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EDITED BY
Karolos J. Kontoleon,
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Muhammad Tayyab Noman,
Electric Power Researcher Center (CEPEL), Brazil

*CORRESPONDENCE
Lea Primožič,
lea.primozic@innorenew.eu

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Key decision factors of professional stakeholders (architects, engineers, constructors) when deciding for sustainable construction

Lea Primožič[1,2]* and Andreja Kutnar[1,2]

[1]InnoRenew CoE, Izola, Slovenia, [2]University of Primorska, Koper, Slovenia

The built environment and the construction industry account for a significant share of global harmful emissions. Sustainable construction appears to be an effective strategy to achieve a more sustainable society, although it is still not used enough. It is crucial to understand what the main decision factors of those deciding about building practices are. Professional stakeholders such as architects, engineers, constructors, are the ones advising consumers and deciding about construction. An understanding about their decision factors is needed, in order to increase the implementation of sustainable construction. In this study we provide evidence about key decision factors of professional stakeholders in Slovenia when deciding for sustainable construction practices. By conducting an online survey (questionnaire) we identified and analyzed the main drivers and barriers of professionals when making decisions about sustainable construction solutions. With statistical analysis we found out that professional stakeholders included in the survey mostly already had previous experiences working with sustainable construction. They are familiar with sustainable construction concepts. The most important drivers were connected to the factor of occupant health, and the energy-efficiency of the buildings, while the biggest barrier in their decision making is related to higher cost of sustainable construction and lack of awareness. Professional stakeholders are concerned about climate change and their attitudes towards climate change are affecting their decision related to sustainable construction. Respondent provided many comments, clearly indicating that a simple definition of sustainable construction is needed, and more efforts should be done to raise awareness about sustainable construction. Results are contributing valuable information for professional stakeholders, policymakers and other important stakeholders in the construction ecosystem.

KEYWORDS

sustainable construction, climate change, decision factors, professional stakeholders, drivers, barriers

1 Introduction

The built environment and the construction industry are responsible for significant portion of global harmful emissions. It is estimated that the built environment is responsible for approximately 40% of the total carbon emissions in the world, encompassing emissions from material production, construction, and operational phases (Tracking Progress | Globalabc, n.d.). Approximately half of all extracted materials in Europe find application in construction and use of buildings. The buildings end of life also represents a pivotal contribution to environmental consequences.

There is a lot of pressure on a global scale to reduce these harmful emissions. European Commission in 2020 defined a set of policy initiatives with the overarching aim of making the European Union climate neutral by 2050. This set of policies are jointly named European Green Deal (A European Green Deal, 2019). With ambition of involving the whole society in the transition, the European Commission in 2021 started the New European Bauhaus (NEB) initiative, first mentioned in the State of the Union Address by the President at the European Parliament Plenary in September 2020 (New European Bauhaus, 2020). The Green Deal and NEB emphasize the need for change also in the construction practices. They call for eco-friendly strategies to create energy-efficient buildings that reduce the consumption of resources during their whole lifecycle (Nikyema and Blouin, 2020).

With the efforts for moving to a sustainable oriented society also in the construction sector, new concepts and design paradigms of sustainable construction are being developed, such as biophilic design, restorative environmental design (RED), regenerative design, and restorative environmental and ergonomic design (REED). They are mostly focusing on including elements of nature in the built environment, while REED is focused also on material choice and integrates aspects of ergonomics and kinesiology, material science, architecture, engineering, psychology, physiology and other disciplines in a scientific framework that seeks to improve building design for occupants (Burnard et al., 2016; Jones and Brischke, 2017). Additionally, regulations aiming towards a more sustainable construction industry, such as the harmonized methodology of life cycle assessment (LCA) and the environmental product declarations (EPDs) were developed (Jones and Brischke, 2017). Certification are another tool that aims to promote a wider use of sustainable construction, like DGNB, LEED, BREEAM (Labaran et al., 2022).

Sustainable buildings, also referred to as green buildings, are characterized by their design and long-term usage, which guarantee a healthier and safer environment. Simultaneously, they demonstrate optimal and minimally invasive practices in land use, energy consumption, resource utilization, and water management (Mohammed and Abbakyari, 2016). Green buildings have developed as a generally accepted phenomena for implementing sustainable development, which takes into account the triple bottom line of environmental, social, and economic building performance (Sev, 2009). It means balancing the environmental conditions and the development activities (Yılmaz and Bakış, 2015), and taking into account also the social and economic dimension to address the construction demands (Slocum, 2015). Some authors argue that the concept of achieving sustainability in construction remains vague, owing to differences in perspectives on sustainability among relevant stakeholders (Stanitsas and Kirytopoulos, 2023). According to the European standard the term sustainable construction means the type of buildings that fulfils all necessary economic, environmental and social as well as technical and functional requirements, based on its intended use over the lifecycle of the building (EN 17680, 2023).

