Modern Nature-Based Construction Technologies and their Public Perception in Poland

Elżbieta Radziszewska-Zielina[1*)], Julia Hałatek[2)]

[1*)] Faculty of Civil Engineering, Cracow University of Technology, 24 Warszawska Street, 31–155 Kraków, Poland; e-mail: elzbieta.radziszewska-zielina@pk.edu.pl; ORCID: https://orcid.org/0000-0002-3237-4360

[2)] Graduate of the Faculty of Civil Engineering, Cracow University of Technology, 24 Warszawska Street, 31–155 Kraków, Poland

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Abstract

This paper presents the results of a survey on the state of public awareness of nature-based technologies in construction and, in particular, opinions on green roof and green wall technologies in Poland. The survey was conducted in December 2023, online, using thematic groups on a social networking site. The groups focus on urban ecology and green solutions in construction. A total of 210 people participated in the survey. Its results showed that although green technologies are gaining interest, the percentage of respondents who either live or have lived in buildings that feature these solutions remains small. The respondents displayed a positive attitude towards green roofs and walls, and considered them an interesting and safe solution. The positive perception of these technologies stems from, among other things, their potential impact on air purification, smog reduction and increased oxygen production. The respondents recognized and valued the aesthetic qualities of green technologies, appreciated their impact on improving the appearance of cities and the creation of additional places for relaxation, which are increasingly sought after in urban space. One can see the need to further promote and educate the public about the benefits of green technologies in construction. Their sustainable development can not only positively affect the aesthetics of cities, but also contribute to the creation of greener and more people-friendly urban spaces, in line with the needs of modern society.

Keywords: *survey, green technologies, construction, Nature-based*

1. Introduction

In research, it is crucial to choose the right method. In the case of survey research, human opinions and preferences are studied. Various factors can influence survey respondents and the relationship between them [1]. Surveys have been used in the construction industry, among other things, as preliminary stages of research [2,3] and have served as data sources in decision support [4,5].

Survey research, although typically used in the social sciences and less frequently in the technical sciences, can facilitate problem-solving in many areas specific to construction. This paper continues the subject matter presented in this area at the WMCAUS conference [6,7].

Nematchoua et al. [8] used a questionnaire to investigate occupant satisfaction with thermal conditions in educational and residential buildings in Madagascar during the rainy and dry seasons. The comfort of buildings with internal thermal insulation was investigated in [9,10].

Fedorczak-Cisak et al. [11] used surveys of experts to assess the societal benefits of preserving a building's heritage. This was later used to support a multi-criteria analysis of selecting a new use function for a heritage building [12]. Expert surveys can also be used to assess how measurable and difficult-to-measure parameters affect each other and the relationships between them [13].

Construction service providers and clients and their needs and preferences can also be surveyed through surveys. Officials, contractors and representatives of consulting firms were asked about the needs of small and medium-sized construction companies in Ghana by Asante et al. [14]. Decision-making factors that influence the choice of building materials were studied by Ivanova and Smetanin [15], while building renovation needs were assessed by Nowogońska [16].

A series of surveys were carried out on construction partnering relations [17,18], as well as methods that can be used to control them [20], while their impact on project time and cost parameters was examined in [19]. and in [22] an original algorithm was proposed to facilitate the selection of subcontractors by general contractors in the context of partnerships. The flow of information in construction projects was also repeatedly studied through surveys [20–22].

Sustainable construction continues to be a major focus of academic research, and energy retrofits are a part of this area [23]. Preferences for technical solutions for sustainability-oriented projects were studied in [24], while the urban layout of a residential neighborhood was assessed in [25] – both studies were based on surveys of expert opinion.

Surveys were also used to examine green building and attitudes toward it. Green roof design solutions were analyzed in Greece on a group of local residents, finding that they were in high demand [26]. Darko and Chan [27] interviewed green building experts in Ghana to identify potentially effective promotional strategies. Barriers to wider adoption of green building were explored in [28], finding a number of significant barriers in the Ghanaian context.

It is estimated that by 2050, 66% of the Earth's population will live in urban areas that are of interest to green urban technologies [29]. In the literature, green walls are referred to as living walls, vertical gardens, vertical greening systems [30]. A green wall is a system of attaching plants to structures or walls of buildings, in which plants grow on a vertical surface in a controlled manner and with regular maintenance [31]. Green wall technologies are discussed in [32], among others. An example of green wall application technology in Singapore is presented in [33].

In addition to the ecological advantages of green solutions, publications point to the psychological and social aspect of green roofs and facades [30–33]:

- a building with a green roof and/or green facade attenuates noise better than a standard wall,
- a green roof and/or facade increases the market value of the building,

- greenery improves the aesthetics of the building/neighborhood/city,
- greenery has a positive effect on the human nervous system,
- more green space in a city has a positive impact on the integration of residents,
- working in a place equipped with green areas positively affects productivity and creativity.

