WORLD CONFERENCE ON TIMBER ENGINEERING 2025
BRISBANE, AUSTRALIA
Advancing Timber for the Future Built Environment

URBAN TRANSITION WITH WOOD FOR ENHANCED RESILIENCE OF CITIES AND FOREST – GLOBAL *VISION* AND *PATHWAY*

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ABSTRACT: In light of climate change and global sustainability challenges, the forest and timber construction sector offer opportunities for positive change. The aim of this project was to establish a *Vision* for a sustainable and resilient future society and pave the *Pathway* by setting up research agendas and policy proposals for research and development in the utilization of wood in urban environments from both local and global perspectives. This was achieved through substantial discussions among various stakeholders with varying backgrounds in local workshops (Japan, Australia, and Sweden) and a global workshop in Japan in November 2024. Seven topics were identified as crucial for urban transition with wood. The *Vision* and *Pathway* of these seven topics was developed and synthesized as a *Resolution* with the intent to serve as a basis for upcoming international research and education collaborations within and beyond the expert community of this project.

KEYWORDS: Resilience, Locality, Globality, International workshop, Education

1 – INTRODUCTION

As a knowledge creation program of the Tohoku Forum for Creativity (TFC) at Tohoku University (Japan), an international workshop series "Urban Transition with Wood for Enhanced Resilience of Cities and Forests" was carried out in 2024 [1]. Stakeholders from academia, industry, and public authority in different regions (Asia, Oceania, Europe) discussed the *Vision* for a more sustainable and resilient future society and attempted to identify steps to pave the *Pathway* by setting up research agendas in the utilization of wood in urban environments from both local and global perspectives. The workshop series aimed at formulating the global and local challenges for research and development to efficiently and effectively utilize forest-based resources while maintaining the forests as a part of the ecosystem at large. Figure 1 shows the project's discussion topics.

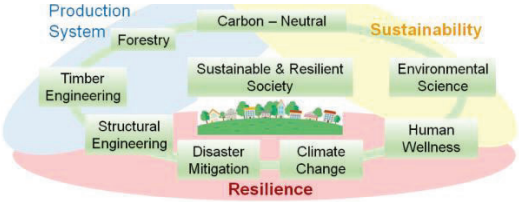

Figure 1. The relevant areas of the discussion and exchange in the workshop series

2 – BACKGROUND AND OBJECTIVE

Considering global challenges with climate change and sustainability, the forest-based sector and the

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https://doi.org/10.52202/080513-0645

construction sector play a major role as policies for a common goal of carbon neutrality have been emerging across the world [2, 3, 4]. However, the challenge is not limited to carbon neutrality, as natural disasters, extreme weather events, resource depletion, and ecosystem conservation are becoming increasingly critical. This calls for the development of urban environments with sustainability and resilience in mind, while considering complex challenges simultaneously. Wood is a promising material in urban development due to its carbon storage capacity, renewability, potential for circularity across different use phases, the socio-cultural value of forests for human society, and its contribution to the natural ecosystem. Only wood resources from sustainably managed forests can contribute to our sustainable development. Therefore, resource management in both the production and consumption of wood is crucial. As a result, policies and development plans for the utilization of wood resources in the built environment have been emerging on different levels (municipal, regional, and national) [5]. Such policies naturally reflect the local context of the environment, economy and resources. For example, the Japanese wood construction industry is shaped by its awareness of large earthquake risks in its forest-rich geography, while Australia focuses on bushfire risk and mitigation. Europe is facing pressures from climate change and biohazards such as the bark beetle [6]. Yet, different opportunities arise, such as advanced seismic engineering in Japan, or the continuous technical advancements and development of larger timber constructions in Europe. Furthermore, large public events such as the Brisbane Olympic and Paralympic Games 2032 create a potential for wood-based urban development.

