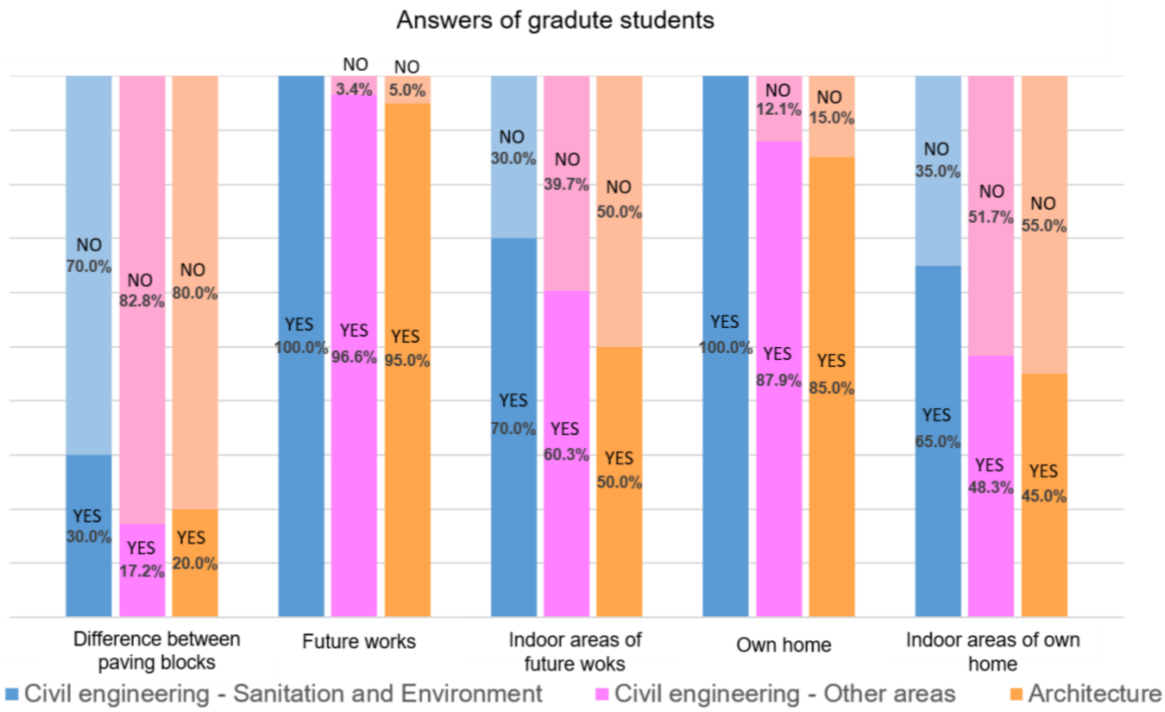

Figure 4. Answers of graduate students. Source: the authors.

In the case of "graduate students in civil engineering in other areas" and "graduate students in architecture," acceptance was high in both general use situations and comparable to that obtained by the previous categories, standing above 85%. However, rejection increases considerably for use in indoor areas and accounts for the opinion of the majority of students when it comes to use in their own homes. Therefore, among graduate students, a possible reason for the higher acceptance rates recorded among students in the "environmental and sanitation area" is the fact that many of them are more familiar with the practices, development and application of new technologies in which concern with reducing environmental impacts is equal to or even more important than their performance.

Considering that no human activity is performed without the support of an environment built with materials, building materials are taken for granted by society on a daily basis. However, for engineers and architects, such materials constitute the foundation of the value chain (John, 2017). Hence, overall, the positive acceptance of the paving blocks by undergraduate and graduate students suggests a promising future, considering that these students will be the future professionals in charge of choosing the materials to be used in different building designs.

Among the respondents classified as university staff, comparing the responses given by "technicians" and "faculty" (Figure 5), one notes that in all situations evaluated, acceptance of the paving blocks is higher among "technicians." This category showed very satisfactory acceptance rates for general use and followed the trend of increased rejection when considering applications in indoor areas, yet remaining above at least 63% in all situations.

