

Article

Application of Social-Life Cycle Assessment in Urban Settings: Social Impact Assessment of Green Roofs

Giulia Mazzucco, Maria Canepa and Katia Perini *

Department of Architecture and Design, University of Genoa, 16123 Genoa, Italy; giuliamazzucco9@gmail.com (G.M.); maria.canepa@unige.it (M.C.)

* Correspondence: katia.perini@unige.it

Abstract: Sustainability brings together three dimensions: environment, economy and society, as according to the Agenda 21, a comprehensive plan of action to be taken globally, nationally, and locally by organizations of the United Nations System, governments, and major groups in every area in which humans impact the environment. To define whether an intervention or process is ‘sustainable’, these spheres must co-exist and be equally contemplated. Green roofs have been extensively studied from environmental and economic perspectives, but as far as the social dimension is concerned, the literature is limited. Indeed, to define these interventions as ‘sustainable’, the social dimension must also be investigated. Over time, Social-Life Cycle Assessment (S-LCA), an extension of the better-known Life Cycle Assessment (LCA), has become widespread. S-LCA allows assessing the potential impact that a production process, and consequently a product, can have on people. This paper aims to propose a model for analyzing green roofs by identifying the possible categories of stakeholders involved in the implementation process, and the impact categories to be referred to. By defining these elements, it is possible to estimate the positive or negative social impact that interventions cause. The results of the survey offer insights into social issues related to the implementation of green roofs by focusing on the stakeholders involved within the entire life cycle.

Keywords: life cycle assessment; nature-based solutions; social dimension social impact; social sustainability; stakeholder



Citation: Mazzucco, G.; Canepa, M.; Perini, K. Application of Social-Life Cycle Assessment in Urban Settings: Social Impact Assessment of Green Roofs. *Buildings* **2023**, *13*, 1659. <https://doi.org/10.3390/buildings13071659>

Academic Editor: Apple L.S. Chan

Received: 6 June 2023

Revised: 23 June 2023

Accepted: 27 June 2023

Published: 28 June 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Green roofs, as Nature Based Solutions (NBS), are an important tool for environmental compensation and mitigation in the urban context. The benefits of green roofs mainly concern: rain water management [1,2], improving air quality [3,4], the reduction and mitigation of the urban heat island phenomenon [5–10], reducing sound propagation [11], increasing roof system’s durability [12], the integration of new kinds of green infrastructures providing ecosystem services [13], improving photovoltaic panels performance [14,15], and biodiversity enrichment [16–20]. In addition, greening systems provide an alternative method of visual access for the occupied space [21]. Several studies [22,23] have also shown that improving air quality and reducing noise pollution consequently improves people’s quality of life. Green spaces enable social interaction and physical and psychological well-being [24]. The correlation between physical and psychological well-being and green space has been investigated by many researchers, especially in the context of urban environments [25–28]. In the literature [29], it has been noted that spending time in green spaces encourages physical activity, social relationships, reduced stress, and decreased exposure to environmental hazards. In fact, green roofs can be used as places for educational and recreational activities, or as rehabilitation areas [30,31].

The economic and environmental benefits of green roofs have been shown by several studies [30–33]. On the contrary, in terms of social sustainability, the topic is not explored with the same thoroughness, even if the social dimension is deeply concerned with sustainability [Figure 1]; this is probably due to the difficulty in translating social impacts

into numerical quantities [33]. Even when the focus shifts to the social dimension, the community is the main, or only, stakeholder involved in the process [32].

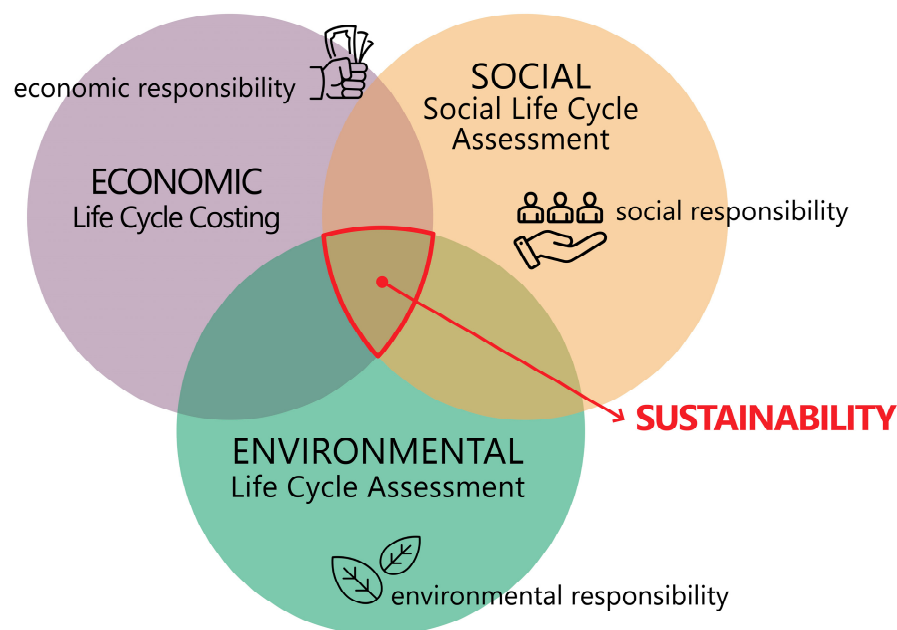


Figure 1. Diagram of the “Triple Bottom Line” adapted from John Elkington.

Social aspects are less explored for several reasons; as Klöpffer [34] said, “Industrialized countries tend to emphasize the environmental aspect (. . .), whereas developing countries give highest priority to economic development”. The three pillars have been commonly approved, but their relative weights are not clear [35]. Over time, new types of analysis emerged, such as the S-LCA, an extension of the better-known LCA, which allows defining whether a product (or activity) has been produced in a ‘socially’ sustainable way, based on certain indicators. Specifically, it allows assessing the potential impact that a product process, and a product itself, may have on people and stakeholders, such as the potential impact on workers’ health and safety [36]. The most complex aspect of the analysis seems to be the combination of concepts and data from different fields, such as sociology and technology [34].

According to Polese and Stren [37], social sustainability is seen as “development (and/or growth) that is compatible with harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population”.

It is possible to argue the thesis that green roofs are sustainable in environmental and economic terms [32,33]. However, it is deemed necessary to investigate the social aspects, given the lack of literature on the subject.