Sustainable construction seems to be an effective way how to reach a more sustainable oriented society, however it is still not used enough. Therefore, it is crucial to understand what the main decision factors of those deciding about building practices are. Namely, professional stakeholders such as architects, engineers, constructors, which are the ones advising consumers and deciding about construction. This is why an understanding about their decision factors is needed, in order to increase the implementation of sustainable construction. Professional stakeholders have a crucial role in creating buildings that are better for the environment. Based on the stakeholders theory, we understand that stakeholders are entities that have a "stake" or an interest in a project (Freeman, 2010). Similarly, in the context of sustainable construction, stakeholder are crucial, as the effective implementation of sustainable construction heavily relies on the active involvement of project stakeholders, and their understanding (Adhi and Muslim, 2023). Professional stakeholder in construction are those that are engaged with construction projects during their lifetime, including architects, designers, engineers, consultants, managers, builders, etc. (Tokbolat et al., 2020). Constructors have an important role, but also architects and clients are important because the decisions, such as the certificate implementation, materials used, etc., are applied during the planning and designing phase (Son et al., 2011). However, some studies showed that the construction sector has a low sustainability performance (Švajlenka and Kozlovská, 2020). All stakeholders in sustainable construction play a crucial role, including the clients with their specific needs, values and objectives that influence the decision-making process of construction planning. Actively engaging with all relevant stakeholders bring a comprehensive and holistic approach to sustainable construction. However, in our study we are focusing on professional stakeholders as the first step in understanding the whole decision-making process.

The construction sector and its stakeholders should be concerned about the climate change and the effects it has on their activities; however, we did not find any past studies that would confirm their concern. On the other hand, there are previous studies which identified drivers and barriers connected to sustainable construction, which include, for example, lack of government support, higher costs, lack of market demand, risks and uncertainties involved in implementing something new (Manoliadis et al., 2006; Pitt et al., 2009; Darko et al., 2017; Oke et al., 2019; Tokbolat et al., 2020; Assylbekov et al., 2021). Some studies discuss also that the architectural and construction area is witnessing important changes in terms of environmentally sustainable structures and optimization and digitalization of projects and design methods (Afzal et al., 2023). However, these studies were done in different countries, like the United States, Greece and Kazakhstan, at different times and included a smaller sample.

The motivation for this study was to provide evidence about key decision factors influencing professional stakeholders (architects,

engineers, constructors) in Slovenia when deciding for sustainable construction practices. Slovenia is among the most forested countries in Europe, is reach with wood–natural and renewable building material, and have a strong forest-based industry and construction sector (Ministry of Agriculture, Forestry and Food, 2022). Additionally, we decided to perform the study only in Slovenia as a first step, to acquire a comprehensive perspective regarding sustainable construction in this geographic area. However, the used methodology can be applied to other countries to gather a more in-depth understanding on the global scale. The main objective of the research was to identify and analyze the decision factors made by professional when choosing sustainable construction solutions by conducting an online survey (questionnaire).

In order to follow the main purpose of this study we developed the hypothesis that were guiding our study:

H1: Professional stakeholders have experience working with sustainable construction projects.
H2: Decision making of professional stakeholders is influenced by several factors.
H3: Professional stakeholders are concerned about climate change and their attitudes towards climate change are affecting their decisions about sustainable construction.

2 Materials and methods

2.1 Sample

To identify and analyze the decision factors made by professional stakeholders (architects, constructors, engineers) when choosing sustainable construction solutions in Slovenia, we conducted a study in the autumn of 2023.

The studied population sample included professional stakeholders (architects, engineers, constructors). These stakeholders were identified by screening the Bizi registry for Slovenia (Bizi, 2023). We emailed the survey invitation to 4,307 companies. There was no incentive offered for participation, besides sharing the survey results with the interested participants. Out of 4,307 emails send, we received several automatic replies that emails are not valid anymore. Additionally, few responses were received, that they do not want to participate. Therefore, a reminder email was sent to 3,869 contacts 2 weeks after the first one. There were additional 23 rejection answers, leading to the whole size of population to be 3,846. With the help of an online calculator where we defined the confidence level (95%) margin of error (5%) and size of population (4,307) we calculated that our sample should include 353 answers. With the responses achieved we can assume that our study provides validity.

In Slovenia we have two professional chambers dealing with architecture and construction, namely, ZAPS (Chamber of Architecture and Spatial Planning of Slovenia) for professional architects, and IZS (Chamber of Engineers of Slovenia) for engineers and constructors. We contacted them and asked to send the invitation to their members, but only IZS replied positively, and shared the invitation. Engineers and constructors that are members of IZS, are registered also on the Bizi registry, this is why we assume some of these contacts receive the invitation to collaborate in the survey twice.

2.2 Online questionnaire

Factors influencing professional stakeholders in their decision for sustainable construction were investigated in an online self-administered survey questionnaire (using Enka tool). The questionnaire was prepared in English, while a Slovene translation was used in the on-line survey.

