World Conference on
Timber Engineering
Oslo 2023

CIRCULAR WOOD CONSTRUCTION – EXPECTATIONS, EXPERIENCES AND ACCEPTANCE AMONG USERS, ARCHITECTS AND INDUSTRY REPRESENTATIVES

Kaja Heltorp[1], Ute Groba[2], Anders Q. Nyrud[3]

ABSTRACT: Circularity approaches aim at keeping resources "in loop" as long as possible, both resulting in a more efficient use of resources and in avoiding waste production. A prolonged and repeated use of wood-based construction materials enhances their function as carbon sinks and as replacements of more harmful materials. Aiming to systematize circularity measures within the building sector, this paper proposes four different fields of ambition as consecutive focus areas during the life cycle of wooden building materials. The first one of these ambitions, prolonging a building's life span, depends not only on the construction's robustness and maintenance or the layout's adaptability, but also on the building's overall "lovability" and acceptance. This renders the user perspective an important part of understanding building performance and architectural quality. Based on interviews and focus groups from 2016 and 2017, insights have been gained about the experiences, expectations, preferences and values tied to wooden materials both among users and architects and how these impact the acceptance and choice of materials. Substantiated by new data collected in 2022 with architects and wood industry representatives, this paper discusses the expectations, experiences and acceptance of re-used and recycled wooden materials among different stakeholders, and how these may affect all four circularity ambitions. Results suggest that language, together with professional background, experience and responsibility inform the acceptance of re-used and recycled wood both in a short-term and in a long-term perspective; they need to be taken into account when aiming for advancing circular wood construction. The user adds an important perspective on circular wood construction that is not covered by industry representatives.

KEYWORDS: Circularity, reclaimed wood, engineered wood, wood construction, user perspective, qualitative research

1 INTRODUCTION

A circular economy (CE) signifies the continuous use of objects and materials. CE has been gaining increasing attention within the building sector. Circularity approaches aim at keeping resources "in loop" as long as possible (ideally forever, as formulated in "cradle-to-cradle"), both resulting in a more efficient use of resources and in avoiding waste production [1]. A maximised life span is not only highly important for the use of finite resources, but also enhances the ecological benefits of renewable resources. In the case of wood-based construction materials, a prolonged and repeated use increases their function as carbon sinks and the replacement of more harmful materials. It is, however, unlikely that a construction from virgin or pre-used wood will last forever. In order to avoid the dead end of cascading use scenarios in a landfill, wood's circular life involves its combustion or composting at some stage. A number of treatments for aesthetic reasons or to make wood more durable result in turning wood into hazardous waste. In order to establish a circular value chain, it is important to keep all use stage scenarios in mind from the outset when designing wooden architecture, and to avoid harmful treatments.

Aiming to systematize circularity measures within the building sector, this paper proposes four different fields of ambition as consecutive focus areas during the life cycle of wooden building materials.

The first aim ("Plan A") is to prolong a building's life span, which depends on its construction's robustness and its maintenance, the layout's adaptability, and its overall "lovability" and acceptance [2]. When a building nevertheless needs to be taken down at some point, the second focus is on re-using the building's components in the least processed way possible ("Plan B"). The third goal is to recycle the materials contained in building components that are not possible to re-use any longer ("Plan C"). In the fourth and last stage, building materials are composted for soil amendment or combusted to obtain energy, both of which are needed in the production of resources that feed into a new cycle ("Plan D").

In general, in this context, the main focus has been on physical and mechanical properties of materials, and the same is true for wooden materials, both virgin and re-used. However, also the materials' non-physical characteristics determine their life span, as they are part of how users experience and value materials, and partake in informing the users' acceptance of both virgin and re-used materials. The user's acceptance also influences the treatment and detailing of wooden materials, which then inform the material's further potential for circular use.

[1] Kaja Heltorp, Norwegian University of Life Sciences (NMBU), Norway
[2] Ute Groba, The Oslo School of Architecture and Design (AHO), Norway, ute.christina.groba@aho.no
[3] Anders Qvale Nyrud, Norwegian University of Life Sciences (NMBU), Norway, anders.qvale.nyrud@nmbu.no

https://doi.org/10.52202/069179-0146

Circular wood construction can therefore not only rely on the physical and mechanical performance of materials, but must include experience and value based concepts. While the user perspective tends to be underrepresented in conventional design processes, it is however gaining recognition as important part of understanding building performance and architectural quality [3].