2. Aim of the Study

The contribution of the study concerns both the investigation of social issues in relation to architectural interventions, and a possible modus operandi for assessing the social impacts of green roofs projects. Therefore, the main object of this research was to define a model for the assessment of the social impact of green roofs, investigating the social dimension in the construction of greening systems for the building envelope, the least explored topic in the field of sustainability.

The objectives of the study can be summarized as follows:

- identify the main social issues related to the design and construction of green roofs in terms of working conditions, health, and safety etc.;

- Determine which groups of people (stakeholders) are involved in the construction and management processes of green roofs;
- Develop a checklist for a simplified assessment of the social impact of green roofs.

3. Methodology

The Guidelines for Social Life Cycle Assessment [36] were the inspiration for the research, and provided the background for the developed methodology [Figure 2].

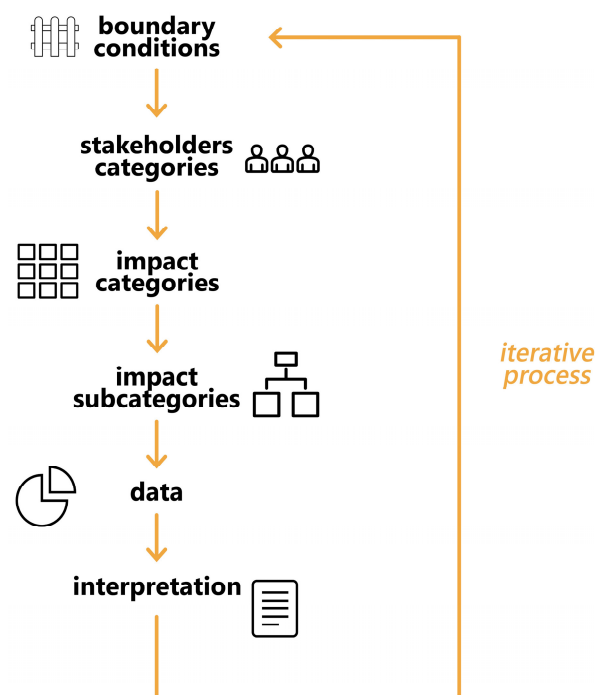


Figure 2. Diagram S-LCA methodology based on the Guidelines for Social Life Cycle Assessment (Benoît Norris et al., 2020).

The definition of S-LCA, according to the Life Cycle Initiative [38], is “a method that can be used to assess the social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle”.

S-LCA is, therefore, understood as an analysis of a product that allows determining its social sustainability to promote people’s and society’s well-being [36].

According to the S-LCA Guidelines, it is necessary to consider three groups of basic indicators: satisfaction of basic needs and quality of life, social justice, and social coherence. The analysis provides information on social and socio-economic aspects, and assesses the potential impacts of a product or activity on society and/or on different categories of people.

This paper focuses on the impacts of green roofs on the different stakeholders involved, according to the S-LCA Guidelines [36].

Therefore, the methodology adopted includes a preliminary study of the topic through interviews with people working in the sector. Such preliminary study supported the draft of two anonymous questionnaires related to the social issues which emerged. The questionnaires were administered to relevant stakeholders, i.e., workers and users (as described in Section 3.2).

3.1. Definition of the Boundary Conditions

As anticipated [Figure 2], the implementation of the S-LCA involves the definition of the objective of the study [36]; in this case, the assessment of the potential social impact of

green roofs. Once the scope has been delineated, it is possible to identify the stakeholder categories involved in the process.

The boundary conditions outline which stages of the production process are going to be considered in the research. The current study will not look at all phases of the life cycle, but it will focus on construction, use, and disposal, i.e., from gate to grave. The decision to exclude the stages related to the extraction of raw materials and their transport stems from the difficulties of finding reliable data. Consequently, it was decided to restrict the scope to those stages that could be examined directly [Figure 3].

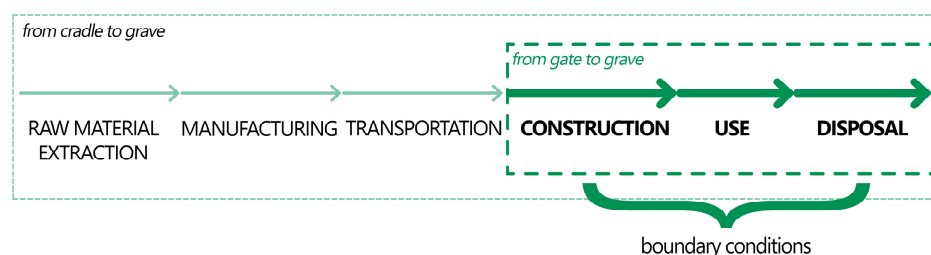


Figure 3. Diagram of a product life cycle-methodology-specific boundary condition highlighted (Life Cycle Initiative).

The boundary conditions also include the definitions of the spatio-temporal boundaries, relating to the place and period in which the survey was carried out. In this case, the data collection took place in Italy in the period between September 2022 and February 2023.

3.2. Definition of Stakeholder Categories

According to the Guidelines for S-LCA [36], the stakeholders involved in the production processes include: workers, the local community, society, consumers, and the players in the value chain. The categories of people that have been chosen for this investigation are the workers, who actively participate in the design and implementation of green roofs, and the users of these interventions who oversee management and maintenance. The category workers is already included in the Guidelines; the category users was defined *ex novo* (the word suggested by the Guidelines [36] is 'consumer', which does not seem appropriate for public spaces).

3.3. Definition of Impact Categories and Sub-Categories

The impact categories described in the Guidelines for S-LCA [36] are divided into: Human rights, Working conditions, Health and safety, Cultural heritage, Governance, Socio-economic repercussions [Figure 4].

Impacts are assessed based on certain indicators, which may differ according to the objective of the study. In the Guidelines [36], general indicators are provided, but they may be modified, or new indicators may be created; however, the exclusion or inclusion of impact categories must be justified.

The impact categories and sub-categories [Figure 5] are related to the 17 Sustainable Development Goals (SDG) included in the 2030 Agenda for Sustainable Development [39].

The analysis involves the exclusion or inclusion of categories depending on the scope and the object of study. Once the cut-off criteria have been justified, it is possible to proceed with their analysis. Preliminary interviews helped to identify the most crucial macro-social issues, and from there, the questions in the questionnaires developed.

For the first stakeholder—workers—the impact categories considered were Working conditions and Health and safety. The reasons for excluding the other categories are the difficulty in finding data or the lack of relevance for the analysis.