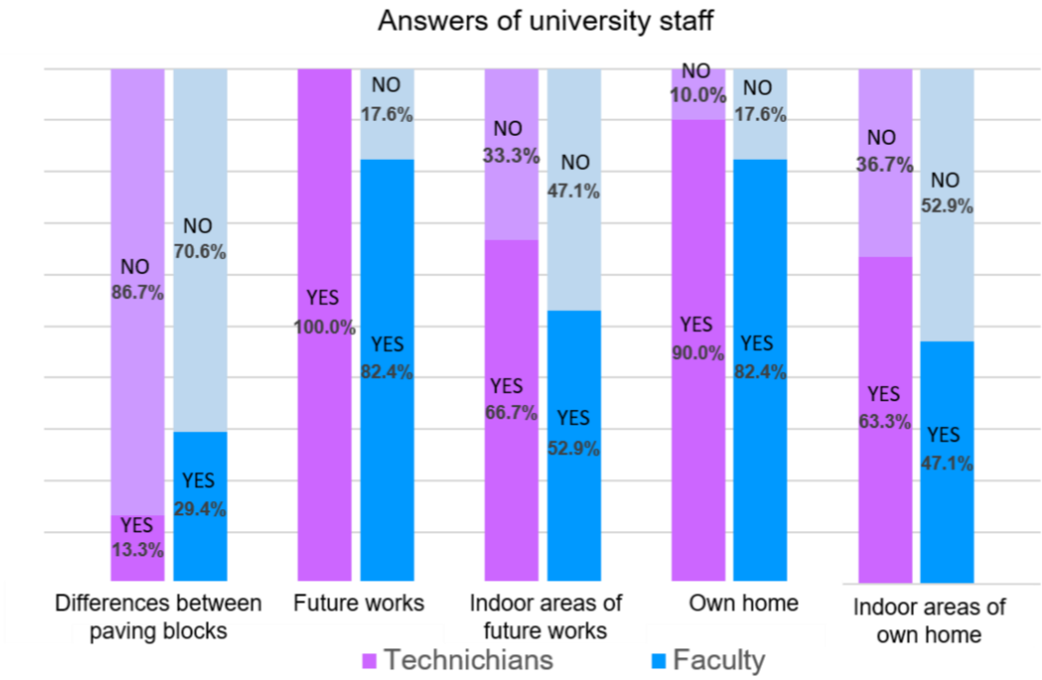

Figure 5. Answers of university staff. Source: the authors.

Regarding the "faculty" category, although it recorded the highest rejection rates of the paving blocks for general use, such rates are considered acceptable since they are quite similar to those of the other groups. In addition, the suggestion to use this material in indoor areas triggered increasing rejection. As with "graduate students in civil engineering in other areas" and "graduate students in architecture," the rejection rate exceeded 50% and became the majority opinion of the category.

This may reflect a greater concern of faculty members with the performance and durability of concrete in the sustainable alternative, or even a conservative stance regarding the practices and techniques of concrete production. The differences in position may also be because the students, especially in undergraduate education, are younger than their professors are and, therefore, more open to the use of innovative materials and processes.

Therefore, comparing the data presented so far, it is possible to discuss some results regarding the use of the paving blocks in future building work. Regarding general use, acceptance was unanimous among "graduate students in civil engineering in the area of "sanitation and environment" and "technicians" while the lowest rate, albeit still considered high, was 82.4% among "faculty." For use in indoor areas of future works, it is observed that while the lowest rejection rate (25%) was recorded among "undergraduate students in architecture and urban design," the highest (50%) was among "graduate students in architecture." In addition, as expected, reductions are noted when comparing acceptance for general and indoor use, with the highest (-45%) and lowest (-18.7%) related to, respectively, “graduate students in architecture” and “undergraduate students in architecture.”

