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Research Article

Architectural students' attitude towards using recycled materials in building design

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Abstract
People are discarding massive quantities of waste. The use of recycling waste in building construction was suggested as an effective solution to optimize resource management and to reduce the serious impact of waste on the environment. There is little information about the attitude of architectural students towards this matter and to what extent they are prepared and willing to integrate recycled materials in their designs. Architectural students at Bilkent University watched two videos of a house built from recycled materials which were visible as recycled waste in the structure of the building, and a house built from recycled materials but not visible as recycled waste. Then, students filled an online survey about their experience after watching the videos. Descriptive statistics were used to summarize the data. Results showed that over half of the students would give priority to using recycled materials in their projects, and that students' preference for using recycled materials was mainly based on the quality of the design rather than the source of materials. The authors identified the importance of educating architectural students about factors related to integrating recycled materials in building design; and addressed the lack of a holistic database related to waste recycling in the academic learning process.

Keywords: Recycling in Building Design, Architectural Students, Education, Curriculum, Mental Health.

INTRODUCTION

Solid waste is a waste type that consists of everyday items that are discarded by the public including papers, plastic, cans, bottles, and food. The amount of solid waste has gained more attention because of its fundamental effect on the environment and resource management (Vergara & Tchobanoglous, 2012: 37). Furthermore, people are discarding growing and massive quantities of solid waste, and its disposal is becoming more complex and challenging every day more (Das et al., 2019: 228). The annual global generation of solid waste was estimated at 17 billion tons in 1990 and was predicted to hit 27 billion tons by 2050 (Karak et al., 2012: 42; Tang et al., 2020: X6). Construction and demolition waste is another type of waste that is defined as the waste produced during the construction, renovation, and demolition of buildings and structures (Kabirifar et al., 2020: 263). Construction and demolition waste is becoming one of the most serious environmental problems, causing toxicity to the soil and water compartments when dumped in landfills (Butera et al., 2015: 44). About 35 per cent of industrial waste in the world is generated by the construction industry (Polat et al., 2017: 196; Solís-Guzmán et al., 2009: 29). In 2014, the construction and demolition waste were 1.13 billion tons in China, 534 million tons in the United States, over 58 million tons in the United Kingdom, and over 19 million tons in Australia (Menegaki & Damigos, 2018: 13).

Recycling solid waste and construction and demolition waste in building construction was suggested and encouraged as an effective solution to optimize the resource management and to reduce the serious

environmental impact of wastes (Jin et al., 2017: 126; Peng et al., 1997: 15). For example, Belgium utilizes about 102 thousand tons of incinerated bottom ashes every year as building sand, road subbase material, and gravel alternatives (Joseph et al., 2018: 11). South Korea established 373 construction and demolition waste treatment corporations to handle an annual construction and demolition waste generation of about 60 million tonnes (Jin et al., 2017: 126). At a municipal level in China, the Chengdu government announced in 2016 that for all government-funded projects, the percentage of recycled contents must be above 5 per cent for building projects (Jin et al., 2017: 126).

Problem

As the world is moving towards waste recycling in construction, there is too little information about the attitude of architectural and interior design students about this matter and to what extent they are prepared and willing to integrate recycled materials in their future designs. Furthermore, the impact of solid or construction and demolition waste integration in building structures on mental health, its reception, and how to use recycled material in construction design by architectural and interior design students were not assessed.

Importance

Like many countries in the world, solid waste, and construction and demolition waste handling are fundamental problems in Turkey and using recycled waste in building construction is encouraged (Arslan et al., 2012; Esin and Cosgun, 2007: 42).

Aims

This study aimed to collect a database of the architectural students' design preferences after exposing them to different styles of using recycled materials in building design. Furthermore, as using recycled materials should be agreed on with the clients, this manuscript aimed to evaluate architectural students' anticipation of how to convince clients to accept using recycled materials in building design. We discussed previously that one of the important factors in building design is to support people's mental health (Aljunaidy & Adi, 2021: 14). Therefore, the study herein aimed to assess the effect of using recycled materials in building design on students' perception, and on stimulating positive emotions such as hope, enjoyment, and optimism.