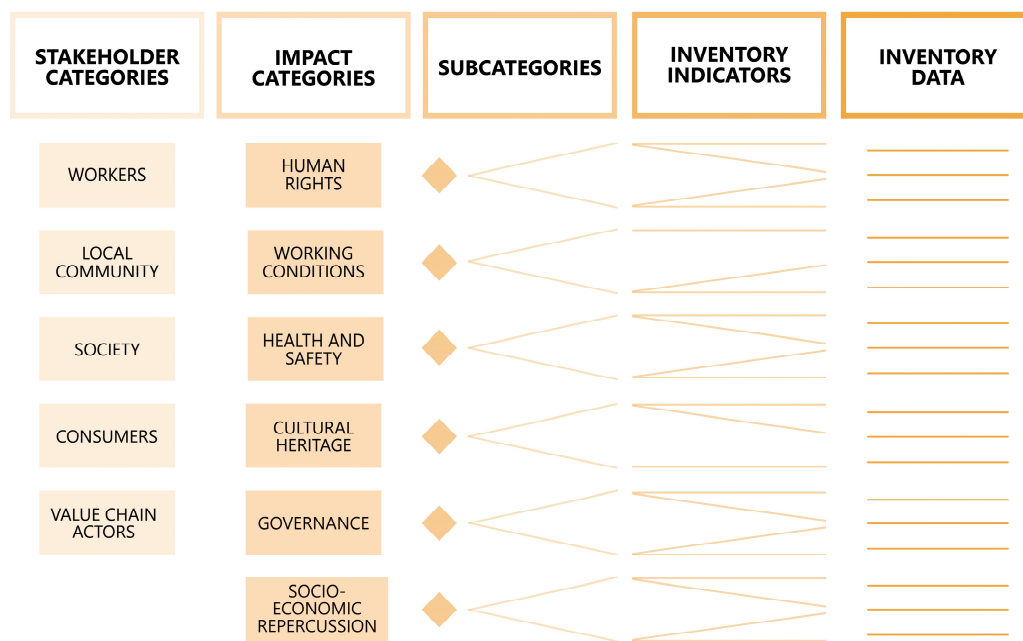


Figure 4. Assessment system from categories to inventory data. Adapted from Benoît et al., 2020. Connections are exemplary and not exhaustive.

Stakeholder categories	WORKER	LOCAL COMMUNITY	VALUE CHAIN ACTORS (not including consumers)	CONSUMER	SOCIETY	CHILDREN
subcategories	<ol style="list-style-type: none"> 1. Freedom of association and collective bargaining 2. Child labor 3. Fair salary 4. Working hours 5. Forced labor 6. Equal opportunities / discrimination 7. Health and safety 8. Social benefits/social security 9. Employment relationship 10. Sexual harassment 11. Smallholders including farmers 	<ol style="list-style-type: none"> 1. Access to material resources 2. Access to immaterial resources 3. Delocalization and migration 4. Cultural heritage 5. Safe and healthy living conditions 6. Respect of indigenous rights 7. Community engagement 8. Local employment 9. Secure living conditions 	<ol style="list-style-type: none"> 1. Fair competition 2. Promoting social responsibility 3. Supplier relationships 4. Respect of intellectual property rights 5. Wealth distribution 	<ol style="list-style-type: none"> 1. Health and safety 2. Feedback mechanism 3. Consumer privacy 4. Transparency 5. End-of-life responsibility 	<ol style="list-style-type: none"> 1. Public commitments to sustainability issues 2. Contribution to economic development 3. Prevention and mitigation of armed conflicts 4. Technology development 5. Corruption 6. Ethical treatment of animals 7. Poverty alleviation 	<ol style="list-style-type: none"> 1. Education provided in the local community 2. Health issues for children as consumers 3. Children concerns regarding marketing practices

Figure 5. List of stakeholder categories and impact sub-categories. Adapted from Benoît et al., 2020.

The category Working conditions includes the sub-categories [36]:

1. Fair salary;
2. Working hours;
3. Equal opportunities;
4. Social benefits;
5. Quality of work;
6. Social interactions;
7. Sustainability of the intervention.

The 5-6-7 categories were added following preliminary interviews. In the Health and safety category, the following sub-categories are considered [36]:

1. Safety;
2. Accidents;
3. Protections.

These sub-categories were integrated to achieve the aim of this study.

For the stakeholder ‘users’, the categories of interest are the Conditions of use and the Socio-economic and environmental repercussions. The inspiration is taken from the impact categories listed in the Guidelines [36]. The impact categories are redefined according to the aim of the study and the definition of the new stakeholder category “users”. The Conditions of use category is created from scratch, and the category of Socio-economic repercussions is implemented by adding environmental consequences.

The sub-categories included in the Conditions of use category include:

1. Governance;
2. Transparency;
3. Sustainability involvement.

They have been defined *ex novo* in order to deepen the impact deriving from the use of the green roof systems.

The category of Socio-economic and environmental consequences, redefined and implemented, includes the following sub-categories:

1. Community involvement;
2. Creation of new jobs;
3. Environmental benefits.

3.4. Methodological Sheets

The methodological sheets were drafted to provide an overview of the sub-category under study [Table 1]. The sheets include an initial basic definition of the sub-category, which enables its most relevant aspects to be understood and its declinations to be described. Then the definition of its purpose in relation to the analysis and its relevance to sustainable development is included, i.e., why it is considered in the analysis and which aspects it entails in terms of sustainability. Once these initial aspects have been defined, we move on to the evaluation of the data, which are divided into quantitative, semi-quantitative, and qualitative data, depending on the type of sub-category being examined: e.g., for the sub-category working hours, the quantitative data requested is the number of working hours per week; semi-quantitative data report affirmative or negative (yes/no) evaluations or rating scales, in the case, for example, of the degree of appreciation of one’s work; qualitative data refer to short texts, e.g., in the case of the sub-category related to social benefits.

Table 1. Summary of methodological sheets. Adapted from Methodological Sheets for Sub-categories in Social Life Cycle Assessment (S-LCA).

Relevant stakeholder	Stakeholder concerned by the sub-category
Sub-category definition	Basic definition of impact sub-category
Aim and approach	Specific objective pursued by the evaluation of the sub-category
Relevance to sustainable development	Relevance of the sub-category for the encouragement or disincentive of sustainable development
Assessment of data	Availability and sources of national and international reference data
Limitations of the sub-category	Possible limitations of the sub-category encountered during the analysis

Data sources are divided into generic data and site-specific data. The former can be traced back to the country of reference and are used as screening tools to highlight possible weaknesses in each topic. Depending on the scope, it is then possible to carry out specific investigations in areas where social risks have been highlighted.