We used the questionnaire developed in the study of (Darko et al., 2017) where they identified barriers and drivers influencing the green building development. In the literature review we identified also other studies (Manoliadis et al., 2006; Pitt et al., 2009; Darko et al., 2017; Oke et al., 2019; Tokbolat et al., 2020; Assylbekov et al., 2021) that used similar questionnaires, however we decided to use the one of (Darko et al., 2017) as the questionnaire was available for us and it delivered data that we need in order to address our research question.

Additionally, we used some questions from the Forest based sector survey (Slavec et al., 2023), and from the NEBUP HUB questionnaire to verify the knowledge of stakeholders. The questions were adapted for the needs of our study. Prior implementation of the survey, the questionnaire was tested with 11 respondents.

Based on the literature review and the chosen existing questionnaire we decided to investigate several factors that guided us towards the main objective of this study. Besides the respondent's demographics, we included factors such as experience in working with sustainable construction projects, drivers and barriers for sustainable constriction, and knowledge of sustainable construction concepts. We added also two factors (size of company and attitude towards climate change) which assured that our study brings also novelty to the research field and additionally supports the main objective.

The questionnaire included 19 questions, and the median response time was about 6 min. First, we wanted to verify some characteristics of our participants, with bellow questions:

- Your gender.
- What is your age?
- What is your completed highest level of formal education?
- What is your professional background?
- Have you ever worked on a sustainable construction project?
- Please indicate the number of employees in the company where you are/were working with construction.

Then we verified the key decision factors and the key barriers of professional stakeholders when deciding for sustainable construction. All this key decision factors and barriers were adopted from the (Darko et al., 2017) questionnaire. Respondents had to select an answer from strongly disagree to strongly agree, where disagree means that it is not an important driver/barrier and agree means that it is an important driver/barrier:

- To what extent do you agree that the following factors are important drivers when deciding for sustainable construction

(5 = Strongly Agree; 4 = Agree; 3 = Neither agree nor disagree; 2 = Disagree; 1 = Strongly Disagree)
- ✓ Energy-efficiency of buildings
- ✓ Water-efficiency of buildings
- ✓ Occupant health
- ✓ Occupant comfort
- ✓ Occupant satisfaction
- ✓ Company image and reputation
- ✓ Efficiency in construction processes (for example, cost savings over the life cycle, reducing the environmental impact, social and economic benefits)

- To what extent do you agree that the following factors are important barriers when deciding for sustainable construction (5 = Strongly Agree; 4 = Agree; 3 = Neither agree nor disagree; 2 = Disagree; 1 = Strongly Disagree)
  - ✓ Higher cost of sustainable construction
  - ✓ Lack of work experience with sustainable construction
  - ✓ Lack of knowledge of sustainable construction
  - ✓ Lack of awareness of sustainable construction
  - ✓ Lack of government support for sustainable construction
  - ✓ Lack of education and research about sustainable construction
  - ✓ Lack of regulations/legislations for sustainable construction available
  - ✓ Lack of market demand for sustainable construction
  - ✓ Resistance of people to change from the use of traditional construction
  - ✓ Risks and uncertainty connected to using something new

Following we learned about the familiarity with concepts related to sustainable building design, with the question bellow. This question was adapted from the NEBAP HUB questionnaire.

- To what extent are you familiar with the following terms (1–I never heard the term; 2–I have heard the term, but do not understand; 3–I understand some; 4–I understand quite well; 5–I understand and could explain to others)
  - ✓ Building information modeling
  - ✓ Cascading use of materials
  - ✓ Certification of green buildings
  - ✓ Circular thinking in planning
  - ✓ Environmental footprint
  - ✓ Environmental impact assessment
  - ✓ Green public procurement of buildings
  - ✓ Life cycle analysis
  - ✓ Low-emission construction techniques
  - ✓ Regenerative and restorative design
  - ✓ Restoration and reuse of building components, products and materials
  - ✓ Reverse logistics of resources (e.g., materials)
  - ✓ Smart sensors in building monitoring

The section was followed by questions related to concern and attitudes towards climate change, adapted from the study Forest based sector survey (Slavec et al., 2023).

- To what extent, if any, are you personally concerned about climate change?
- To what extend does your attitude towards climate change affect your decisions related to sustainable construction practices?
- To what extent do you agree with the following statements: (5 = Strongly Agree; 4 = Agree; 3 = Neither agree nor disagree; 2 = Disagree; 1 = Strongly Disagree)
  - ✓ I perceive climate change as an opportunity my company or company where I work.
  - ✓ I perceive climate change as an opportunity for the construction sector in the country where my company operates.
  - ✓ I perceive climate change as an opportunity for the construction sector worldwide.
- To what extent do you agree with the following statements: (5 = Strongly Agree; 4 = Agree; 3 = Neither agree nor disagree; 2 = Disagree; 1 = Strongly Disagree)
  - ✓ I perceive climate change as a threat to my company or company where I work.
  - ✓ I perceive climate change as a threat for the construction sector in the country where my company operates.
  - ✓ I perceive climate change as a threat for the construction sector worldwide.