Regarding the use of the paving blocks in the respondents’ homes, general use was unanimously accepted among “undergraduate students in architecture and urban design” and “graduate students in civil engineering in the area of “sanitation and environment,” with the lowest acceptance once again recorded among “faculty” (82.4%). However, concerning their use in indoor areas, the lowest rejection rate was recorded among “undergraduate students in civil engineering” (32.9%) and the highest among “graduate students in architecture” (55%). Furthermore, reductions were also observed when comparing acceptance rates of general and indoor use, with the highest recorded among “graduate students in architecture” (-40%) and the lowest among “undergraduate students in civil engineering” (-20.6%).

Finally, when comparing use in future works and respondents’ home, one notes that for general use all other groups showed a reduction, especially “undergraduate students in civil engineering (-10,9%). The exception of that are “undergraduate students in architecture and urban design” which showed a 6.2% increase in acceptance and “faculty” and “graduate students in civil engineering in the area of sanitation and environment” which did not change. Comparing use in indoor areas, all categories registered slight reduction in acceptance when their own house was considered, being greater among “undergraduate students in architecture,” reaching -12.5%.

3.2. Overall interpretation and analysis

The analyses of the responses with no separation by category also show relevant results. Regarding the perception of visual differences between paving blocks produced with drinking water and treated wastewater, most participants did not identify any differences and were unable to point out which strips contained blocks made with treated wastewater. Of the total respondents, 79% were unable to identify any differences between the two types of paving blocks and 62.2% were unable to point out which of the two strips of blocks had been produced with the use of treated wastewater.

Acceptance of the paving blocks for general use in future works and in the participants’ homes was, respectively, 96.6% and 89.5%, considered high for both situations. However, regarding their use in indoor areas, in both future works and own homes, a significant reduction in acceptance is noted, reaching 64.7% and 58.0%, respectively.

Such reduction rates are possibly related to social and cultural barriers regarding the reuse of wastewater in production activities and processes. Furthermore, most users still fear having direct contact with these products in the belief that they may pose a direct risk to health, especially because, in indoor areas, many people tend to go barefoot and children and animals are usually in direct contact with the floor. This may relate in some way to the “cleanliness” aspect of product acceptance (Shove, 2003a).

Moreover, the lack of knowledge of part of the participants about the possible influences of treated wastewater on the physical and mechanical properties of the material may also be pointed out as an impediment to its acceptance.

Analyzing the reasons given by the participants for accepting the use of the paving blocks in indoor areas of their own homes (Figure 6), one notes that most of them justified their choice by claiming that this contributes to the reuse and recycling of a natural resource (27.5%) and to saving drinking water (20.3%). In addition, promoting sustainability and the fact that it is an ecological material were reported as reasons by 30.4% of respondents. This result endorses what is also a concern of the SDGs: preservation of natural resources and their use in the most conscious way possible (ONU, 2015).

As discussed above, alternative forms of water sources are key for the preservation of better quality water for more essential purposes. This survey showed that the respondents are aware of this fact, since the majority were in favor of using the paving blocks in indoor areas of their homes and the main reason for using them was “reuse and recycling of a natural resource”. Nevertheless, acceptance was not as high as expected, especially when comparing general and indoor use in own homes.

Regarding the participants who would not use the paving blocks in indoor areas of their own homes (Figure 7), 40% cited potential health risks as a reason.