In the generic data section, institutional, governmental, and inter-governmental sites are used to provide a benchmark. In the site-specific research section, reference data are obtained from the stakeholders' interviews.

Finally, the limitations of the sub-category are listed to highlight any critical issues.

3.5. Data Collection

A preliminary overview on the context was obtained by means of telephone interviews with architects, agronomists, associations, and companies specialized in the production and design of green roof systems. Such interviews allowed to preliminarily define the questions to include in the two anonymous questionnaires, the first to be administered to the stakeholder workers, and the second to the users [Table 2]. Both questionnaires are based on the most relevant indicators discussed in the Guidelines for S-LCA [36].

Table 2. Summary tables with questionnaire data.

WORKERS	
n. interviewed	35
n. questions	22
When	September 2022–February 2023
Where	Italy
How	mail, social media
USERS	
n. interviewed	60
n. questions	23
When	September 2022–February 2023
Where	Italy
How	mail, social media

The first questionnaire (workers) was administered to two associations and two main companies, with relevant and international experience on the topic, to architectural firms, to agronomists and gardeners, and to different associations involved in redeveloping urban areas. The questionnaires were circulated by e-mail and via social networks such as LinkedIn and Facebook.

The user questionnaire was shared with the previously selected operators who were in contact with their clients, and with various associations promoting green roofs.

The questionnaires' samples are relevant and suitable for the specific field, as they include associations, such as the Italian Federation of Green Roofs, and companies operating in the green roof sector. The number of responses is reduced, but it provides useful information; this approach was adopted by other investigations [32,40].

The first questionnaire [Table 3] is made up of 22 questions divided into two sections; the first section is drafted to obtain generic data on the respondents and their jobs, and the second investigates the relationship between green roofs practice and the potential impact categories involved.

Table 3. Table of questions from the workers' questionnaire and their categories and sub-categories.

1	Gender		Personal information
2	Age		
3	Job		
4	Do you work as a freelancer or as an employee?		Job information
5	Describe shortly your work		
6	Do you think that your salary is appropriate for your work?	Fair salary	Career
7	How many hours do you work in a week, approximately?	Working hours	
8	Are there any gender inequalities?	Equal opportunities	
9	What kind of social benefits are guaranteed in your job?		Working conditions
10	How would you rate your profession? (opinion based on work time, salary, etc.)		
11	Could you work from home?		
12	Does your job allow you to grow professionally?		
13	Which workers do you usually collaborate with for the construction of products such as green roofs, urban gardens, or similar?		Social interactions
14	Who is the commissioner of your work? (e.g., Architect, client, company, etc.)		
15	Do you work in a team or alone?		
16	How long does the construction of a green project take? (years, months, days, etc.)	Sustainability	Safety
17	What kind of dangers can occur in your workplace?		
18	Could you explain shortly?		
19	Have accidents ever occurred during the construction of a green roof?	Accidents	Health and safety
20	If you answered yes, could you explain shortly?		
21	Do you have any personal protective equipment (ppe)?	Protections	
22	If you answered yes, which type of ppe?		

The second questionnaire [Table 4] is divided into 23 questions; the first section aims at collecting users' personal information in relation with green interventions, and the second one explores the topic of green roofs through the different impact categories considered for the specific stakeholder.

Table 4. Table of questions from the users' questionnaire and their categories and sub-categories.

1	Gender		Personal information
2	Age		
3	This survey aims to interview people who take advantage of projects such as green roofs, urban gardens, etc. Do you have access to one of these interventions?		
4	If you answered yes, could you specify what kind of project? (green roof, urban garden, etc.)		

Table 4. Cont.

5	Who decided to carry out the project?		
6	Is the project made for private individuals or is it open to everyone?		
7	How do you use the project? How are you involved?		
8	Who oversees the maintenance and management of the project?	Governance	
9	In the case that the users oversee the management, do they work as a team or as independent individuals?		
10	Are you in contact with the people who worked on the project for any problems?		
11	Has the system been realized according to UNI11235?		
12	Do you think that the people who worked on this project transparently explained sustainability issues?	Transparency	Use conditions
13	Do you think that the people who worked on this project gave enough information in the materials?		
14	And about the construction process?		
15	And did they give information about the end of life of the product?		
16	Do you think the management of this project is sustainable in economic terms?		
17	If you answered no, could you explain shortly why?	Sustainability involvement	
18	And is it sustainable in terms of time? (Considering the time it takes to manage such a project)		
19	If you answered no, could you explain shortly why?		
20	How does collaboration between users work? Is there an association or something similar?	Community involvement	
21	Has any new job position opened because of this project?	Creation of new jobs	Socio-economic and environmental repercussions
22	If you answered yes, which positions?		
23	What kind of social benefits has this project brought to both individuals and the community?	Environmental benefits	

4. Results and Discussion

4.1. Questionnaires Outcomes

In this paragraph, the interviews' results are summarized to highlight the social issues deriving from the construction, use, and disposal of green roofs projects.

The data collected through the questionnaires addressed to the worker stakeholders show that: the construction sector has a strong male dominance; out of 35 persons interviewed only three were women. In recent decades, the economic status of women has changed considerably, and women now occupy virtually equal positions in sectors that were once predominantly male-dominated [41]. Although there is no extensive literature on gender inequalities in the construction sector [42], the predominance of males in the construction sector can be related to: cultural and social influences, personal or physiological reasons, stereotypes of various kinds, family, and economic motivations [43].

Another relevant datum that emerged is that 74% of the respondents were freelancers. By isolating the freelancers' data, some considerations can be made. Of the freelancers surveyed, 85% generally work more than 40 h per week. Less than 20% of the professionals answered that they have other social benefits besides retirement (such as training, disability benefits, or others). The results show that for both categories, the guaranteed social benefits are limited [Figure 6]; for example, only 11% claimed to have paid maternity and paternity leave. The lack of subsidies in this respect is confirmed by the drafting of new laws and regulations focused on maternity or paternity leave [44].

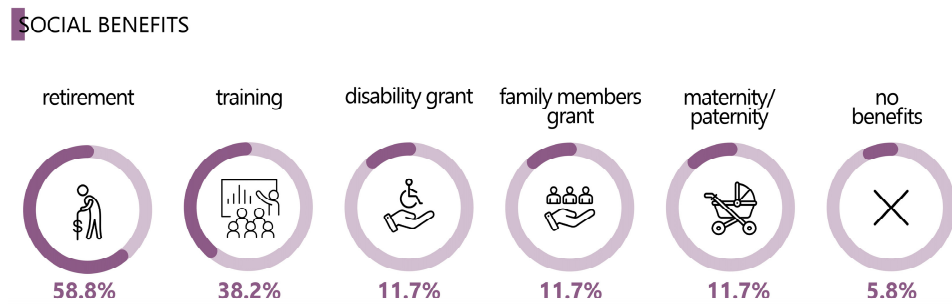


Figure 6. Social benefits results from the workers' questionnaire.