Additionally, the questionnaire contained four more questions related to the use of questionnaires but for the purpose of this study, we did not include those questions in the analysis.

The last question enabled respondents to write additional comments related to the survey, questions and topics covered.

2.3 Data collection and analysis

The survey was active from 16 October 2023 until 21 November 2023.

The results of the survey were analyzed by using the Jamovi software (2.3.28.0) and the analytics in Enka tool for the general information (gender, age, education, profession, experience with sustainable constriction projects). Jamovi is an open-source software, integrated with R, and it is efficient to be used for data analysis. In Jamovi the means and standard deviation were calculated (Tables 1, 2) and the correlation matrix applied (Supplementary Appendix Tables 3–11, in attachments). Further, In Enka frequencies were performed (Figures 1–3).

In total, we collected 346 responses, including 295 fully completed and 51 partially completed questionnaires; 98 respondents refused to participate in the study, 351 began to respond but did not complete the questionnaire, 553 were found to be ineligible. The overall response rate was 8.9%. This data was obtained from analytics in Enka tool.

3 Results

First, we found out that of the 295 respondents, more than half were engineers (52%), for example, registered engineer, supervising engineer, civil engineer, woodworking engineer, assistant or colleague from this field, or similar. Followed by architects (31%), and the least were constructors (5%). Most respondents

TABLE 1 Mean scores of sustainable construction drivers.

	Energy-efficiency of buildings	Water-efficiency of buildings	Occupant health	Occupant comfort	Occupant satisfaction	Company image and reputation	Efficiency in construction processes
Mean	4.53	4.38	4.62	4.40	4.38	3.82	4.39
Standard deviation	0.606	0.721	0.615	0.736	0.729	0.987	0.760

(75%) are male from the age group of 55 or more (30%), with the university degree or bologna master's degree (58%). This data is comparable with the data we received from IZS. Among their members there are 88% of males, and 40% are from the age group 55 or more. Respondent mostly work in smaller companies, namely, 83% of respondents work in companies with up to nine employees. More than half of respondents (56%) have already worked on projects related to sustainable construction, mostly (34%) they worked on one to five such projects, while 11% collaborated in more than 15 sustainable construction projects.

We used the mean scores method to understand which drivers and barriers are the ones influencing the most the professional stakeholders when choosing sustainable construction solutions. As seen in Table 1, all drivers were ranked with the mean higher than 3.8 which indicates their agreement with all the proposed drivers being important for them. However, they agreed the most with the occupant health (mean = 4.62), followed by energy-efficiency of buildings (mean = 4.53). Other important drivers were water-efficiency of buildings, occupant comfort, occupant satisfaction, and efficiency in construction processes. In contrast with the previous studies (Darko et al., 2017) the respondents ranked the company image and reputation lower (mean = 3.82).

Similarly, also all the proposed barriers were ranked as higher than 3.4 indicating that respondents agreed all are influencing their decisions. As seen in Table 2 the one with which they agreed the most was higher cost of sustainable construction (mean = 4.11), followed by lack of awareness of sustainable construction (mean = 4.04). Lack of work experience, knowledge, education and research, and lack of government support for sustainable construction were also identified as important barriers. Respondents did not perceive risks connected to using something new as high as in the study of (Darko et al., 2017).

Respondent were mostly neutral in agreeing that climate change is an opportunity for the construction sector, for Slovenia and for their company. Mostly they did not agree with statement that climate change is a threat for the construction sector, for Slovenia and for their company (Figures 1, 2).

Further, we wanted to explore how much are professional stakeholders concerned about the climate change and its effects, and we found out that most respondents (36%) are very concerned about it (Figure 3). Despite this we did not find any existing literature on this topic, meaning that there is a research gap in the published literature about this unexplored topic.

Additionally, we were interested to see how different variables that we studied are correlating. By applying the correlation matrix (Spearman's rank correlation coefficient), we found out that having experience with working on sustainable construction project is correlating with perceived barriers for decision making. Those who reported having experience working with sustainable construction projects negatively corelate (p = −0.112) with the barrier of perceive risks for using something new, which is somehow understandable. Since they have experience working with sustainable construction, they are aware that it is not risky and that it is a well performed construction method (Supplementary Appendix Table S3). Possible risks could be connected to the performance and durability of sustainable materials, maintenance, assembly, and other factors (Sanderford et al., 2014; Darko et al., 2017). Additionally, correlations were noticed between different key decision factors and barriers showing that respondents agreed all are influencing their decisions.

Respondents who worked with sustainable construction correlate with all concepts related to sustainable building design, suggesting that they are familiar with concepts, such as building information modelling, environmental footprint or LCA (Supplementary Appendix Table S4). This is understandable since those concepts are important pillars of sustainable construction.