An online survey was conducted between November 20, 2023, and December 24, 2023, to gauge the interest of potential users in buildings equipped with a green roof or green wall technology. The survey also focused on the degree of consumer awareness of such solutions. The survey was conducted online, using thematic groups on a social networking site. The groups focused on urban ecology and green building solutions. A total of 210 respondents took part in the survey. The survey consisted of 24 single-choice questions.

The purpose of this paper is to present the results of a survey on the state of public awareness of nature-based technologies in construction in Poland, and in particular, opinions on green roof and green building wall technologies.

2. Results of the Survey

The vast majority of the people surveyed (60.5%) were aged 18–29, those aged 30–39 accounted for 24.8%. A smaller group (6.7%) was made up of people aged 40–49, while those aged 50–59 accounted for 7.6% of those surveyed. Only one person that took part in the survey was over 60 years old (0.5%). The demographic analysis indicates that the vast majority of those interested in the survey topic were young people. This is of particular significance, given that people aged 18 to 29 are also the largest group looking for apartments to buy or rent. It is this age category that seems to be most interested in buildings with green roofs and facades, which could be a key factor for developers and project owners when designing modern residential buildings.

Most of those surveyed had a university degree (52.9%). 93 people declared that they had a high school education which was 44.3% of the respondents. Only 6 people responded that their education was primary.

The largest number of people taking part in the survey were those living in cities with more than 750,000 residents (31%). Those residing in rural areas accounted for 28.6% of respondents. The remaining people resided in cities with less than 750 thousand residents.

The vast majority (59%) of respondents reported that they had previously encountered the concept of a green roof and/or green facade. A total of 32% of respondents said they had not encountered such concepts, while 9% could not remember. The results suggest that while green roofs and facades seem to have some presence in the public conscious, there were areas where more awareness and education were needed.

In terms of the source of knowledge, 68.5% of respondents learned about green roof and/or green facade technology from the media, while 17% of respondents learned about it from family or friends, and 14.5% of people learned about it from literature.

The vast majority of respondents (89.%) reported that they had not previously lived in a building using green roof and/or green facade technology. Only 10.5% of respondents gave a positive answer to this question. This suggests that while such innovative solutions were gaining popularity, they were still not being used on a wide scale. This may be due to the limited availability of such buildings, lack of public awareness or other factors.

In terms of interest, 41% of respondents expressed no interest in living in a building with a green roof and/or green facade, while 26% of respondents considered such a solution, 20% responded negatively (did not consider living in such a building) and 13% responded positively.

When asked whether, if given the opportunity to live in a building with a green roof, a respondent would choose a solution with a usable or non-usable roof, slightly more than half of the respondents (52%) stated that they would choose a usable roof, while 32% of respondents indicated that both a usable and non-usable roof would be suitable for them. Only 9% of respondents preferred a non-usable roof on their building. while 7% of respondents have no opinion on the subject.

A total of 80% of respondents had a positive view of a green usable roof in terms of engaging leisurely activities on it, considering it safe or at least relatively safe (36% “strongly agree,” 44% “agree”). Only 13% of respondents expressed a negative or mostly negative opinion on the subject (11% “disagree,” 2% “strongly disagree”). The responses suggest that the majority of respondents perceived usable green roofs as a relatively safe place to spend leisure time. Only 7% of respondents had no opinion on the subject.

The majority of respondents (a total of 63%) were willing or considering incurring additional costs for the maintenance and care of a green roof. On the other hand, 37% of respondents (27% “disagree,” 10% “strongly disagree”) expressed doubt or strong reluctance to incur additional costs related to this. There were varying attitudes about financial preparedness to maintain such an arrangement.

The vast majority of respondents (72%) agreed that a green roof should be a common space for all of a given building’s residents, regardless of the floor on which they resided. Only 10% thought it should be restricted to residents of the top floor only, and that they should thus bear more of the associated costs, while 18% of respondents had no opinion on this issue.

When asked whether living in a building with a green roof and/or green facade would improve living comfort, 23% of respondents answered in the affirmative, and 41% rated this concept rather positively. In contrast, 30% of respondents expressed a rather negative attitude, and only 6% were strongly opposed. Despite a number of those who expressed doubts or reluctance, the majority of respondents seemed to be positive about the idea of living in a building with green infrastructure elements.

We observed fairly strong support for the idea that public institutions, such as offices and schools, should use green roof and/or green facade technologies. A total of 61% of respondents answered positively (28% “strongly agree” and 32% “agree”). In contrast, 19% expressed a rather negative view (“disagree”) and 6% were strongly opposed (“strongly disagree”). In addition, 14% of respondents had no concrete opinion on the subject. Thus, it is noteworthy that the majority of respondents seemed to be open to the idea of using green technologies by public institutions.