The data on the wage difference is not striking, since most respondents (29 out of 35) stated that there was no wage discrimination between men and women [Figure 7]. However, it should be emphasized that among the 35 respondents, only three women participated in the interview, and, therefore, the data is not reliable and complete. It can also be noted, however, that the six persons claiming differences in salary were all male freelancers (mostly gardeners).

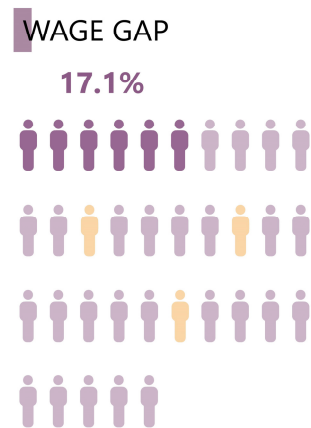


Figure 7. Wage gap results from the workers' questionnaire.

Regarding the user questionnaire, the main results are the following. The data show a significant majority of private (75%) rather than public (20%) green roof interventions. Only 20% of the projects referred to in the questionnaires are public. This figure is relevant in terms of accessibility. The possibility for the 'public' to access these roofs, in the case of public buildings or community spaces, would provide additional community benefits.

In terms of sustainability, it appears that users are aware of the sustainability issues and the social, environmental, and economic benefits derived from the projects [Figure 8]. Good community involvement is one of the most important aspects of social responsibility [45]. Users' understanding of issues related to the use of materials, their management and maintenance, and their eventual disposal, promotes a conscious and sustainable attitude. Although social and economic benefits are emerging, environmental benefits prevail as more investigations and experiments have been conducted in this field [32].

Another interesting finding concerns the socio-economic dimension [Figure 9]. As mentioned previously, issues relating to economic and social impacts are not as developed as environmental ones. However, it was possible to focus on the new job creation. Of respondents, 23% answered that the construction of a green roof created job opportunities, mainly in the maintenance and management sectors. In some cases, reintegration activities for former prisoners or support for people in need were mentioned.

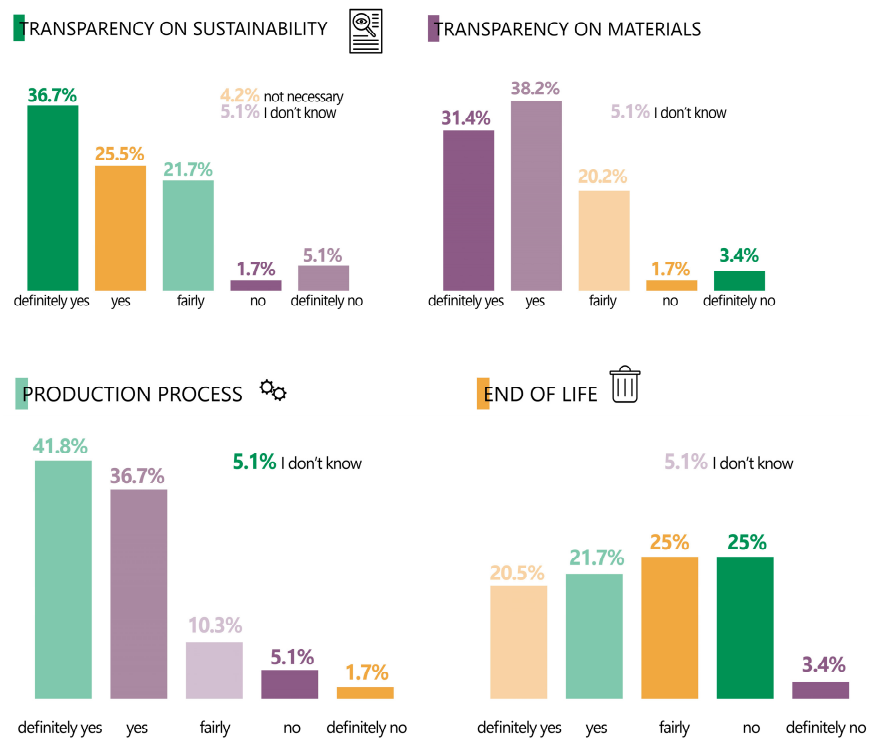


Figure 8. Project sustainability results from the users' questionnaire.

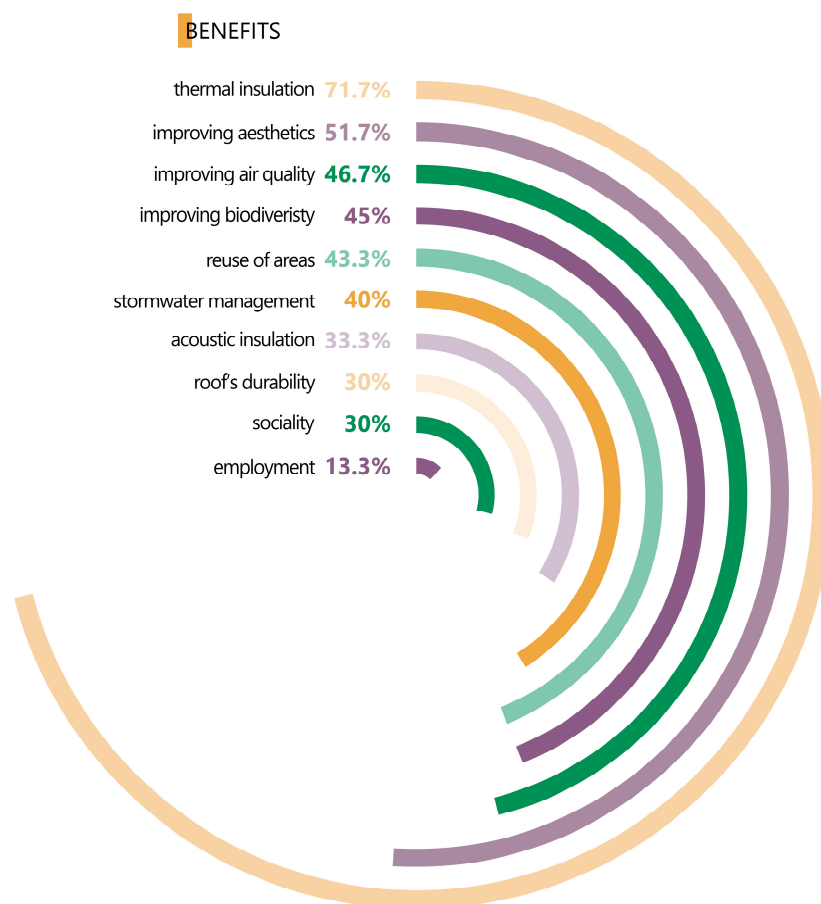


Figure 9. Project benefits results from the users' questionnaire.