Approaching the issues from academic, industrial and public perspectives, an organizer group was formed to run the workshop series "Urban Transition with Wood for Enhanced Resilience of Cities and Forests". The organizer group consisted of Tohoku University (chair of the organizer group, Japan), Okayama University (Japan), Synegic (Japan), the University of Queensland (Australia), Timber Queensland (Australia), Chalmers University of Technology (Sweden), and Dresden University of Technology (Germany). The objectives of the workshop series were:

1. to develop a local *Vision* and *Pathway* for a sustainable and resilient society by effectively utilizing wood resources,
2. to discuss the localities and globalities of the *Vision* and *Pathway* from various regions,
3. to synthesize them into a global *Vision* and *Pathway* with a high level of detail and propose a *Resolution* as a policy for research and development of the wood-based industry.

3 – PROJECT DESCRIPTION

The project had 2 phases, namely local workshops and a global workshop. Three local workshops (in Australia, Sweden, and Japan) were held from May to October in 2024. In each local workshop, local experts from academia, the forest and timber industry, housing agencies, government and other stakeholders were invited to discuss contemporary issues to co-create a *Vision* for a local future society. The discussion aimed to consider the gap between the future *Vision* and the today's status to identify what is required to close the gap, which is then formulated as *Pathway*.

After the local workshops, representatives from Japan, Australia, New Zealand, Sweden, and Germany gathered for a 6-day global workshop in Okayama and Sendai, Japan, in November 2024.

3.1 LOCAL WORKSHOP - AUSTRALIA

27 experts with backgrounds in forest and timber, design, architecture, and research were invited to come together at the University of Queensland in Brisbane on 30.05.2024 to exchange knowledge and ideas to plan a pathway towards sustainable and renewable cities and societies.

Introduction

After an icebreaker session where the participants discussed the characteristics of Australian cities, four speakers gave short thought-provoking presentations on their topic of expertise (demographic trends, resource availability, circular economy, and urban planning) to inspire discussion between participants. Participants were then asked to prompt an AI image generator to "paint" an image considering the following: "what makes a good city?" and "what makes a bad city?". The collected images are shown in Figure 2. The following themes were associated with "good cities": greenery, nature, canals, leafy shady trees, footpaths, walkability, public transport, a balance of ecofriendly cities and technology, integrated services and housing etc. Negative associations were traffic jams, pollution, homelessness, poor sanitation, concrete jungles, sprawling congested cities, fragmented cities, violent crime etc.

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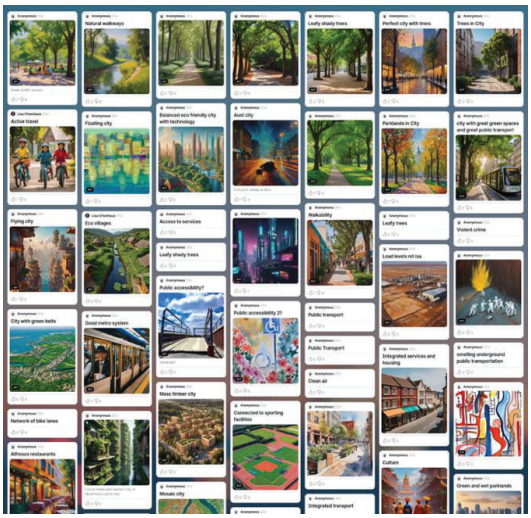

Figure 2. AI images of good and bad cities (Australian local workshop).

Australian *Vision*

Participants were asked to develop a vision in groups and share their visions through a digital platform by (1) discussing their values in relation to urban environments, (2) brainstorming ideas related to happiness, sustainability, resilience, and (3) developing a vision: "What do sustainable future cities & societies look like?" and "How can timber/natural building materials support that vision?". The shared inputs were unpacked, upvoted, and synthesized into a collective vision statement: *"Inclusive, affordable, and connected urban hubs built from sustainable locally sourced materials along circular economy principles. Nature-positive biophilic neighbourhoods provide public transport, active travel and work-life balance, a sense of community, safety and amenity for all with a near zero environmental foodprint while regenerating biodiversity."*

Australian *Pathway*

Participants were asked to discuss in groups about topics from ARUP's Cities Alive cards [7] (each person selected 1 topic card). They were encouraged to discuss their thoughts and reflect on what they found most interesting and surprising. From this, the groups were asked to develop actions, research topics, policies, and steps to achieve the vision, and asked to share their ideas on a digital platform. The ideas were categorized and transferred into an impact/effort matrix. Lastly, participants were asked to rank each action in terms of impact and effort. Interestingly, all actions / interventions were ranked similarly, with education perhaps being more impactful while not creating too much effort. From the room discussion it transpired that government planning and regulations (policies) were seen as most impactful but also hardest to achieve. These were added as an afterthought to the matrix. Figure 3 shows the list of topics and the ranking result.