The questions this paper addresses include how different stakeholders and decision makers understand, perceive and value wooden materials, and especially their reuse and recycling.

2 METHODS

Qualitative approaches, such as semi-structured interviews and focus groups, have been used both in the precursory studies on wooden building materials that this paper builds on, and in a follow-up study that addresses re-used wooden materials.

2.1 Semi-structured qualitative interviews with architects and inhabitants of urban timber buildings conducted in 2017

27 inhabitants of urban residential timber projects by recognized contemporary timber architects have been interviewed as part of a doctoral research project conducted at The Oslo School of Architecture and Design [4].

The interviewees were chosen on the background of their homes that complied with a number of common denominators, such as timber as the main construction material; housing on an urban scale as a functional typology; and Austria, Germany and Norway as comparable climatic and cultural contexts. Other aspects were deliberately chosen to differ, such as the construction system (massive timber, column-and-beam systems or hybrid structures); the urban typology (referring to building geometry and access system); the type of occupancy (rental or owner-occupied); and the exposure of wooden construction members (covered by gypsum, painted, glazed or with wood's natural surface). The cases' maximum variation strengthens the findings' significance in qualitative research where, as opposed to quantitative research, a limited number of strategically chosen cases is investigated with many variables [5].

Set up as semi-structured qualitative interviews, the conversations were organised around a predefined set of themes and consciously left time to explore topics of special interest to the interviewees in greater detail. Without the presumption of any theoretical framework, the open-ended questions addressed more general architectural values and qualities first, before turning to how these relate to wooden materials. The interview data was analysed by structuring the transcribed conversations according to the topics addressed, and by pinpointing corresponding and contrasting statements.

2.2 Focus groups with users conducted in 2016

Focus groups are carefully planned group discussions, typically with 5–10 participants, that are designed to gather participants' views and opinions on specific topics. The group discussion is led by a moderator. Results from focus groups cannot and should not be generalized to the population as a whole but should rather be seen as the opinions of a small subset that merit further investigation to determine their validity for the population as a whole.

Focus groups were conducted in 2016 in Norway with inhabitants and wood related professionals. The interview guide was directed at gauging the participants' perceptions of topics related to the use of natural materials, and particularly wood, in the interior built environment [6].

2.3 Semi-structured qualitative interviews with architects and stakeholders in the Norwegian sawnwood industry in 2022

As part of a pilot study on drivers of the future demand for sawnwood, another series of semi-structured interviews with industry experts (3), industry representatives (3) and architects (4) was conducted via Teams video calls in 2022. The reuse and recycling of wooden construction parts were part of the topics included in the interview guide developed for the study, aiming to map i. weather and why (or why not) participants believed wood should or could be re-used or recycled, ii. barriers they perceived as preventing the reuse and recycling of wood, and iii. how they envisioned wood to be re-used or recycled. In addition, all participants were asked to appraise the current market value, i.e. the willingness to pay for used wood. Rather than defining a theoretical framework or hypothesis prior to the study, it had an explorative set-up. The industry experts and representatives were purposely sampled based on their assumed knowledge of the industry and the market. Likewise, the architects were sampled because of their experience with wood-based constructions.

The interviews were not recorded; instead, the interviewer took extensive notes. The interview data was assessed by structuring the notes by themes and analysing the content with a focus on i. identifying common perceptions and attitudes and assessing the degree of consensus, and ii. describing the spread or extremes in perceptions and opinions.

3 RESULTS

3.1 Addressing wood through three dimensions of materiality (2016 and 2017)

Two preceding studies have established the importance of involving users (e.g. inhabitants), professionals and other stakeholders in the wood-based construction industry when aiming to understand their perspective on wooden construction materials and to advance the implementation of these. Insights have been gained about the experiences, expectations, preferences and values tied to wooden materials and how these impact the acceptance and choice

https://doi.org/10.52202/069179-0146

of materials. The studies also revealed diverging ways of talking about material related issues.