Most of those surveyed agreed that mandating the use of green roof and/or facade technologies for public institutions could encourage private project sponsors to construct new buildings using these technologies. Nearly 66% of respondents answered positively (26% “strongly agree,” 39% – “agree”). In contrast, 18% expressed a rather negative view (“disagree”), and 3% were strongly opposed (“strongly disagree”). By contrast, 13% of respondents had no opinion on the subject.

The majority of respondents (80% in total) considered urban environmental protection highly relevant or relevant. As many as 46% of respondents answered “strongly agree,” indicating a direct interest in environmental protection in an urban context. Here, 34% chose “agree,” suggesting that while urban environmental protection was important to them, other aspects may also be highly

relevant to them. Only 14% of respondents marked “disagree,” and 6% answered “strongly disagree.” A clear minority of respondents had a negligible interest in environmental protection in the urban context.

For the majority of respondents (a total of 71%), environmental aspects played an important role in choosing where to buy a home. “Strongly agree” answers accounted for 29%, while “agree” accounted for 42% of respondents, suggesting that ecological aspects were a key factor when deciding to buy a property. Conversely, 24% of people marked “disagree” and 5% marked ”strongly disagree,” indicating that a minority of respondents qwre not interested in ecological aspects when choosing where to live.

For most respondents, environmental issues were either highly relevant or relevant. Air purification was considered the most important benefit, as confirmed by 82.8% of respondents (51.4% considered it “relevant” and 31.4% considered it “highly relevant”). Oxygen production and smog reduction were also considered relevant aspects by respondents. In contrast, taking care of biodiversity seemed to be less relevant – for 4.8% it was completely unimportant, and for 26.2% it was indifferent (Table 1).

Tab. 1. A compilation of responses to the question regarding what are the perceived benefits of a building with a green roof and/or green facade?

Advantages	Insignificant number of responses (%)	Mostly insignificant number of responses (%)	Indifferent number of responses (%)	Relevant number of responses (%)	Highly relevant number of responses (%)
Air purification	7 (3.3%)	14 (6.7%)	15 (7.1%)	108 (51.4%)	66 (31.4%)
Treatment of rainwater	8 (3.8%)	16 (7.6%)	33 (15.7%)	109 (51.9%)	39 (18.6%)
Reducing the phenomenon of "urban heat island"	12 (5.7%)	12 (5.7%)	34 (16.2%)	81 (38.6%)	68 (32.4%)
Natural fireproof layer	7 (3.3%)	19 (9.0%)	50 (23.8%)	90 (42.9%)	40 (19.0%)
Caring for biodiversity	10 (4.8%)	18 (8.6%)	55 (26.2%)	94 (44.8%)	31 (14.8%)
Regulation of humidity	7 (3.3%)	14 (6.7%)	43 (20.5%)	105 (50.0%)	38 (18.1%)
Recovery of biologically active area lost by development	10 (4,8%)	18 (8.6%)	30 (14.3%)	94 (44.8%)	54 (25.7%)
Protection of surfaces from overheating	11 (5.2%)	13 (6.2%)	29 (13.8%)	104 (49.5%)	52 (24.8%)
Neutralization of harmful substances such as dust	6 (2.9%)	16 (7.6%)	31 (14.8%)	90 (42.9%)	61 (29.0%)
Reducing the concentration of smog in cities	7 (3.3%)	13 (6.2%)	21 (10.0%)	75 (35.7%)	90 (42.9%)
Generation of oxygen	9 (4.3%)	14 (6.7%)	24 (11.4%)	82 (39.0%)	80 (38.1%)
Protection of the building from UV radiation	7 (3.3%)	18 (8.6%)	45 (21.4%)	87 (41.4%)	50 (23.8%)

Respondents identified price as the main disadvantage in choosing to live in a building with a green roof and/or green facade. Only 1.9% of respondents considered this factor to be completely insignificant. In contrast, the greater weight of the structure proved significant to less than half of the respondents 47.2% (36.2% “relevant,” 11% “highly relevant”). A worrying factor is the possibility of plant roots penetrating the insulation, which was confirmed by 72.4% of respondents (Table 2).

Tab. 2. A compilation of responses to the question regarding what are the perceived disadvantages of a building with a green roof and/or green facade?