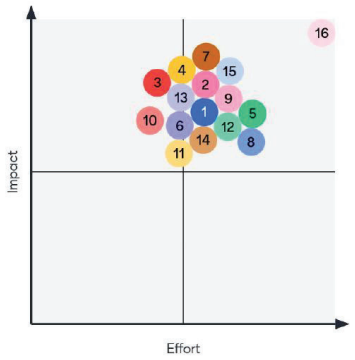

Figure 3. Topics as Pathway and their evaluation for the realization of the Vision in the Australian case. 1 Functional forests, 2 Green infrastructure, 3 Waste minimization, 4 Energy efficiency, 5 Circular economy in transport, infrastructure and services, 6 Timber reuse, 7 Retrofit of buildings, 8 Local manufacturing, 9 Products as a service, 10 Sustainability education, 11 Affordable e-mobility, 12 Standards to allow retrofit, 13 Medium density policies 14 Equitable access to green spaces, 15 Decarbonisation, policy and frameworks, 16 Government regulations.

3.2 LOCAL WORKSHOP - SWEDEN

The local workshop in Sweden was held on 30.08.2024 at Chalmers University of Technology (Chalmers) in Gothenburg, Sweden. 19 stakeholders (industrial associations, architects, engineers, manufacturers, consultants, academics, and public administration) participated in the workshop.

Introduction

Following the presentation on the background and aim of the workshop, preliminary statements of the *Vision* (prepared by the workshop facilitator in advance) were presented in four focus areas: Ecosystem, Resource, Material, and Building. For example, the preliminary *Vision* statement for Resource was: *"virgin and circulated wood resources are allocated rationally across various sectors based on systemic resource management policies"*. The participants were then divided into four groups according to the four focus areas.

Swedish *Vision*

Each group was asked to select relevant issues from [7]. Among various selected issues, the following were prevalent among the four groups: decarbonization, waste

https://doi.org/10.52202/080513-0645

minimization, retrofitting, biodiversity loss, circular economy, sustainable behaviours, and building standards.

Based on the selected issues and the preliminary *Vision* statement, each group refined their *Vision* with the aid of an AI image generator. The *Vision* description text was used as a prompt for an AI image generation in the first place. When the AI image was not satisfactory to represent what the *Vision* really envisages, the description was modified. Each group iterated the process until it reached a satisfactory result in both the written description and its image visualization. Figure 4 shows examples of the AI image from this iteration exercise.

Figure 4. AI image of the Vision of Ecosystem (left) and Resource (right) group of the Swedish local workshop.

The revised descriptions after the iterations in each group were given as follows:

Ecosystem: *"The forests are managed to balance the resource demand and the impacts of forest operations on the ecosystem. It is important to combine production goals with nature considerations in forestry as prescribed by law. The forest's raw material is an important part of solving the climate crisis. The forest is a place for recreation as well as someone's livelihood, which entails that the public right also means obligations. It is important to work for a rich biological diversity in harmony with active forestry"*

Resource: *"Sustainable behaviour mindset guided by political leadership giving incentives for individuals as well as for public-private partnerships to use virgin and circulated wood resources rationally allocated across various sectors in systemic ways supported by building standards."*

Material: *"New and re-used wood-based materials are applied in a small society in an appropriate manner to enable sustainability, biodiversity and conservation. The society should promote equality. Only sustainable energy sources."*

Building: *"All buildings are designed, constructed, and maintained to promote carbon storage, accommodate for changed user needs and allow for updated energy efficiency."*

Swedish *Pathway*

Following the *Vision* formulation, each group was asked to propose a *Pathway* to achieve their *Vision* based on inspirations from the policy recommendations by the wood4bauhaus alliance [5]. With regard to the promotion of wood resource use, a commonly discussed *Pathway* among all groups was the establishment of a common quantitative evaluation method of the biogenic carbon in wood products to highlight and incentivise the use of wood resources. Furthermore, all groups included resource efficiency measures in different contexts. One option is the efficient use of wood resource itself. This is highlighted by the promotion of rational allocation of wood resources among various sectors and the extended service life by reusing wood in the construction sector. Another option was promotion of efficient use of the existing building stock by implementing technical solutions.