Additionally, as seen in Supplementary Appendix Table S5, attitude of respondents towards climate change is associated to their decisions related to sustainable construction practices more often when they have experience working with sustainable construction (p = 0.219). We can assume that since they are aware of the climate urgency and the benefits of sustainable construction, they decide to use it more frequently. Moreover, these respondents have also a stronger perception of climate change as an opportunity for their company or company where they work (p = 0.167) and the construction sector in the country (p = 0.154).

In Supplementary Appendix Table S6 we present the correlation of age with different factors, and we found out that it does not correlate, while there is a correlation with age and familiarity with the concept of cascading use of materials and certification of green buildings (Supplementary Appendix Table S7).

Most of the respondents were from the age group of 55 and more, and we observed that they correlate the strongest with the attitude towards climate change (Supplementary Appendix Table S8) that is affecting their decisions related to sustainable construction practices (p = 0.213). This means that older individuals who have a stronger attitude towards climate change are more likely to make decisions in favor of sustainable construction practices. This is somehow in contrast with the recent literature found where they discuss the awareness of mostly younger people about climate change (Lee et al., 2020).

In Supplementary Appendix Table S9 we present the correlation of level of formal education with other observed factors. The level of education correlates negatively with the drives of company image

TABLE 2 Mean scores of sustainable construction barriers.

	Higher cost of sustainable construction	Lack of work experience with sustainable construction	Lack of knowledge of sustainable construction	Lack of awareness of sustainable construction	Lack of government support for sustainable construction	Lack of education and research about sustainable construction	Lack of regulations/ legislations for sustainable construction	Lack of market demand for sustainable construction	Resistance of people to change from the use of traditional cons	Risk and uncertainty connected to using something new
Mean	4.11	3.98	3.98	4.04	3.99	3.82	3.47	3.61	3.65	3.68
Standard deviation	0.804	0.827	0.839	0.803	0.995	0.916	1.06	0.952	0.972	0.928

and reputation ($p = -0.199$), and with the barrier factor of lack of government support for sustainable construction ($p = -0.131$). This indicates that professional stakeholders with the university degree mostly do not see the improvement of company image and reputation as an important factor to decide for sustainable construction which is in contracts with the previous studies (Darko et al., 2017). At the same time respondents in the Darko et al. (2017) study do not perceive the lack of government support for sustainable construction as a barrier factor, which is in contrast to the general results of our survey. This is somehow interesting as the intensified communication in the media and in the policy was put in place in the recent years.

Additionally, we notice (Supplementary Appendix Table S10) the correlation between the level of education and knowing the terms environmental impact assessment ($p = 0.150$), green public procurement of buildings ($p = 0.117$) and life cycle analysis ($p = 0.130$). These concepts are important in terms of sustainable construction. Therefore, it is understandable that professional stakeholders with higher education are more familiar with them. We did not find the correlation between the level of education and attitudes of respondents towards climate change (Supplementary Appendix Table S11). Most of the respondents had the university degree or bologna master's degree, nevertheless, we did not identify a clear pattern indicating that higher levels of education are associated with more positive or negative attitudes towards climate change.

At the end of the survey we also enabled respondent to provide their comments about the topic and the survey itself. We received a number of comments and the main message from the comments is that the topic of sustainable construction is very complex, and this is why a clear definition of the term is needed. Respondents also raise doubts about tackling climate change through construction and about the effectiveness of green building. This is an important insight showing that more should be done to educate, communicate, and raise awareness of this topic. Additionally, they highlight the problems of producers of building materials and the lack of regulation and sanctions for industrial plants in Slovenia that are not sustainable. They pointed out that materials should be more accessible. Respondents were also critical of the practical aspects of sustainable construction and have concerns that today's society is often driven by capitalism, which is not moving in the direction of sustainable development. These findings can surely help us in the future studies. Specific focus should be on how to effectively define and communicate the concept of sustainable construction with stakeholders, given the complexity of the topic. Additionally, the production and procurement of building materials in the context of sustainable construction should be addressed, and needed incentives studied. Further investigation is needed about how policy and education interventions should promote a more sustainable approach in the construction industry and more research on the transition towards sustainable construction practices in the today's society, driven by economic interests, is needed. On the global scale these challenges were already noticed and are being addressed. For example, the European Commission is aware that reskilling the professionals is needed if we want to enhance sustainable construction. For this purpose, they set up the New European Bauhaus Academy (NEBA) which aims at creating training materials for the construction ecosystem and thus help increasing the use of bio-materials.