Hypothesis

We hypothesized that architectural students' design preferences, feelings, acceptance, and prioritizing of using different types of recycled materials in building design are mainly driven by the perceived quality of design rather than the source of building materials.

METHODS

Ethical approval and consent

Ethical approval was obtained from Bilkent University (the Office of the Vice-Rector for Academic Affairs, 8 March 2021, board decision No. 2021_03_08_03). The ethical approval followed the principles endorsed by relevant professional bodies to Declaration of Helsinki (WMA), Ethical Principles of Psychologists and Code of Conduct (APA), and Ethical Standards for Research with Children (SCRD).

Study Instrument

A team of cross-disciplinary researchers designed a survey that included 31 open- and closed-ended questions related to preferences, feelings, mental health, and attitudes towards using recycled materials from solid waste, or construction and demolition waste in building construction. The survey was uploaded online using the "Google Forms" website. A link to the survey was then spread by email to graduate and undergraduate students at the Faculty of Architecture at Turkey's Bilkent University. The participants were informed that the survey would be confidential, their responses would be anonymised, and they could withdraw from the survey without giving any justification. Before they could fill in the survey, the students needed to watch two video recordings of about 3 minutes each. The first video recording was showing a house built from solid waste materials including plastic and glass bottles, cans, milk cartoons, newspapers, magazines, marble waste, carbon papers,

bamboo, compact discs, and clothes [building A, (Renewable Home by SBS Australia, 2020)] (Figure 1, a). The recycled materials were used artistically and were visible in the structure of building A. The second video recording was showing a house built mainly from recycled construction and demolition waste especially wood, glass, and metal [building B, (Penn B, 2020)] (Figure 1, b). Used recycled materials were not visible in the structure of building B, and students were not informed that building B was built mainly from recycled materials until the last part of the survey. The reason for that was to assess the students' actual feelings and preferences in these two types of building design after neutralising the fact that both buildings were made from recycled materials. After announcing that building B was mainly built from recycled construction and demolition waste, the students were asked if they changed their preference of buildings A and B, and what was the reason.

Figure 1. Buildings A & B

a: Building A was a house built from recycled materials which were visible as recycled waste in the structure of the building. **b:** Building B was a house built from recycled materials but not visible as recycled wastes. Building A: Renewable Home by SBS Australia, 2020; Building B: Penn B, 2020.

The survey was divided into two major sections. The first section was about students' design preferences and feelings about these two different buildings. We purposefully did not indicate any opinion, nor did we include any information regarding materials so that we would not affect what our participants choose. The second section focused on their future vision of using recycled waste in their building design and to what extent they feel prepared and encouraged to do that. A wide range of words to describe feelings were taken from a previous study to encourage deeper thoughts in students' responses (Graham, 2015). Those words were the following: happy, excited, interested, amazed, fascinated, proud, curious, fantastic, surprised, special, marvellous, buzzing, tired, bored, silly, fed up, sad, scared, and strong (Graham, 2015).

Data Analysis

Participants were invited to rate the statements in the survey, using a 5-point Likert scale, from "strongly disagree" (one point) to "strongly agree" (five points). The higher the students' score is, the more positive their satisfaction towards their tours' experience. Descriptive statistics were analyzed and organized in figures, and tables using the "Google Forms" website and Microsoft Excel Worksheet.

RESULTS

Participants' Distribution

The call of the survey received 81 participants. 83.8 per cent of the study participants were females, and 16.3 per cent were males. This imbalanced gender participation ratio is a characteristic of the architecture department at Bilkent University. All students provided information about their year of study, indicating that 22.2 per cent were in their first year, 33.3 per cent in their second year, 18.5 per cent in their third year, 12.3 per cent in their fourth year, 6.2 per cent were master's students, and 7.4 per cent were Ph.D. students.