3.3 LOCAL WORKSHOP - JAPAN

The local workshop in Japan was divided into two sub-workshops with participants from various fields such as architecture, structure, timber industry, and manufacturing. Each workshop focused on a different theme, namely regionality and circularity of wood utilization and resilience of wood and urban areas.

In each workshop, a workshop facilitator presented a predefined *Vision* and *Pathway* for each workshop theme. Following this, a Q&A session was held with the participants to delve into key discussion points and organize them effectively. After the discussion, the organizer edited the debate and reorganized the *Vision* and *Pathway*.

Japanese *Vison* and *Pathway* workshop 1 - Regionality and circularity of wood utilization

Workshop 1 was held on 17.07.2024 with twelve participants with a specific focus on "region." The goal was to envision a future where each region becomes an attractive place characterized by local circularity and sustainability.

As a result, the *Vision* was formulated as follows: *"Local Communities are characterized with circularity, sustainability and originality by (1) discovering the*

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unique strength of a region to create a more appealing community, (2) establishing mechanisms to utilize the strength of local community, and (3) quantifying the values on locality and other sustainability characteristics."

For achieving this, the following *Pathway* was proposed: 1. Development of wood circulation systems tailored to regional characteristics. 2. Improvement of production and distribution systems in the wood-based industry through open dialogue among relevant actors. 3. Development and promotion of new comprehensive evaluation standards for wooden architecture.

Japanese *Vison* and *Pathway* workshop 2 - Resilience of forest and urban areas

Workshop 2 was held on 03.10.2024 with nine participants with a specific focus on "resilience." The discussion covered three main aspects: resilience within urban areas, resilience related to forests, and the resilience that should be demonstrated through the collaboration between urban and forest systems. Participants explored what needs to be done in each of these areas to realize this vision.

As a result, the *Vision* was formulated as follows: *"Forests and Cities coexist and enhance mutual resilience by (1) improving resilience of cities with wood on disaster prevention, climate change mitigation, and post-disaster recovery, (2) improving resilience of forests on resource conservation and disaster prevention, and (3) fostering exchanges between urban and forest areas, which leverages each of their strengths beyond their closed industrial spheres."*

For achieving this, the following *Pathway* was proposed: 1. Wood utilization planning based on quantitative evaluation of the carbon budget across the entire circulation system. 2. Enhancement of the value of wooden buildings as disaster (earthquake, fire, and flooding) prevention infrastructure. 3. Creation of a collaborative production system and market which spans upstream, midstream, and downstream sectors. 4. Connecting stakeholders on different scales for dialogue and integration towards shared goals.

Synthesis of the Japanese workshops

A common challenge identified was the lack of developed dialogue between different actors, leading to an underdeveloped platform for discussions. Consequently, there is insufficient collaboration between forest managers and designers to set industry goals from economic and production perspectives. Additionally, in technological development, there is inadequate cooperation between individual technologies and feedback through coordination and design adjustments across entire buildings.

Furthermore, it was pointed out that there are still many unexplored aspects regarding the impact of urban wooden structures on the urban environment, beyond the performance of individual buildings. In this regard, indicators for quantitatively discussing these issues have not been sufficiently established.

A significant challenge identified is that Japan's forestry industry is not economically self-sufficient and relies heavily on government subsidies. To achieve economic independence, pathways have been suggested, such as collaborating with downstream industries to establish favorable economic conditions and referring to advanced international case studies.

Overall, there is a need to establish a discussion framework to set common goals based on quantitative indicators, going beyond individual field-specific improvements.

These issues include not only global challenges but also many local challenges unique to Japan. It was anticipated that the global workshop will provide opportunities to share knowledge and gain deeper insights into these problems and their potential solutions.