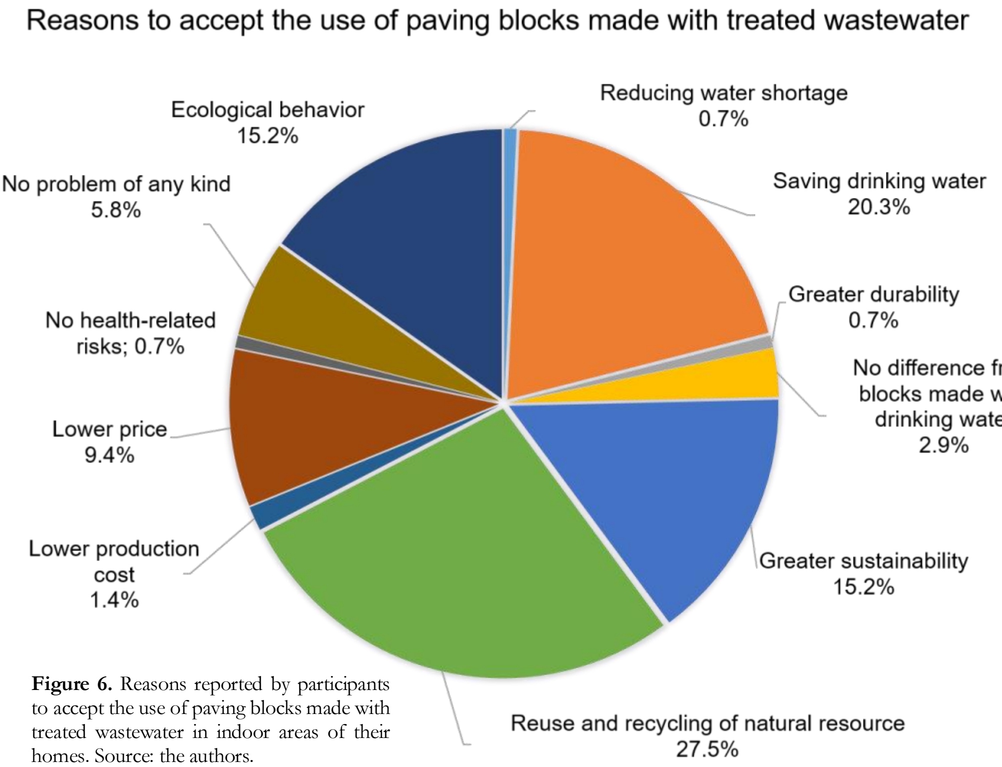

Figure 6. Reasons reported by participants to accept the use of paving blocks made with treated wastewater in indoor areas of their homes. Source: the authors.

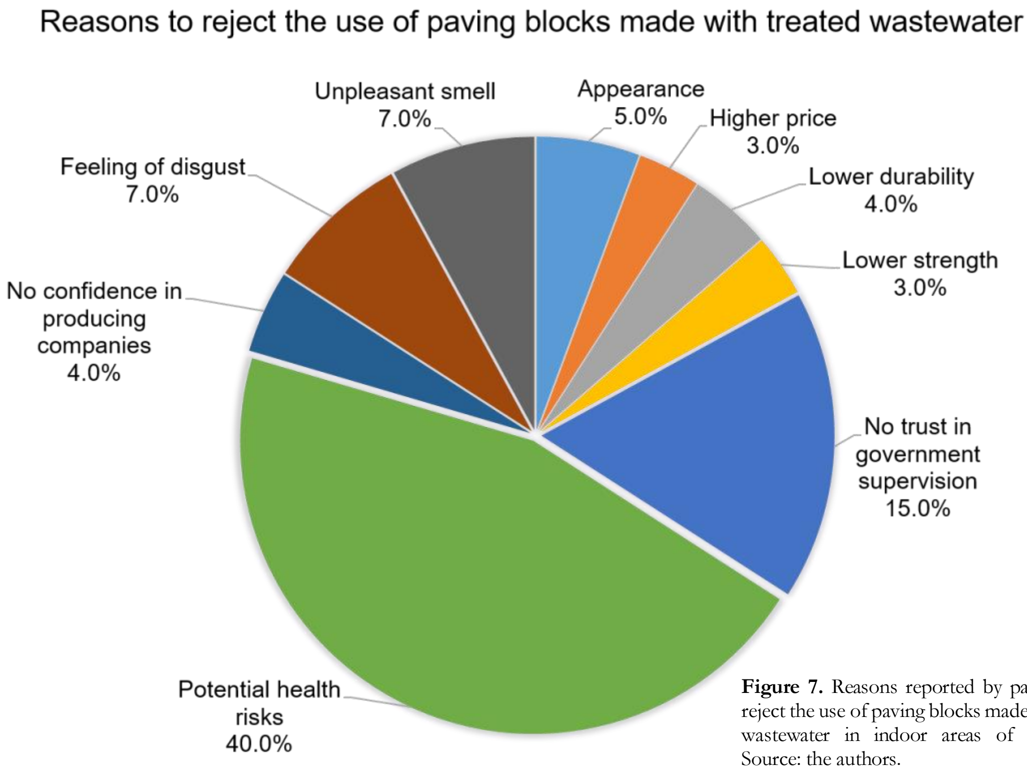

Figure 7. Reasons reported by participants to reject the use of paving blocks made with treated wastewater in indoor areas of own home. Source: the authors.