4.2. Check-List

One of the goals of the study was to create a simplified checklist to support the designers during the construction of green roofs. The list [Table 5] describes step by step how to deal with these projects in a socially sustainable way. It consists of a series of questions to undertake in the implementation of a green roof system in order to consider the social dimension. These steps are related to different thresholds units and references to evaluate useful benchmarks, such as the Guidelines for S-LCA [36] and the SDG [39]. The latter are important to introduce different social themes related to the questions.

Table 5. Checklist.

n.	Steps	Thresholds Units	References
1	Which stakeholders are involved in the projects?	Number of stakeholder categories involved	Guidelines for S-LCA
2	How much do workers earn?	Wage adequacy	Guidelines for S-LCA, SDG 1 and SDG 8
3	How many hours do they work?	Number of working hours	Guidelines for S-LCA, SDG 8
4	Are men and women paid equally?	Presence of wage inequality	Guidelines for S-LCA, SDG 5, SDG 8
5	Which kind of social benefits are guaranteed?	List of social benefits guaranteed by their jobs, such as retirement, parental leave, etc.	Guidelines for S-LCA, SDG 1, SDG 8
6	Do they work in safe conditions?	Data based on the availability of PPE and number of accidents	Guidelines for S-LCA, SDG 8
7	Are they satisfied with their working conditions?	Level of satisfaction	Guidelines for S-LCA, SDG 8
8	What kind of social interactions are there in their workplace?	Relation possibilities	SDG 8
9	Is the project sustainable in terms of time?	Duration of the intervention	SDG 11, SDG 12
10	Is there transparency on the technical aspects of the project?	Level of awareness	Guidelines for S-LCA, SDG 12, SDG 15
11	How do users manage the project?	Level of involvement	SDG 11
12	What aspects of sustainability are assessed?	List of sustainability aspects relevant for the users	Guidelines for S-LCA, SDG 12, SDG 15
13	Have the social and economic repercussions been considered?	Possible consequences of the interventions	Guidelines for S-LCA, SDG 8

The first step, concerning the groups of people involved in the production process, is important to understanding how and how many people are involved in a project. This step is relevant to understanding the part of society affected by the implementation process and its repercussions.

The fair salary issue is important to ensure decent living conditions for all. This topic is also relevant for the SDG Goal number 1—End poverty in all its forms everywhere, and number 8—Decent work and economic growth. The possible threshold of this step can be identified when a person's salary does not fall within the minimum standards defined by law, or when the same salary does not allow people to support their basic needs. Specific European directives address this issue, as the Directive (EU) 2022/2041 on adequate minimum wages in the European Union [46]. In addition, working hours must comply with the regulations and the national and international standards (SDG8). Also in this case, sustainability standards can be deduced from the compliance with national decrees, such as the Italian Legislative Decree No. 66/2003 [47] on the organization of working time, or international conventions, such as the No. 1 of 1919 on working hours drawn up by the International Labour Organization [48].

Gender equality is a human right. The lack of equal opportunities for all is an important obstacle to sustainable development. Possible limits are enshrined in the 1951 Convention No. 100 on Equal Remuneration for Men and Women for Work of Equal Value of the International Labour Organization [49] and the Universal Declaration of Human Rights [50].

Social benefits help individuals and communities by ensuring better working conditions and increased productivity. In this case, the most relevant conventions include: 1952 Convention No. 102 on Social security [51] and 1967 Convention No. 128 on Invalidity, Old-Age and Survivors' Benefits [52].

The International Labour Organization (ILO) and the World Health Organization (WHO) focus on the safety at work. In this field, relevant criteria for assessment include statistical surveys on accidents at work (for example, from the National Institute for Industrial Accidents Insurance INAIL statistical database), or the compliance of the national legislative decrees on the specific topic (Italian Legislative Decree No. 81/2008) [53].

The quality of work is directly linked to the well-being of the workers, and thus constitutes one of the fundamental elements in determining better living conditions for people. The sample surveys on the quality of work developed by the Institute for the Development of Professional Training for Workers (ISFOL), or the one on Working conditions in a global perspective by ILO and Eurofound, can be cited to identify validity thresholds. It must be pointed out that the question may lead to courtesy bias and that consequently the data may be forced and unreliable. Recent research [54] has reported that the formulation of a question (positive/negative) can influence the way participants answer, and therefore, a neutral tone should be preferred.

Information on social interactions is useful to understand what kind of relationships arise in the workplace (with direct influence on job quality).

From the data observed, it emerged that paying attention to the duration of a project is relevant, in terms of both construction and maintenance (SGD 11-12).

Transparency is relevant in terms of, e.g., responsible use of soil (Goal 12 and Goal 15-Life on land) and the relationship between workers and users to enable greater user involvement (as according to the European Directive 2022/2464 on Corporate Sustainability Reporting Directive [55] and UNI EN ISO 26000/2020 on social responsibility) [45]. Each project should also be properly managed (Goal 11). Finally, for social responsibility, citizen involvement is also relevant, to support users in making informed choices in an ethically correct and transparent manner.

The last steps focus on the socio-economic and environmental impacts of a project. Economic impacts are related to job creation [36], while environmental impacts are related to the benefits provided by green roofs, described in the introduction.

5. Conclusions

In conclusion, this study shows that the social impact of green roofs projects can be assessed. Despite the limits of the present study and possible future developments, it was shown that surveys can be effective tools in such studies, producing relevant results, which could also broaden the debate on the social dimension. The following main conclusions can be drafted:

- The research developed a tool (checklist) to aid the design of green roofs to investigate the social impact of these interventions. Studying the projects from a more inclusive point of view allows focusing on social issues linked to construction and management processes;
- The involvement of stakeholders provides a holistic view of the intervention and its repercussions. To investigate precise social issues, diverse categories and sub-categories were analyzed. Understanding the most relevant social themes is crucial to considering the positive or negative effects of these projects on people.