The focus groups conducted in 2016 in Norway focused on users´, professionals´ and stakeholders´ perception of wood in the interior environment [6]. The study concluded that both professionals and non-professionals can identify and explain relevant physical and immaterial properties of wood, but that the way these properties are expressed differ between professional stakeholders and non-professionals.

Likewise, the interviews conducted in 2017 found that inhabitants and architects talk about the same thematic dimensions when discussing wooden construction materials, but with different views on them, weighting them differently, and with a different vocabulary **[4]**. Three overarching and overlapping thematic dimensions were identified in the interview material, relating to wood's *properties*, *experiences* and *values*.

- Mechanical *properties* were identified as important in the semi-structured interviews, such as the ones that allowed inhabitants to use or modify the wooden structure. Their interpretation as either robust, safe and reliable in the long run, or as unsettling, unstable and vulnerable influenced the users' acceptance. For the interviewed architects, constructive efficiency and systematization was important. Apart from atmospheric qualities, some favoured exposing wooden construction elements as a risk-minimizing measurement, as potential water damages would be detected earlier.
- The *experiences* of wooden materials as something living, healthy, warm and comforting or in contrast as pressing, overwhelming or dated were often tied to associations and memories that would co-determine the acceptance of wooden surfaces. Some inhabitants appreciated the stories weathered or worn surfaces exhibit and how this individualizes buildings, for example through traces of use or from weather exposure. Others wished they could maintain wooden surfaces in such a way that the materials would appear to be new and untouched. They also described bodily reactions to wooden materials. The architects' answers were less detailed and exhaustive in this realm, and not all architects expected the users to be concerned with or sensitive to experiential qualities.
- The *values* associated with wooden building materials included sustainability, a connection to nature and life, and local identity. A personal connection to the materials' origin, to the neighbourhood community the architectural design fostered, and an understanding of leading design principles and ideals were found to impact the users' acceptance and appreciation of the project's materiality in its various dimensions. For architects, important wood related values also included the status of wood related professions and workmanship quality.

3.2 Attitudes among professionals in the wood-based construction sector (2022/2023)

In the follow-up interviews from 2022/23, the four interviewed architects agreed without any reservation that wood always should be re-used if possible. To their mind, burning wooden materials from demolished or deconstructed buildings in heating plants (combustion power plants) for district heating should be the very last option and only considered when all other alternative usage was unrealistic. As of today, burning used wood in heating plants is the most common utilization of this resource in Norway [7,8]. For all architects, minimalizing resource use and waste production as well as limiting carbon emissions were the main motivation for their view. In addition, one architect mentioned the need for limiting the harvesting of fresh wood to preserve natural habitats and to protect vulnerable species.

Among the industry experts and representatives, one participant was uncertain whether the reuse of wood was environmentally and economically sound and thus not convinced that systems for wood reuse or recycling should be implemented. This participant reasoned that as fresh wood from sustainable forestry already had a very low carbon footprint, it was likely that the process of deconstructing, transporting, sorting, rinsing, testing and then possibly processing, producing or reworking the materials into new products would cause more carbon emissions than using fresh wood. The industry representatives also believed that said process would be rather costly and time consuming, so that products from used wood would have a hard time to be economically sustainable and competitive compared to products from fresh wood. Another participant shared some of these doubts, claiming that to be environmentally and economically sound, transportation, processing and handling would need to be kept at a minimum. In addition, they claimed that for some segments of used wood, reuse and recycling would be technically challenging or risky due to a lack of knowledge on for example pre-existing treatments. They argued that using such materials for energy recovery (i.e. district heating) was a sound and established option. Apart from these two, the industry experts and representatives conceded that wood, if possible, should be re-used or alternatively recycled – either because of the need for all industries to minimize carbon emissions, or because external pressure, for example from the EU, would force the sector to do so. However, compared to the architects, the participants from an industry background were more focused on barriers and quick to elaborate on practical issues, obstacles and prerequisites that would need to be addressed before the reuse or recycling on a larger scale would be practically feasible.