Effects of Different Designs on Students' Perception and Mental Health

Most of the students (86.42 per cent) chose building B as their favourite building design, while only 13.58 per cent of the participants chose building A. Among the reasons indicated by the students were that building B seemed cozy, warm, and close to nature; while building A seemed too busy and felt like living in a "waste place" (Figure 2). Those who chose building A mentioned that it was because it seemed like a representation of freedom of creativity and art and was unusual. However, only one student justified choosing building A because it was built from recycled materials; indicating "because it fits my idea of recycling".

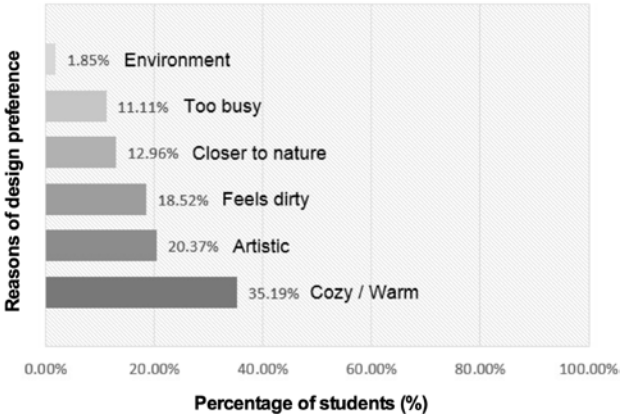

Figure 2. Reasons indicated by the architectural students to justify their design preferences after touring buildings A and B

Among the 19 words that were given to students to choose from that best described their feelings in the tours, the most reported feelings regarding the tour in building A were being interested or surprised, while the most reported feelings regarding the tour in building B were being happy, special, or interested (Table. 1).

Table 1. Words were given to architectural students to choose from the best that described their feelings in the building tours

Students' feelings	Percentage of students (%) Building A	Percentage of students (%) Building B
Happy	2.5	**31.3**
Sad	1.2	0
Bored	4.9	8.8
Fascinated	6.2	7.5
Excited	1.2	0
Scared	6.2	0
Amazed	8.6	8.8
Fantastic	1.2	2.5
Proud	8.6	1.2
Special	2.5	**17.5**
Marvelous	0	1.2
Buzzing	3.7	0
Fed up	2.5	0
Silly	8.6	0
Strong	0	0
Tired	7.4	1.2
Interested	**16**	**13.7**
Surprised	**13.6**	0
Curious	4.9	6.3

When students were asked if the tours in buildings A or B gave them positive emotions such as hope, enjoyment and optimism, more students strongly disagreed about having positive emotions in building A compared to building B (Figure 3).

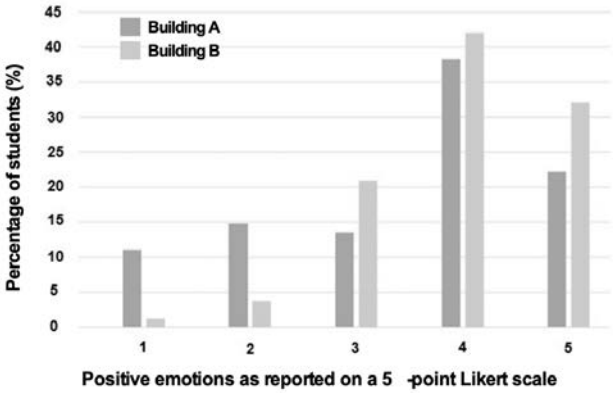

Figure 3. Positive emotions such as hope, enjoyment, and optimism as reported by architectural students after touring buildings A and B

More students strongly disagreed about having positive emotions in building A compared to building B. A 5-point Likert scale, from "strongly disagree" (1 point) to "strongly agree" (5 points) was used for the assessment.

Moreover, most students felt that the tour in building B reduced their level of anxiety and was a calming experience (Figure 4, a). However, only a few participants indicated that the tour in building A reduced their level of anxiety and was a calming experience (Figure 4, a). Although over half of the students reported they would recommend the tour in building B to others, some students strongly disagreed with recommending the tour in building A to others. The strong disagreement of recommending the tour of building A to others was not chosen by any study participant when it came to building B (Figure 4, b).