Such fear is possibly associated with their belief that microorganisms that remain in the effluent, capable of posing risks to human health, are not inactivated when incorporated into the concrete. However, none of the works consulted in the literature (Al-Ghusain & Terro, 2003; Al-Jabri et al., 2011; Asadollahfardi et al., 2016; Duarte et al., 2019; El-Nawawy et al., 1991; Ghrair & Al-Mashaqbeh, 2016; Hassani et al., 2020; Ismail & Al-Hashmi, 2011; Mahasneh, 2014; Meena & Luhar, 2019; Noruzman et al., 2012; Rao et al., 2014; Raza et al., 2020; Shekarchi et al., 2012; Tay & Yip, 1989; Terro & Al-Ghusain, 2003; Tonetti et al., 2019; Tumediso et al., 2014) contain warnings of this risk, possibly because concrete is an extremely alkaline and hostile environment, which makes it difficult for most microorganisms to survive, except in the case of specific bacteria that may be added to concrete to help close cracks through the production of calcium carbonate (Knoben, 2011). Furthermore, it should be noted that although concrete is conventionally produced with drinking water, inspection or physical-chemical testing of water used in concrete production is not routinely carried out. In other words, despite being considered potable, the water used may not conform to specified standards and present characteristics that are worse than or comparable to those of treated wastewater.

When the results obtained here are compared with other studies, it is noted that, in fact, there is a significant variation in the acceptance of paving blocks. That is because, according to Peattie (2010), research has shown that individuals are highly inconsistent in their consumption and environmental values, which makes it more difficult to perform conclusive evaluations. Furthermore, the studies on the subject, which are mostly quantitative, create modeling that is often partial considering the complexity of consumer behavior, therefore presenting partial answers (Peattie, 2010).

Studies on conscious consumption suggest that few people would pay more for a more sustainable product and that the intention to consume often does not result in actual consumption (Groenig et al., 2018). In other words, despite the awareness of the need for more sustainable consumption, its practice is still often postponed by consumers, as seen in this study.

Lack of trust in government supervision and in the production of paving blocks by companies were mentioned as reasons by 15.0% and 4.0% of respondents, respectively. Thus, it is clear that a significant part (19.0%) of participants who rejected the paving blocks is not concerned about the quality and physical and mechanical characteristics of the paving blocks or the possible risks they might offer to users, but rather about the need to control production processes and provide adequate supervision. Thus, ensuring the proper standardization of processes, combined with an effective supervision system, might result in increased acceptance and, consequently, more widespread use of this material.

Other reasons reported by the participants to reject the use of the paving blocks in indoor areas of their homes (Figure 7) relate to the fact that they consider reusing treated wastewater in paving blocks an unpleasant practice (7.0), or claim that the blocks would have an unpleasant smell (7.0%) or an unpleasant appearance (5.0%). However, among the scientific studies on the use of treated wastewater in concrete production available in the literature (Al-Ghusain & Terro, 2003; Al-Jabri et al., 2011; Asadollahfardi et al., 2016; Duarte et al., 2019; El-Nawawy et al., 1991; Ghrair & Al-Mashaqbeh, 2016; Hassani et al., 2020; Ismail & Al-Hashmi, 2011; Mahasneh, 2014; Meena & Luhar, 2019; Noruzman et al., 2012; Rao et al., 2014; Raza et al., 2020; Shekarchi et al., 2012; Tay & Yip, 1989; Terro & Al-Ghusain, 2003; Tonetti et al., 2019; Tumediso et al., 2014) no mention was found of odor emanation, change in appearance or health risk caused by the presence of wastewater in the composition of the concrete mix.