Barriers and obstacles towards reuse and recycling surfaced repeatedly throughout most of the interviews, without the interviewer asking. In addition, these themes were a predefined topic in the interview guide, so that all participants assessed barriers and obstacles at least once during the interviews. Barriers and obstacles that surfaced in nearly all the interviews included:

https://doi.org/10.52202/069179-0146

- The lack of infrastructure/ a system for collecting, transporting, testing and sorting, rinsing, processing etc. used materials or alternatively the (perceived) high cost of (establishing infrastructure/ a system for) collecting, transporting etc. wood materials.
- The lack of knowledge regarding the amount of, state of, and quality of used wood materials from demolition and deconstruction, making it challenging to estimate the potential for different types of reuses and recycling.
- The (poor) quality and heterogeneity of (proportions of the) used materials, due to e.g., maintenance level throughout the lifespan of the buildings, impacts like leakages, rot, fungus etc. and the current practice of demolishing rather than deconstructing buildings, resulting in materials being destroyed, poorly sorted or contaminated.
- The (perceived) high cost of changing demolition practices.
- Lack of knowledge about previous treatments and/or lack of ability to/methods for/cost of determining pervious treatments, limiting the potential for reuse and recycling (e.g., due to potential health hazards).
- The notion that used materials lack strength and tolerance which would limit potential uses, and the cost associated with testing these characteristics.

Other, less frequently mentioned barriers included high energy prices and thus the potential competition for the materials from other usages including export for bioenergy purposes. In addition, the relatively cheap price of wood might limit how much effort or resources would be sound to invest in systems for the re-use and recycling of used wood.

Apart from this, several participants mentioned the established conventional building practices and a lack of focus on deconstructability and reusability when the buildings had been planned and built. Interestingly, opinions on whether the more recent building practices (i.e., after 1950) or the older ones constituted the biggest challenges for reuse differed. Some participants argued that prior to around 1950, buildings were generally constructed in a way that allowed deconstruction and reuse. In addition, their opinion was that building materials used in older buildings often were of great quality. Others argued that the knowledge about construction and thus materials used in buildings from before 1950 was neglectable, making it necessary to sort and test all materials and to plan each deconstruction process in detail. Deconstructing newer, more standardized houses and reusing the well-documented materials from them would therefore be more straightforward and less demanding.

Finally, representatives from the sawnwood industry mentioned the high costs of processes such as joining smaller pieces and lengths of wood into more usable dimensions and materials, e.g., using techniques like finger jointing, glue laminating (glulam) and cross laminating timber (CLT). In addition, they thought that such elements and materials engineered from used wood might possibly have poorer properties in terms of strength, tolerance etc. than when using fresh wood. In addition, testing such products would be essential to ensure so that customers could trust their capacity, which again would add costs to the process.

Quite often in the conversations, views on how used wood materials could be re-used or utilized in other ways surfaced without encouragement. In addition, the participants were directly asked to give their view on this. Two of the participants displayed a high level of technical insight on the subject and based their answers on this knowledge. These two gave relatively detailed answers, e.g., they differentiated between materials, gave examples and were quite specific. The other participants talked more generally of wood materials, differentiated less, and although some displayed technical knowledge and based their assessments on this knowledge, there was still a clear difference between these and the first two in how specific and detailed their views and underlying reasonings were.

A common reply to questions regarding how the participants visioned materials being re-used or recycled was "in any way possible". Elaborating, participants explained that if technically possible, materials should be re-used in the same way they were originally used, i.e., "direct re-use", keeping handling and processing to a necessary minimum. Materials no longer meeting requirements for the original use, e.g., requirements for load tolerance, should be processed as little as possible and then utilized for the second-best alternative e.g., cladding, cross laminated timber (CLT) or glulam elements. One of the architects stated that if utilized as a layer in CLT-elements, used wood would add extra aesthetical interest.