Students' Vision Regarding Using Recycled Materials in Design

Most students (86.4 per cent) agreed or strongly agreed that adding recycled materials in building design will help the environment, 7.5 per cent were neutral, and 6.2 per cent disagreed or strongly disagreed. About a third of the students (34.6 per cent) reported that they do not mind living in a house built from recycled materials. However, all students were asked if one day they decided to use recycled materials in the construction of their own houses, would they choose to use recycled materials in the core of their house design or only as a decoration. Many students answered that they preferred to use recycled materials only as a decoration of their houses (58 per cent), and under half of the students would use recycled materials as a core of their house design (44.5 per cent).

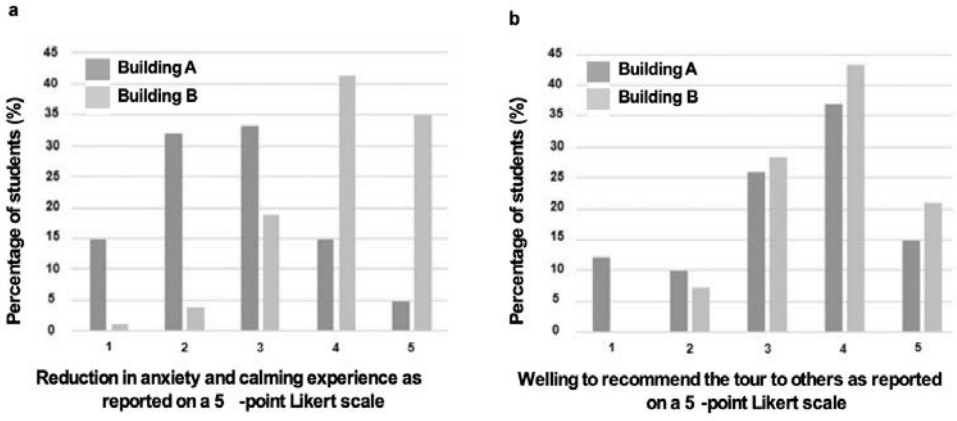

Figure 4. Effects of different designs on students' perception and mental health

a: More students felt that the tour in building B reduced their level of anxiety and was a calming experience compared to building A. **b:** Some students strongly disagreed on recommending the tour in building A to others. The strong disagreement of recommending the tour of building A to others was not chosen by any of the study participants when it came to building B. A 5-point Likert scale, from "strongly disagree" (1 point) to "strongly agree" (5 points) was used for the assessment.

To effectively convince the clients to accept using recycled materials in the design of their buildings, most architectural students thought that the best way was to explain that using recycled materials in a building could be a cheaper option than using new materials, and that using recycled materials does not necessarily mean that the final product would be of a bad quality (Figure 5). Only a few students thought that it could help convincing the client by explaining the environmental impact, or that the buildings would be unique in shape and/or structure (Figure 5).

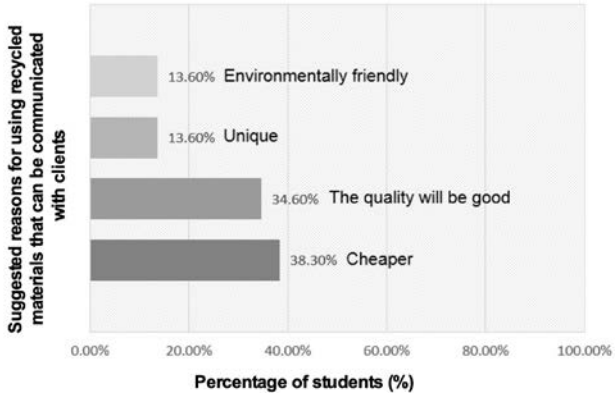

Figure 5. Architectural students' anticipation of how to convince clients to accept using recycled materials in building design

Furthermore, only about a quarter of the students (26.6 per cent) believed that big budget project managers would accept the idea of using recycled materials in building design rather than working on new nonrecycled materials. Many students thought that they were encouraged throughout their architectural study to integrate recycled materials in their project designs (55.5 per cent agreed or strongly agreed, 23.5 per cent neither agreed nor disagreed, and 21 per cent disagreed or strongly disagreed). Over half of the students mentioned that they would give a priority to add or integrate recycled materials to their project designs after graduation (Figure 6).