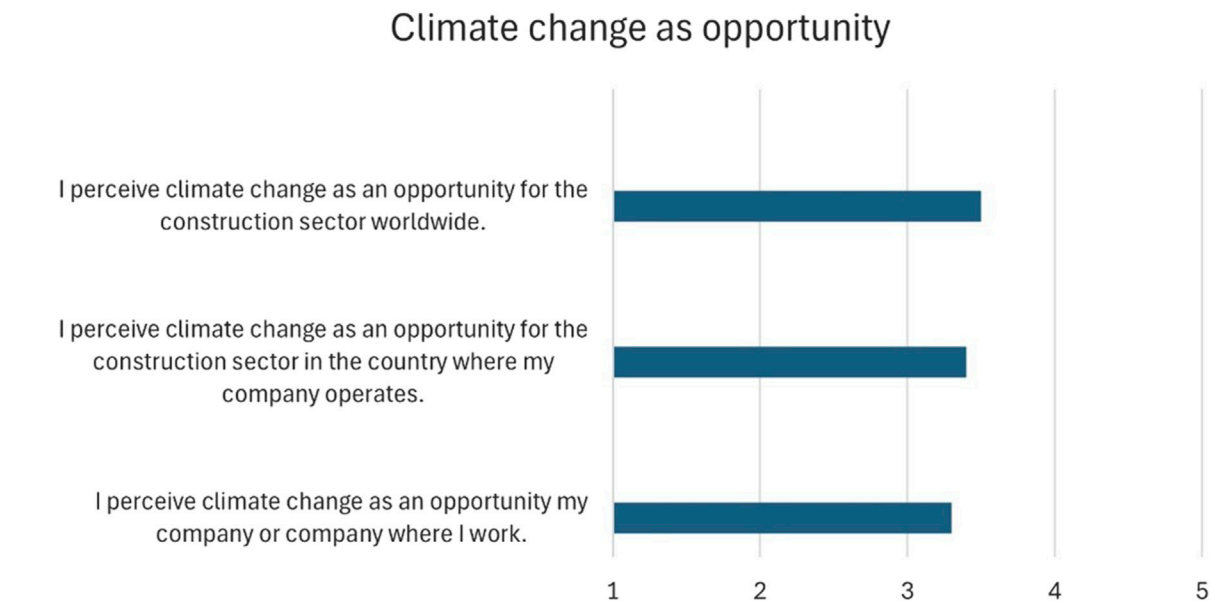

FIGURE 1
Climate change as opportunity.

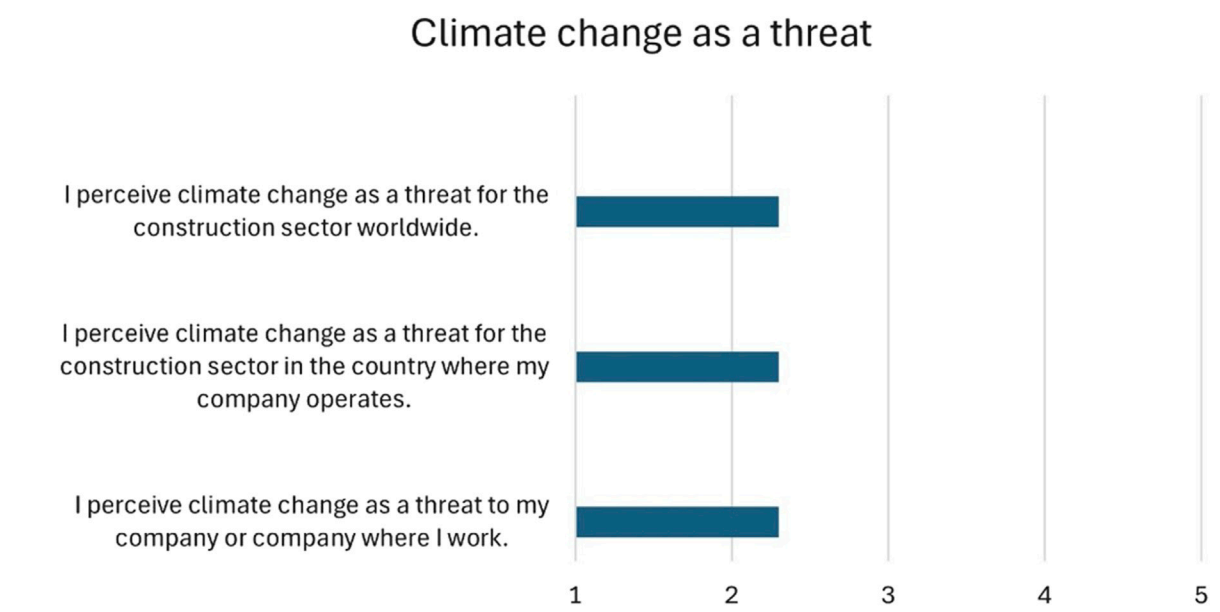

FIGURE 2
Climate change as a threat.

4 Discussion

In our study we found out what drives and barriers are important to professional stakeholders when deciding for sustainable construction. We identified what is driving their decision when deciding of building materials for construction, and what are the main issues and challenges that are enabling its wider use.