Shorter bits of wood of high quality could e.g., be joined together using techniques like finger jointing in what several participants called "reversed sawmills", making new, strong, materials. However, according to sawnwood-industry experts and representatives, the most likely and realistic first step towards more circularity would be the recycling of untreated, used materials in wood-based panels. This alternative was considered the most likely because of the (perceived) low costs and effort required for processing used wood into raw materials for wood-based panels, and the (relatively) low requirements in terms of material heterogeneity (e.g., length, strength, moisture, condition) for this usage. One of the experts was of the opinion that wood-based panels would be the prevalent utilization of used wood materials in the near and intermediate future, together with continuing to burn them in heatplants for energy purposes. In the more distant future, i.e., around 70 years, this would shift, and more direct uses would dominate.

They thought 70 years to be a likely timeframe for such a shift, believing that by then, the majority of buildings to be deconstructed would have been built with techniques and materials intended for deconstruction and reuse. One of the architects believed that planning for reuse soon would become an integrated part of building standards and already had some experience with planning such buildings due to the clients' requirements.

Table 1: *Table summarizing if and how participants signalled that sawnwood, engineered wood and wood-based panels could be reused, recovered, recycled, composted, or put to other usages.*

	Reusable	Recoverable	Recyclable	Compostable	Other usages
Sawnwood	Yes, a proportion of used sawnwood is almost directly reusable (endings may need to be adjusted etc.), provided that materials are controlled and meet quality standards. In a short-time perspective, increasing the reusable proportion requires a shift from demolition to deconstruction. To upscale the reusable proportion, reuse must already be considered when planning and constructing buildings.	Yes, a proportion of used sawnwood is recoverable, provided that materials are controlled and meet quality standards. Examples of recovery include processing loadbearing wood into cladding, interior products or engineered wood products. In a short-time perspective, recovering more sawnwood requires a shift from demolition to deconstruction. Upscaling requires already considering recoverability when planning and constructing buildings.	Yes, a proportion of used sawnwood may be recycled into wood-based panels or materials for pallets, provided that materials are free from metals and contaminations. Recycling into wood-based panels is considered the most likely and easiest way of keeping the resource in circulation longer at present.	Not discussed	Energy-recovery i.e., burning in heatplants for district heating, is the most likely usage of a considerable part of used sawnwood in a short-time and medium-term perspective.
Engineered wood	Yes, a proportion of used engineered wood is reusable, provided that materials are controlled and meet quality standards. Requirements for increased reuse were not discussed.	Recoverability of engineered wood products were not discussed.	Yes, may be recycled, provided that materials are clean (e.g. glue must be biobased and not constitute a health hazard). Examples of uses were not explicitly mentioned apart from general statements, implying that the participants assumed that if meeting health- and technical requirements, all wood-based materials could be recycled into wood-based panels.		Not explicitly discussed, but general statements implied that the participants assumed that most used wood could be converted into energy.
Wood-based panels	Not explicitly discussed. However, implicitly included as one of the materials when discussing the need for a shift from demolition to deconstruction, i.e., if new, gentile practices are introduced, a larger proportion of used wood-based panels might be reusable.	Recoverability of wood-based panels were not discussed.	Examples of recycling were not explicitly mentioned, apart from general statements implying that the participants assumed that if meeting health- and technical requirements, all wood-based materials could be recycled into wood-based panels.		Not explicitly discussed, but general statements implied that the participants assumed that most used wood could be converted into energy.

https://doi.org/10.52202/069179-0146

Table 1 summarizes the possible forms of re-use discussed by the participants, sorted into the categories "re-usable", "recoverable", "recyclable", "compostable" as proposed by the International Organization of Standardization [9], and "other usages". Most participants focused implicitly or explicitly on sawnwood, while none included explicit details on how wood-based panels could be re-used. From the general statements however, it could be derived that participants assumed that wood-based panels meeting health requirements, e.g., not treated with products or coating containing dangerous chemicals, could be recycled. None of the participants mentioned composting wood-based materials, suggesting that the participants did not associate composting of wood materials with circular economy.