This paper shows that, in addition to analyzing the potential environmental and economic impacts of green roofs, social aspects can also be assessed to evaluate their sustainability.

The presented analysis offers a simplified way of assessing social impacts in projects where the social dimension is not always considered. Future research will be focused on consolidating the method and expanding the data samples offered, to provide a broader view of the subject.

Author Contributions: Conceptualization, G.M. and M.C.; methodology, G.M. and M.C.; formal analysis, G.M.; investigation, G.M.; resources, K.P.; data curation, G.M.; writing—original draft preparation, G.M.; writing—review and editing, M.C. and K.P.; visualization, G.M.; supervision, K.P.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Mentens, J.; Raes, D.; Hermy, M. Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century? *Landsc. Urban Plan.* **2005**, *77*, 217–226. [\[CrossRef\]](#)
2. Stovin, V.; Vesuviano, G.; Kashmir, H. The hydrological performance of a green roof test bed under UK climaterica conditions. *J. Hydrol.* **2012**, *414–415*, 148–161. [\[CrossRef\]](#)
3. Rowe, B. Green Roofs for Pollutants' Reduction. In *Nature Based Strategies for Urban and Building Sustainability*; Pérez, G., Perini, K., Eds.; Butterworth-Heinemann: Oxford, UK, 2018; pp. 2141–2148.
4. Speak, A.F.; Rothwell, J.J.; Lindley, S.J.; Smith, C.L. Urban particulate pollution reduction by four species of green roof vegetation in a UK city. *Atmos. Environ.* **2012**, *61*, 283–293. [\[CrossRef\]](#)
5. Bevilacqua, P.; Mazzeo, D.; Bruno, R.; Arcuri, N. Surface temperature analysis of an extensive green roof for the mitigation of urban heat island in southern mediterranean climate. *Energy Build.* **2017**, *150*, 318–327. [\[CrossRef\]](#)
6. Köhler, M.; Kaiser, D. Evidence of the Climate Mitigation Effect of Green Roofs—A 20-Year Weather Study on an Extensive Green Roof (EGR) in the Northeast Germany. *Builidings* **2019**, *9*, 157. [\[CrossRef\]](#)
7. Smith, K.R.; Roebber, P.J. Green Roof Mitigation Potential for a Proxy Future Climate Scenario in Chicago, Illinois. *J. Appl. Meteorol. Climatol.* **2011**, *50*, 507–522. [\[CrossRef\]](#)
8. Rosenzweig, C.; Gaffin, S.; Parshall, L. (Eds.) *Greenroofs in New York Metropolitan Region: Research Report*; Columbia University Center for Climate Systems Research and NASA Goddard Institute for Space Studies: New York, NY, USA, 2011.
9. Kurn, D.M.; Bretz, S.E.; Huang, B.; Akbari, H. *The Potential for Reducing Urban Air Temperatures and Energy Consumption through Vegetative Cooling*; Energy & Environment Division, Lawrence Berkeley Laboratory, University of California: Berkeley, CA, USA, 1994.
10. Dimoudi, A.; Nikolopoulou, M. Vegetation in the urban environment: Microclimatic analysis and benefits. *Energy Build.* **2003**, *35*, 69–76. [\[CrossRef\]](#)
11. Connelly, M.; Hodgson, M. Experimental investigation of the sound transmission of vegetated roofs. *Appl. Acoust.* **2013**, *74*, 1136–1143. [\[CrossRef\]](#)
12. Köhler, M.; Schmidt, M.; Grimme, F.W.; Laar, M. Green roofs in temperate climates and in the hot-humid tropics—Far beyond the aesthetics. *Environ. Manag. Health* **2002**, *13*, 382–391. [\[CrossRef\]](#)
13. Langemeyer, J.; Wedgwood, D.; McPhearson, T.; Baró, F.; Madsen, A.L.; Barton, D.N. Creating urban green infrastructure where it is needed—A spatial ecosystem service-based decision analysis of green roofs in Barcelona. *Sci. Total Environ.* **2020**, *707*, 135487. [\[CrossRef\]](#)
14. Köhler, M.; Schimdt, M.; Laar, M.; Wachsmann, U.; Krauter, S. Photovoltaic panels on greened roofs. *World Clim. Energy Event* **2002**, *6*, 151–158.
15. Hui, S.C.; Chan, S.C. Integration of green roof and solar photovoltaic systems. In *Proceedings of the Joint Symposium 2011: Integrated Building Design in the New Era of Sustainability*, 2011, Kowloon Shangri-la Hotel, Tsim Sha Tsui East, Kowloon, Hong Kong, 1–10 January 2011.
16. Brenneisen, S. Space for Urban Wildlife—Designing Green Roofs as Habitats in Switzerland. *Urban Habitats* **2006**, *4*, 27–36.
17. MacIvor, J.S.; Ksiazek-Mikenas, K. Invertebrates on Green Roofs. In *Green Roof Ecosystems*; Springer International Publishing: Cham, Switzerland, 2015; pp. 333–355.
18. Fernandez-Canero, R.; Gonzalez-Redondo, P. Green Roofs as a Habitat for Birds: A Review. *J. Anim. Vet. Adv.* **2010**, *9*, 2041–2052.
19. Baumann, N. Green Roofs, and Biodiversity: Ground-Nesting Birds on Green Roofs in Switzerland: Preliminary Observations. *Urban Habitats* **2006**, *4*, 37–50.