In relation to the first hypothesis, we noticed that professional stakeholders mostly have experiences working with sustainable construction. The topic of sustainability has been around for many decades and in the last years a lot of initiatives and global endeavors have been made (A European Green Deal, 2019; New European Bauhaus, 2020). Therefore, it was expected that professional stakeholders have experience working on such projects. Additionally, we noticed that professional stakeholders with previous experience working with sustainable construction were more familiar with concepts related to sustainable building design, such as building information modelling, environmental footprint or LCA, which is also somehow a logical result. We can assume that the ones who have more knowledge and skills are more prone to use sustainable construction The questionnaire we used

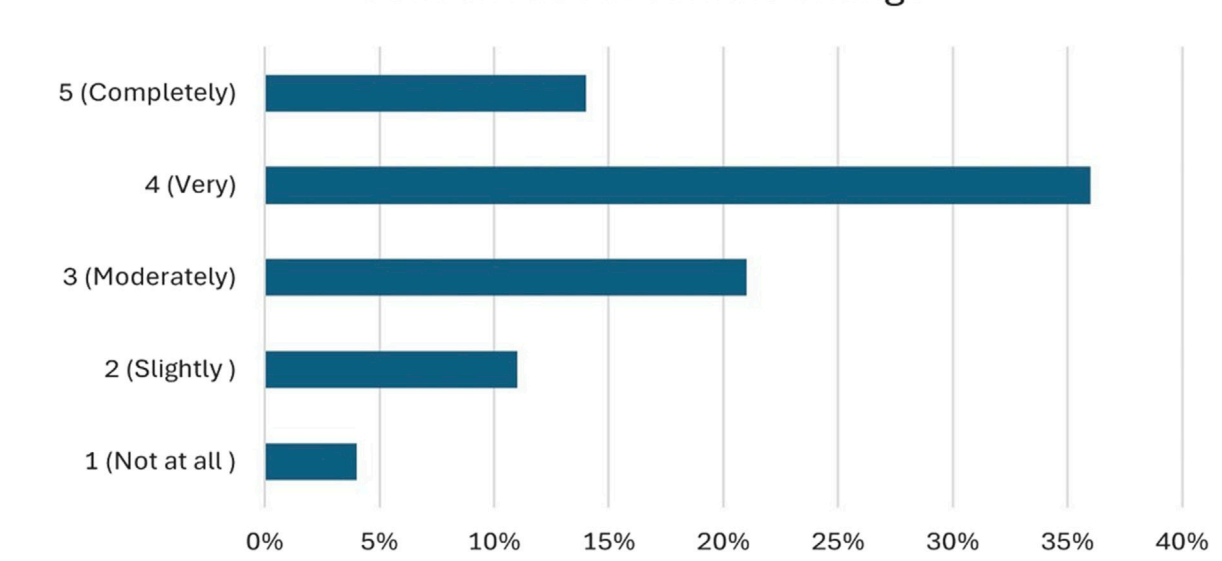

FIGURE 3
Concern about climate change.

did not give details about topics such as circular thinking in design, traceability of materials, modified wood, and similar, that are important for sustainable construction. Additional studies showing knowledge gaps could lead to more findings about the training materials that need to be developed. For example, at the University of Primorska they recently created the New European Bauhaus Academy Pioneer Hub for Sustainable Built Environments with Renewable Materials (NEBAP HUB) to study the knowledge gaps of different stakeholders in the construction ecosystem. This study can support them in their activities and future research. We should note that most of respondents are from smaller size companies, nevertheless we found out that they have knowledge and experience of working with sustainable construction.

Regarding the second hypothesis, we observed that all proposed drivers and barriers were important for professional stakeholders. The most important drivers were connected to the factor of occupant health, and to the energy-efficiency of the buildings. This is somehow in line also with previous literature where they found that similar factors (greater energy efficiency of buildings, improved occupants health, comfort and satisfaction, etc.) are important drivers for green buildings (Darko et al., 2017). This gives also great implication that sustainable construction concepts such as REED and others (Burnard et al., 2016), highlighting the human health and wellbeing aspect of the built environment will most likely gain more attention in the future on the global scale. As for the barriers, the higher cost of sustainable construction was noted as the most important one, followed by a lack of awareness of sustainable construction. Also in the study of (Darko et al., 2017) they identifies the lack of awareness as important barrier, however in our study respondents ranked higher the barrier of costs. Perhaps this difference can be attributed also to the fact that our study is performed in a different geographical location and in different times as compared to other studies. This presents an interesting finding as in the last years more effort was done in terms of promoting sustainable practices., We would like to point out that policymakers can make a difference with providing more government support and legislation that would help with the price strategies. Lack of work experience, knowledge, education and research, and lack of government support for sustainable construction were also identified as important barriers. Investing and creating more educational programs and perhaps communication strategies for sharing the right information and raising awareness would be beneficial. The twin green and digital transformation of the construction ecosystem is an enormous opportunity to create sustainable employment in urban and rural areas. It is central to decarbonizing Europe's economy and fighting climate change. To achieve this, massively accelerating up- and reskilling of the current and future workforce is necessary to transition to a carbon-neutral, resilient domestic sustainable construction sector in Europe. Therefore, the European Commission announced the NEBA, and previously mentioned NEBAP HUB has received the task to develop it on European level.