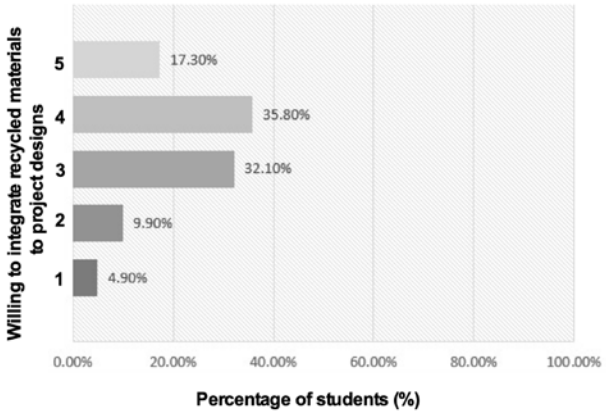

Figure 6. Students' vision regarding integrating recycled materials in building design

Over half of the students said that they will give a priority to add or integrate recycled materials to their project designs after graduation. y axis is a 5-point Likert scale, from "strongly disagree" (1 point) to "strongly agree" (5 points).

After announcing that both buildings A and B were mainly built out of recycled materials, most of the students (86.4 per cent) did not change their design preference. However, 13.6 per cent of the students changed their design preference indicating that they prefer building B over building A, while none of the students changed their design preference to become building A overbuilding B. This change in design preference to building B showed that the main drawing factor behind making a design choice was the perceived quality of design rather than the environmental impact of solid waste or construction and demolition materials.

DISCUSSION

Our study aimed to assess architectural students' attitudes towards using recycled materials in building design. Furthermore, assessing the effect of using recycled materials in buildings on students' mental health and perception was novel as no study did that previously. The main aim of the study was to address the need for a strong and clear curriculum about recycled material used in building design to increase the incorporation of waste recycling in buildings and consequently save the environment. The main results were that over half of the students would give priority to using recycled materials in their projects, and that students' preference for using recycled materials was mainly based on the quality of design rather than the source of materials. Building B, which looked more like a usual home, reduced the level of anxiety and was a calming experience to the students compared to building A where recycled solid waste usage was visible in its design structure. The students suggested ways to communicate these matters and convince their clients to accept using recycled materials. However, no training is usually provided to students about this matter, indicating the need for a holistic database related to waste recycling options and strategies in the architectural students' curriculum.

Our paper emphasised the importance of design quality in architectural students' perception of building design. In general, the students considered building A unique in an artistic way, but it was fun to see not to live in. While building B was not considered artistic by most of the students but felt relaxing and home-like. Quality in construction is defined by the totality of the characteristics and performance evaluations that determine the purpose fulfillment of a product (Thomson et al., 2003: 31). Although, architectural students' preference of design quality over the source of building materials was not assessed previously, design quality has always been of great demand by constructed space users (Frontczak et al., 2012: 22; Thomson et al., 2003: 31; Watson et al., 2016: 25). Therefore, using recycled materials might be encouraged by teaching and guiding architectural students on how to use those recycled materials in a way that feels warm, and livable rather than the work of the design to be artistic but in a way that visibly shows that it is made of recycled waste.

The impact of physical environment design on mental health is gaining more attention (Aljunaidy & Adi, 2021: 14). The main feeling of students in building A was being interested, while the main feeling in building B was being happy. The happiness created in building B was mainly justified by the students by indicating that building B felt "like-home". Feeling "interested", although it is not as strong as the word "happy", is still a positive feeling reflected by the originality and artistic features of building A, which means that using recycled waste in an artistic way can still support positive emotions, but not as strong as keeping the design close to ordinary, cozy, and being "like-home". A previous study supports our findings by showing that to support customers' happiness in building design, architects should design for belongingness (Sääksjärvi & Hellén, 2013: 29). Building B seemed like an ordinary but cozy home, and gave architectural students the feeling of "belongingness" which could justify why most of the students preferred it over building A. The results out of our study can be used as a reference for designers when they make relevant decisions.