Advantages	Insignificant number of responses (%)	Mostly insignificant number of responses (%)	Indifferent number of responses (%)	Relevant number of responses (%)	Highly relevant number of responses (%)
Higher price	4 (1.9%)	19 (9.0%)	20 (9.5%)	116 (55.2%)	50 (23.8%)
Need for care	6 (2.9%)	25 (11.9%)	39 (18.6%)	101 (48.1%)	37 (17.6%)
Significantly higher weight construction	16 (7.6%)	27 (12.9%)	65 (31.0%)	76 (36.2%)	23 (11.0%)
Possible execution errors, which may result in the formation of water stagnation	5 (2.4%)	18 (8.6%)	34 (16.,2%)	97 (46.2%)	55 (26.2%)
Possible penetration of plant roots through the insulation	4 (1.9%)	20 (9.5%)	31 (14.8%)	101(48.1%)	51 (24.3%)

According to survey respondents, the key elements on a green usable roof were places for relaxation, such as deck chairs, benches, and paths and walkways. The results shown in Table 3 clearly indicate a high demand for spaces for relaxation in cities. Much less importance is given to elements such as a fountain or pond. About one-third of survey participants considered elements such as a playground or gym indifferent to them.

Tab. 3. Summary of responses to the question regarding what elements the respondent believes should be included on a green utility roof?

Elements	Insignificant number of responses (%)	Mostly insignificant number of responses (%)	Indifferent number of responses (%)	Relevant number of responses (%)	Highly relevant number of responses (%)
Benches	6 (2.9%)	13 (6.2%)	28 (13.3%)	112 (53.3%)	45 (21.4%)
Paths/walkways	10 (4.8%)	22 (10.5%)	33 (15.7%)	105(50.0%)	38 (18.1%)
Outdoor gym	16 (7.6%)	38 (18.1%)	68 (32.4%)	57 (27.1%)	28 (13.3%)
Resting area (e.g., year-round deck chairs)	5 (2.4%)	18 (8.6%)	31 (14.8%)	100 (47.6%)	55 (26.2%)
Playground	36 (17,1%)	42 (20.0%)	60 (28.6%)	51(24.3%)	17 (8.1%)
Trees, shrubs providing shade	7 (3.3%)	19 (9.0%)	33 (15.7%)	80 (38.1%)	68 (32.4%)
Fountain	55 (26.2)	48 (22.9%)	61 (29.4%)	28 (13.3%)	15 (7.1%)
Pond	53 (25.2%)	48 (22.9%)	39 (18.6%)	47 (22.4%)	17 (8.1%)
Flower compositions	19 (9.0%)	32 (15.2%)	33 (15.7%)	66 (31.4%)	58 (27.6%)

More than 68% of respondents (25.7% “strongly agree,” 42.4% “agree”) expressed interest in buying an apartment in a building with a green roof and/or green facade, while nearly 32% of people responded negatively (22.4% “disagree,” 9.5% “strongly disagree”).

A detailed analysis of the responses shows that the group residing in cities showed significantly more interest in purchasing an apartment in a building with a green roof and/or green facade compared to those living in villages and smaller towns. This is probably the result of the residents of rural areas having better access to green areas. The community living in cities, on the other hand, was more likely to express a desire to live in such buildings. This phenomenon may be the result of growing environmental awareness among urban residents and the increasing popularity of green technologies in construction.

Some 71% of survey respondents aged 18–29 expressed potential interest in buying an apartment in a building with a green roof and/or green facade. This is a high result compared to other age groups, which may be due to growing environmental awareness and modern housing preferences. Those aged 30–39 declared such a desire at a rate of about 67%, while those over 40 at 51%. It is therefore worth taking a closer look at the factors influencing this difference in preference.

Analyzing the interest in ecology of different age groups, it can be noted that for more than 88% of 18–29 year olds, urban environmental protection was important. Among those aged 30–39, 65% chose the answer “agree” or “strongly agree,”while for those over 40 the choice of such answers was 70%. The survey shows that the younger generation was more interested and involved in urban environmental issues than older people. It is important to continue educational and informational efforts to sustain and develop environmental awareness in all age groups.

3. Conclusion

The results of this survey, conducted in Poland, showed that despite a generally positive attitude toward buildings with a green roof or green walls, the share of people who have actually had the experience of living in such a building is relatively small. This may suggest that while there is a general interest, educational and promotional activities are still needed to increase actual use of green technologies in construction. Overall, the positive reception of these solutions by potential users is a promising indicator of the development of green innovations in the future.

The positive reception of green technologies is due, among other things, to their potential impact on air purification, smog reduction and increased oxygen production. Respondents recognized the aesthetic value of green technologies, appreciated their impact on improving the appearance of cities and creating additional places for relaxation, which are increasingly sought after in urban space.

The need to educate the public about the benefits of green technologies in construction is apparent. The sustainable development of these technologies can not only have a positive impact on the aesthetics of cities, but also contribute to the creation of greener and more people-friendly urban spaces, in line with the needs of modern society.

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