As to whether there was an added value in used wood materials visually appearing to be used, the participants, with a few deviations, suggested that this would depend on the segment, purpose and use of said materials, and the timeframe. For visible materials, at present, many thought that there could be some market advantages if used wood looked used. For non-visible wood, and in a longer perspective, the participants doubted that there would be any such advantage. The few interviewees with a different view focused solely on visible wood and the present market and agreed that used wood with vintage patina would be beneficial. One participant explained how a product literally had been driven over and tossed around by the manufacturer to achieve the desired used look and thought that since this was a product that was popular with some segments, genuinely used materials would probably also be popular with some costumers. Regarding the willingness to pay for used wood, all participants assumed that it would be lower than the willingness to pay for fresh wood.

4 Discussion

Wooden materials can be re-used in many valid ways and play an important role in replacing more harmful materials and in prolonging the storage of CO_2 as "climate sinks" – both when the constructive elements are exposed and when not visible in the building.
The materials can be:

- Hidden between gypsum boards.
- Treated / repaired / refined / renewed, visible and recognizable.
- Recycled, hidden or visible but unrecognizable (e.g. in particle boards).
- More or less in their original state, and visible and recognizable.

Both the precursory interviews and focus groups and the recent interviews showed a tendency among architects and industry representatives to mostly talk about tangible, technical aspects, both when discussing wooden construction materials in general, and the reuse and recycling of such materials. The values they focused most on also coloured their view on the feasibility and the time aspect of reusing and recycling wooden construction materials – some focused more on the short time economic risks and gains for their company and were more sceptical about re-use and recycling becoming common practice before circular construction had become the common and possibly prescribed way to build. These participants were mainly industry representatives. Others highlighted more idealistic values, and ideals that would benefit society at large. They were more prone to seeing opportunities rather than obstacles, to start at a small and experimental scale at once in order to actively contribute to making a change, and to invest in future and more common gains. A subsequent more in-depth analysis of the interview data could include information on the participants being employees or company owners. This might influence how positively one looks at risks – an employee does not have the same responsibilities as a company owner.

In the study from 2022, the interviewer noticed that the architects described qualitative aspects of the material in ways that surprised her and that she hadn't considered herself or not formulated in that way, while interviewees with a technical focus (naturally) focused more on the technical than on the experiential or idealistic aspects, but also used a different and more straightforward language.

However, the experiences of re-used and recycled materials were barely addressed in the recent interviews. In the preceding research cited here [4], it was discovered that the users' (inhabitants') statements about their experiences with wooden construction materials were much more articulate, specific and rich than the architects' (and also than some architects expected). It stands to reason to assume that users also could fill a gap in understanding the experience-related acceptance of re-used and recycled wooden construction materials.

In the previous research, it was argued that these qualitative aspects were an essential part of architecture's "lovability", influencing the life cycle of a building. As cited before [2], loved buildings are expected to motivate the user to a greater degree to adapt to the building even when it is not a perfect match for the user's need any more, to take better care of the building, and to find new functions for the building when users change.

"Lovability" includes tangible, experiential and value related aspects of materiality. Based on interviews with inhabitants. these include:

- Sensory perceptions that cause bodily response (e.g. effects on heart-beat rate, sleep quality, recovery) and mental responses (e.g. stress level, behaviour, interaction with others).
- Associations, either with earlier experiences and memories, or with acquired ideas; these will influence the acceptance and appreciation of materials, of their state and treatments, and of their changing appearance when ageing.
- Individualisation of materials and products – even industrial, standardized products will become unique when weathered and used, and display their situatedness

in a geographical and in a cultural context (e.g., their orientation towards the sun/wind/rain, and habits of use entailing repeated touch).

- Atmospheric qualities
- Narrative (e.g. about the materials' earlier location or user)
- Affordance: the possibilities of use that a material signals. For example, a massive wooden wall suggests which loads it can carry and which tools to use, while a gypsum wall could either cover a void that makes it difficult to hang heavier things (curtains, pictures, furniture), or a concrete wall that requires heavier tools.

In the earlier study, "lovability" has been used in an argument for prolonging the life cycle of buildings, and for including the users' experiences [2,4]. It can also be a useful term when aiming at a greater degree of reuse and recycling.

In the interviews from 2022, architects tended to focus more on the possibilities and were optimistic about the realization of new ideas, while industry representatives tended to focus more on possible obstacles, risks, costs and how long it would take to implement new ways of doing things. A reason may be that architects and industry representatives have different roles in a project - architects are more used to selling new ideas, and industry partners must make ensure the financial feasibility; furthermore, they are already selling wooden products and do not depend on new markets for the re-use and recycling of wood.