Architects usually decide about the design and then order the products. However, when recycled materials are going to be integrated heavily in a building design, the architects need to know first what the available resources are and then work on the design of the building accordingly. Therefore, reaching a solid agreement with the clients about whether to use recycled material or not and to what extent is essential at the early stages of architectural projects. Understanding architectural students' thoughts about clients' preferences and how to effectively communicate with clients is crucial to support the students and guide them to develop and strengthen their communication skills in a way that they can establish early and solid agreements with their clients. Previous studies suggested that educating the clients is an important element of the successful architect-client relationship (Norouzi et al., 2015: 172; Siva and London, 2011: 7). Clients who find themselves involved with unfamiliar processes feel stressed and confused, but they become more comfortable as they gradually learn more about the process and the reasons behind it (Norouzi et al., 2015: 172; Siva and London, 2011: 7). Our study showed that architectural students think that to encourage clients to accept using recycled materials in their building design, the architect should emphasize to the client the financial impact of integrating recycled materials in building design, and that using recycled materials does not necessarily mean compromising the quality of the final product. Only a few students thought that communicating the environmental impact or possibly ending up with a unique design will be of much help in convincing the clients. Further studies are still needed to know the clients' points of view and their preferences about using recycled materials in building

design. This is particularly important to create a holistic database that can be integrated into architectural students' curriculum, so they are trained to be more effective and successful in communicating with their clients after graduation. Further, students can be trained to deal with clients by making them work in group environments which means that students need to develop their negotiation skills, compromise, and reach solutions that everyone is happy with. The other way is through internships where the students can work in an actual architectural office environment and deal with clients under supervision and the help of mentors who can guide the students through the process. Workshops are another way to train the students about how to negotiate design materials with their clients.

Recommendations

Studying about using recycled materials in architectural and interior design projects should be made available as early as possible in the academic curriculum, preferably when students are studying "Materials in Design" which is usually on the second or third academic year. To encourage students to use recycled materials in their projects, it is important to show them good examples of using recycled material in design and convince them through practical examples that using recycled materials does not always mean compromising the quality of the building and its design. Furthermore, students can be exposed to practical scenarios in their design projects where they are forced into using limited material selections specifically using unconventional and recycled materials. By doing that, students will gain practical experience in handling recycled materials-dependent projects.

CONCLUSION

As the world is moving towards waste recycling in construction, it is essential to assess architectural students' design preferences and perceptions regarding this matter. This study collected a database of the architectural students' design preferences and perceptions after exposing them to different styles of using recycled materials in building design. In general, architectural students' design preferences, feelings, and prioritizing the usage of different types of recycled materials in building design were driven by the perceived quality of design rather than the environmental impact of recycling. Students would prefer to give the building design a feeling of being cozy and warm, rather than emphasizing the environmental aspect visibly in the final product of their design. Many students indicated that they would give a priority to add or integrate recycled materials into their project designs after graduation. Therefore, it is necessary to educate architectural students about the best ways of integrating recycled materials in their future building design and expose them to practical scenarios in their design projects. Furthermore, as using recycled materials is a matter that should be agreed on with the clients, training students to effectively communicate with their clients regarding using recycled materials in building design should be of great focus in the academic learning process.

Authors' Contributions

The authors contributed equally to the study.

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Authors received no funding for this project.

Competing interests

The authors have no conflict of interest.

Ethical approval and consent

Ethical approval was obtained from Bilkent University (the Office of the Vice-Rector for Academic Affairs, 8 March 2021, board decision no. 2021_03_08_03). The ethical approval followed the principles endorsed by relevant professional bodies to Declaration of Helsinki (WMA), Ethical Principles of Psychologists and Code of Conduct (APA), and Ethical Standards for Research with Children (SCRD).

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