20. Wooster EI, F.; Fleck, R.; Torpy, F.; Ramp, D.; Irga, P.J. Urban green roofs promote metropolitan biodiversity: A comparative study. *Build. Environ.* **2022**, *207*, 108458. [CrossRef]
21. Ko, W.H.; Kent, M.G.; Schiavon, S.; Levitt, B.; Betti, G. A Window View Quality Assessment Framework. *Leukos* **2022**, *18*, 268–293. [CrossRef]
22. Shafique, M.; Kim, R.; Rafiq, M. Green roof benefits, opportunities and challenges. *Renew. Sustain. Energy Rev.* **2018**, *90*, 757–773. [CrossRef]
23. Tuner-Skoff, J.; Cavender, N. The benefits of trees for livable and sustainable communities. *Plants People Planet* **2019**, *1*, 323–335. [CrossRef]
24. Triguero-Mas, M.; Dadvand, P.; Cirach, M.; Martínez, D.; Medina, A.; Mompert, A.; Basagaña, X.; Gražulevičienė, R.; Nieuwenhuijsen, M.J. Natural outdoor environments and mental and physical health: Relationships and mechanisms. *Environ. Int. J.* **2015**, *77*, 35–41. [CrossRef]
25. Mosca, F.; Dotti Sani, G.M.; Giachetta, A.; Perini, K. Nature-Based Solutions: Thermal Comfort Improvement and Psychological Wellbeing, a Case Study in Genoa, Italy. *Sustainability* **2021**, *13*, 11638. [CrossRef]
26. Mayer, F.S.; Bruehlman-Senecal, E.; Dolliver, K. Why is Nature Beneficial? *Environ. Behav.* **2009**, *41*, 607–643. [CrossRef]
27. Brookes, A.M.; Ottley, K.M.; Arbuthnott, K.D.; Sevigny, P. Nature-related mood effects: Season and type of nature contact. *J. Environ. Psychol.* **2017**, *54*, 20–26. [CrossRef]
28. Davydenko, M.; Peetz, J. Time grows on trees: The effect of nature settings on time perception. *J. Environ. Psychol.* **2017**, *54*, 91–102. [CrossRef]
29. De Vries, S.; Verheij, R.A.; Groenewegen, P.P.; Spreeuwenberg, P. Natural environments—Healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environ. Plan.* **2003**, *35*, 1717–1731. [CrossRef]
30. O'Hara, A.C.; Miller, A.C.; Spinks, H.; Seifert, A.; Mills, T.; Tuininga, A.R. The Sustainable Prescription: Benefits of Green Roof Implementation for Urban Hospitals. *Front. Sustain. Cities* **2022**, *4*, 798012. [CrossRef]
31. Mesimäki, M.; Hauru, K.; Lehvävirta, S. Do small green roofs have the possibility to offer recreational and experiential benefits in a dense urban area? A case study in Helsinki, Finland. *Urban For. Urban Green.* **2019**, *40*, 114–124. [CrossRef]
32. Nguyen Dang, H.-A.; Legg, R.; Khan, A.; Wilkinson, S.; Ibbett, N.; Doan, A.-T. Social impact of green roofs. *Front. Built Environ.* **2022**, *8*, 1047335. [CrossRef]
33. Manso, M.; Teotónio, I.; Matos Silva, C.; Oliveira Cruz, C. Green roof and green wall benefits and costs: A review of the quantitative evidence. *Renew. Sustain. Energy Rev.* **2021**, *135*, 110111. [CrossRef]
34. Klöpffer, W. Life-Cycle Based Methods for Sustainable Product Development. *Int. J. LCA* **2003**, *8*, 157–159. [CrossRef]
35. Klöpffer, W. Life Cycle Sustainability Assessment of Products. *Int. J. LCA* **2008**, *13*, 89–95. [CrossRef]
36. Benoît Norris, C.; Traverso, M.; Neugebauer, S.; Ekener, E.; Schaubroeck, T.; Russo Garrido, S.; Berger, M.; Valdivia, S.; Lehmann, A.; Finkbeiner, M.; et al. *Guidelines for Social Life Cycle Assessment of Products and Organizations 2020*; United Nations Environment Programme (UNEP): Nairobi, Kenya, 2020.
37. Polese, M.; Stren, R. *The Social Sustainability of Cities: Diversity and the Management of Change*; University of Toronto Press: Toronto, ON, USA, 2000.
38. Life Cycle Initiative. Available online: <https://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-ica/#:~:text=A%20social%20life%20cycle%20assessment,impacts%20along%20the%20life%20cycle> (accessed on 1 May 2023).
39. United Nations. Available online: <https://sdgs.un.org/goals> (accessed on 18 April 2023).
40. Besser, L.M.; Meyer, O.L.; Streitz, M.; Farias, S.T.; Olichney, J.; Mitsova, D.; Galvin, J.E. Perceptions of greenspace and social determinants of health across the life course: The Life Course Sociodemographics and Neighborhood Questionnaire (LSNEQ). *Health Place* **2023**, *81*, 103008. [CrossRef]
41. Akinlolu, M.; Haupt, T.C. Women in construction: Sociocultural gender-linked influences on career choices. In Proceedings of the 12th Built Environment Conference, Durban, South Africa, 6–7 August 2018.
42. Manesh, S.N.; Choi, J.O.; Shrestha, B.K.; Lim, J.; Shrestha, P.P. Spatial Analysis of the Gender Wage Gap in Architecture, Civil Engineering, and Construction Occupations in the United States. *J. Manag. Eng.* **2020**, *36*, 15. [CrossRef]
43. Amaratunga, D.; Haigh, R.; Lee, A.; Shanmugam, M.; Elvitigala, G. *Construction Industry and Women: A Review of the Barriers*; Research Institute for the Built and Human Environment, The University of Salford: Salford, UK, 2006.
44. Gazzetta Ufficiale. Available online: <https://www.gazzettaufficiale.it/eli/id/2022/07/29/22G00114/sg> (accessed on 6 May 2023).
45. UNI EN ISO 26000:2020. Available online: <https://store.uni.com/uni-en-iso-26000-2020> (accessed on 12 March 2023).
46. European Union. Available online: <https://eur-lex.europa.eu/legal-content/it/TXT/?uri=CELEX%3A32022L2041> (accessed on 12 March 2023).
47. Parlamento Italiano. Available online: <https://www.parlamento.it/parlam/leggi/deleghe/03066dl.htm> (accessed on 12 March 2023).
48. International Labour Organization. Available online: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO:P12100_ILO_CODE:C001 (accessed on 15 March 2023).
49. International Labour Organization. Available online: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO:12100:P12100_ILO_CODE:C100 (accessed on 15 March 2023).
50. Universal Declaration of Human Rights. Available online: https://www.icnl.org/wp-content/uploads/Transnational_UNIVERSAL_DECLARATION_OF_HUMAN_RIGHTS.pdf (accessed on 20 May 2023).

51. International Labour Organization. Available online: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C102 (accessed on 12 March 2023).
52. International Labour Organization. Available online: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:55:0:::55:P55_TYPE,P55_LANG,P55_DOCUMENT,P55_NODE:CON,en,C128,/Document (accessed on 12 March 2023).
53. Gazzetta Ufficiale. Available online: <https://www.gazzettaufficiale.it/eli/id/2008/04/30/008G0104/sg> (accessed on 20 March 2023).
54. Kent, M.; Parkinson, T.; Kim, J.; Schiavon, S. A data-driven analysis of occupant workspace dissatisfaction. *Build. Environ.* **2021**, *205*, 108270. [[CrossRef](#)]
55. European Directive 2022/2464. Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022L2464> (accessed on 12 March 2023).

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.