A note on value: one interviewee said that materials were handled harshly to create a more used look. Then, "Plan A", the option to give the material a long life in a primary function and in its pristine state, is passed by. Hereby, the values tied to the re-use and recycling of materials are foiled. Then, the entire universe of interrelated material aspects (tangible, experiential and value related) are reduced to visual characteristics.

5 Conclusion

Precursory studies have established that physical properties, sensory and intellectual experiences, together with associated values and narratives are important dimensions to consider when understanding expectations towards and the acceptance of wooden materials. It is important to include the user in the group of stakeholders when discussing these dimensions. It is expected that this is also valid for re-used and recycled wooden materials. Furthermore, in order to include the entire value chain in circular models for wooden construction materials, the combustion for energy gain and the composting of wooden materials have to be part of all considerations.

The recent set of interviews presented in this paper focused on how professional decision makers (stakeholders from the wood industry and architects) relate to the wood-related properties, experiences and values established by users when discussing re-used and recycled materials. Important findings were that the professionals were detailed and explicit when focusing on mechanical and physical properties, and that their assessment of whether and how to pursue circular construction goals (and how soon) were guided by values, ideals and convictions, and in addition colored by their professional roles and responsibilities. Experiential aspects were largely absent from their statements. However, when developing new products and areas of application for re-used and recycled wooden construction materials, all three wood-related dimensions should be considered; besides properties and values, experiential aspects should be included, and the user perspective should complement the knowledge and insights already at hand in the wood industry.

Among others, this plays an important role when deciding if and how to process and treat wooden materials for aesthetic reasons, as this is greatly based on the users' assumed acceptance and appreciation of wooden materials but might impact the combustibility and compostability of wooden materials negatively. If the full cycle in a circularity perspective is part of how products both from new and from recycled wooden construction materials are promoted, this may also influence public taste and trends. When considering the full cycle of wooden material flows that includes their burning or composting, and when asking oneself if one would like to eat or to breathe in one's building (materials), then preferences of varnish, paint and other decorative treatments may be judged anew and change.

REFERENCES

[1] McDonough, William, and Michael Braungart. *Cradle to Cradle: Remaking the Way We Make Things*. 1st ed. New York: North Point Press, 2002.

[2] "Only things people like get a long life" states architect Dietmar Eberle. Sattrup, Peter Andreas. 'Arkitekter, arkitektur og ressourcer: Interview med Dietmar Eberle'. *Arkitekten* 11 (2008): 42–43. Translation by the author.

[3] Preiser, Wolfgang F. E., and Jack L. Nasar. 'Assessing Building Performance: Its Evolution From Post-Occupancy Evaluation'. *International Journal of Architectural Research:* ArchNet-IJAR 2, no. 1 (2008).

[4] Groba, Ute. 'Timber Tales: A Qualitative Study of Timber Materiality in Housing Projects'. Doctoral dissertation. The Oslo School of Architecture and Design, 2021.

[5] Flyvbjerg, Bent. 'Five Misunderstandings About Case-Study Research'. *Qualitative Inquiry* 12, no. 2 (April 2006): 219–45.

[6] K. Strobel, A. Q. Nyrud and K. Bysheim. 2017. 'Interior wood use: linking user perceptions to physical properties'. *Scandinavian Journal of Forest Research* 32(8): 798-806

[7] Statistisk sentralbyrå, Behandling av avfall fra nybygging, rehabilitering og riving (tonn), etter år, statistikkvariabel, behandlingsmåte og materialtype (Tabell 09781). 2022.

[8] Statistisk sentralbyrå, Avfall frå hushalda, etter nedstrømsløsning, år, statistikkvariabel, region, behandling og materiale. 2022.

[9] International Organization of Standardization, Definitions related to circularity - proposed by ISO/TC 287/WG 3 for use within ISO/TC 287, in ISO/TC 287/WG 3 N192. 2022. p. 6.

https://doi.org/10.52202/069179-0146