As for the third hypothesis we found out that professional stakeholders are concerned about climate change and their attitudes towards climate change are affecting their decision related to sustainable construction. For those who have more experience in the field of sustainable construction this is even more important. Also in the study (Slavec et al., 2023) they found out that respondents who were Slovenian and Austrian companies were on average quite concerned about climate change. Nevertheless, we did not identify previous studies and published literature on the topic of concern of professional stakeholder in the construction sector about the climate change and its effect to their activities. This is why we believe that future studies should explore this area and perform research to get a better understanding of construction sector concern. Future studies should investigate adaptation strategies of professional stakeholders, assessing climate change risks of construction sector and similar. Additionally, we would like to point out that besides the professional stakeholder's concern towards climate change they mostly do not agree nor disagree that climate change is an opportunity for the construction sector, for Slovenia and for their company and they mostly did not agree that it is a threat. This provides an implication that professional stakeholders in Slovenia do not perceive the construction sector as the one where changes could be made in order to address the

climate change issue. Perhaps with more efforts put in the education and raising awareness this could be improved, and future studies should definitely focus on further discovering this finding. It should be also noted that the respondents were mostly male engineers, older than 55 years. This result is in line with the official data of the Slovenian Chamber of Engineers and can be further explained by the methodological approach used, since the survey was re-sent to the members of engineers chamber. This is one of the study limitations, since perhaps other professional, from other gender and age groups, could bring different results. This is also one of the recommendations we provide for future studies. Moreover, in the future studies additional analysis can be done to confirm results we got with the correlation matrix, for example, by applying the regression analysis. Another limitation is that this study relies on data obtained only in one country (Slovenia), and future studies should focus on expanding this method to other European countries and even beyond Europe as climate change and construction sector emissions are a global problem. Additionally, the regional characteristics of studied stakeholders could be influencing the study's findings, this is why future studies should focus on addressing the regional and geographical parameters of professional stakeholders. Nevertheless, understanding the key decision factors of professional stakeholders from this geographic area is important, as it gives good basis for future similar studies in other countries. It should be also pointed out that we found previous similar studies performed in other countries (Manoliadis et al., 2006; Pitt et al., 2009; Darko et al., 2017; Oke et al., 2019; Tokbolat et al., 2020; Assylbekov et al., 2021).

Many comments received from respondents gave us a clear insight that a clearer definition of sustainable construction is needed. We found similar findings also in the past studies (Stanitsas and Kirytopoulos, 2023). It is important for researchers and other relevant practitioners to rethink and refine the conceptual understanding of sustainable construction in order to be more consistent and clearer. This is also an implication for future studies which should address the need of a clearer definition of sustainable construction.

More efforts should be done from either researchers, communication practitioners, educators, policymakers, and other important stakeholders, to raise awareness about sustainable construction. Lack of awareness was also identified as important barrier for professionals therefore future studies could study this phenomenon more in detail to bring better suggestions for real life applications. Respondents also do not perceive climate change as a thread for the construction sector and for their company which is an additional reason why more efforts to spread the knowledge and raise awareness is needed. Climate change is altering the surroundings in which we build, and new buildings must be constructed to accommodate the "new normal" of greater temperatures, more frequent hail, strong winds, floods, and so on.

5 Conclusion

Our study provides evidence about key decision factors influencing professional stakeholders when deciding for sustainable construction practices. Based on these findings we created knowledge about decision factor that are important for sustainable construction practitioners which can serve also for other fields.

Additionally, and despite the identified limitation, these study findings make an important contribution to research on wider use of sustainable construction and climate change. Results are expected to contribute valuable information for professional stakeholders, policymakers and other important stakeholders in the construction sector. An significant finding is also the knowledge gap in the literature connected to concern of construction sector about climate change which should be further explored. The need for a clear definition of sustainable construction is another important finding and suggestion for future research.

Moreover, the study provides an excellent confirmation of knowledge gaps and needs for delivering more trainings related to sustainable construction. The NEBA should make a significant change in this respect. Similar study to ours should be repeated in few years, when potential impacts of the NEBA could be identified. However, an important aspect to be addressed as well in future studies is the demographics of the engineers that participated in our study. The lack of young engineers is a significant threat to our society. Therefore, efforts need to be performed also in making the sustainable construction an attractive field of work. Young people are in general aware of the impacts of human activities on the climate change (Lee et al., 2020; Yamane and Kaneko, 2021), and therefore present a good opportunity for enhancing sustainable construction attractiveness for their career orientation.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the (patients/ participants OR patients/participants legal guardian/next of kin) was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

LP: Writing–review and editing, Writing–original draft, Visualization, Methodology, Investigation, Formal Analysis, Data curation, Conceptualization. AK: Writing–review and editing, Writing–original draft, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fbuil.2024.1420163/full#supplementary-material

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