That said, the broad disclosure of the results obtained so far and of the characteristics of concrete made with treated wastewater, as well as the development of new research in the area, are possible ways to improve the acceptance of this material by the public. However, one must still consider that despite regulation and proof that this practice poses no risk or harm, some users may continue adopting a conservative stance and come up with other reasons to continue rejecting the use of this material.

Due to a possible disapproval by users, five psychological factors are observed in sustainability-oriented marketing, namely: social influence, habit formation, feelings and cognition, tangibility and individual self (White et al., 2019).

Therefore, these aspects, even if unconsciously at times, may influence the decision of consumers of whether to buy more environmentally friendly products/materials. Such points should probably be addressed in awareness campaigns and other forms of encouragement, such as more competitive prices or offering discounts to potential users. Chan et al. (2017) highlight that, in the building sector, in addition to financial incentives, three other practices can greatly encourage the adoption of green technology: providing more information on product costs and benefits, government regulations and policies, and adoption of green certification or other forms of sustainable assessment.

Besides these issues, part of the respondents showed concern about the reduction in concrete strength (3.0%) and its durability (4.0%). Although such concerns were less recurrent, the literature shows that there is a tendency towards reduced compressive strength due to the residual presence of organic matter and solids.

However, such reduction is generally acceptable, depending on the level and quality of treatment to which the wastewater has been submitted, and is below the maximum limit set by different standards (ABNT, 2009; ASTM, 2012; BIS, 2000; BS, 2002; ISO, 2010, SABS, 2006).

Regarding durability, some properties have been evaluated by different authors (Asadollahfardi et al., 2016; Hassani et al., 2020; Raza et al., 2020; Rao et al., 2014; Saxena & Tembhukar, 2019; Shekarchi, 2012; Terro & Al-Ghusain, 2003). Nevertheless, further studies are still needed, especially for use in reinforced concrete structures due to the possible influence of soluble compounds on steel.

4. Conclusions

This study identified a few aspects that should be noted. The first is that most respondents were unable to distinguish which strip contained the paving blocks made with treated wastewater. In addition, most users were willing to use such blocks in future works, but not so much in their own homes and even less in indoor areas of their residences.

Regarding the three concepts that explain social consumption practices (Shove, 2003a), one notes that the paving blocks meet the criteria of comfort, since the use or not of treated wastewater produced no visual changes that might allow users to identify the difference. Furthermore, comfort was also associated with the fear of contracting diseases (since the water originates from treated wastewater) and the aesthetic issue of the paving's appearance. The former aspect was considered an issue of concern by a significant number of users and the latter was not viewed as an obstacle by many respondents.

Regarding convenience, despite the direct connection with the reduced consumption of drinking water and consequent lower demand of water resources, for consumers the use of this product is seen as no different from products made in a conventional way. For producers, however, there is a logistical issue involved in the operations of collecting, transporting and storing treated wastewater, which would imply possible increases in production costs and in the final price of the product. Therefore, a feasibility study of the financial and logistical aspects of the paving blocks herein investigated is in order. As for cleanliness, as pointed out, a difference was identified in the acceptance of the paving blocks for indoor and general use, which was significantly higher for the latter. This may indicate a greater need for a sense of healthiness in indoor areas.

Although satisfactory results for all groups evaluated were generally obtained regarding the acceptance of this material, it is important that, once its technical feasibility has been established, standards are set for the use of treated wastewater as an alternative source of water for the production of concrete. Furthermore, supervision will make users feel safer when use paving blocks or any other material that contains reused water in building work, whether in indoor or outdoor areas.

Furthermore, widespread disclosure of scientific research findings on the use of treated wastewater in the production of concrete and its influence on the physical and chemical properties of this material tends to contribute to a greater sense of security. This feeling can be enhanced among non-professional consumers through marketing techniques. It is also important to conduct and disseminate research to assess the health risks from contact with concrete artifacts produced with treated wastewater so that users have greater confidence to use this material.

Therefore, given the results obtained herein, it can be concluded that despite the high rates of acceptance among people familiar with the building sector, there is still a long way to go in terms of expanding the acceptance of the use of alternative water sources, especially as a component of concrete paving blocks.

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