3.4 GLOBAL WORKSHOP

The global workshop took place in Okayama City and Sendai City, Japan, across 17-22.11.2024. 37 participants engaged in various programs through the workshop days, with additional visitors at two public seminars. In addition to the organizer institutions (see 2), the participating institutions and companies were Kyoto University (Japan), Meiken Lamwood Corporation (Japan), Okumura Corporation (Japan), Mitsubishi Jisho Design (Japan), Forest and Wood Products Australia (Australia), CFMEU (Australia), White Architekter (Sweden), University of Auckland (New Zealand), and University of Canterbury (New Zealand).

The program consisted of three main components. The first and the primary component was a series of thematic workshops designed to incrementally develop the global *Vision* and *Pathway* by running daily thematic workshops. Details of the framework and outcomes of each thematic workshop are presented later in the present section.

The second component were study trips to provide "food for thought" for the discussions in the thematic workshops. They were intended to inspire participants through site visits showcasing successful timber utilization and disaster damages and mitigations in urban and rural contexts. Discussion with local experts took place on each study trip to achieve a deep understanding in the technical and local aspects of those cases. The trip destinations included a local bioeconomy establishment in the construction and energy sector by Meiken Lamwood Corporation in Maniwa City (Okayama) and earthquake and tsunami memorial sites in Sendai City.

The third component consisted of two public seminars (attended mostly by university students and professionals in timber construction) to disseminate state-of-the-art knowledge in the global context, and insights gained throughout the workshops. One seminar was at Okayama University (Nov 19th) and the other one was at Tohoku University (Nov 21st), which were attended by ca. 100 combined participants. Selected speakers from the workshop participants gave a presentation in each seminar. Figure 5 shows the group after finishing the seminar at Okayama University.

Figure 5. Workshop group picture at the end of the public seminar in Okayama University.

The following sections discuss the framework and key outcomes of each thematic workshop during the global workshop period.

Thematic workshop 1 - Locality

The *Locality* workshop was held on 18.11.2024, with a study visit to Meiken Lamwood Corporation and a presentation by one of the workshop participants on case studies on architectural design reflecting the local wood material circularity. An open discussion was held to discuss the following question: *Is locality important? If so, why?*

The key conclusion from this workshop was: locality is important because every project is different and there is no universally correct answer. At the same time, sharing local solutions in a bigger (global) community may inspire others. "Think locally and communicate globally" was identified as a key attitude to value locality.

Thematic workshop 2 - *Vision*

The *Vision* workshop was held on 19.11.2024. The question to be answered was: *what is a 'Future vision' from each region? What is different and what is common?* Following presentations on the outcomes of *Vision* from local workshops in the three regions (see 3.1, 3.2, and 3.3), the participants discussed in groups identify globally common and locally unique issues.

By specifying the commonalities among all regions, globally common issues were listed as follows: carbon neutrality & circularity, sustainable forestry, governance, education, resilience, supply chain, and population & housing. These issues were then formulated into a global *Vision* statement:

> *"Our vision for Urban Transition with Wood for Enhanced Resilience of Cities and Forests entails the following vision:*
>
> *We achieve carbon neutrality by 2050, through measures based on sustainability, circularity, and responsible consumption concepts.*
>
> *We adopt a new and more sustainable approach in forestry that includes active management, the use of native species, biodiversity protection, and the health of multi-use forests. Improving vertical supply chain integration between the forestry, manufacturing, and construction sectors will enhance unity and information flow, driving greater efficiency and collaboration.*
>
> *Urban development pursues the vision in a timely manner by simultaneously solving the changes in housing demand and population. Resilience against disaster and climate change is crucial.*
>
> *The vision is supported by education at both societal and technical levels and right governance, with a strong role for government through a balance of incentives, regulations, and financial support."*

Thematic workshop 3 - Resilience

The *Resilience* workshop was held across 20-21.11.2024. It started with a study trip to earthquake and tsunami

https://doi.org/10.52202/080513-0645

memorial sites in Arahama area (Sendai City) which was devastated by the tsunami of the Great Kanto Earthquake in March 2011. The area has been going through a restructuring of the urban planning and local people's community. Selected speakers from the workshop participants gave presentations (on earthquake disaster mitigation measures in New Zealand, earthquake damage mitigation technologies in Japan, an economic feasibility study of Design for Structural Adaptation in case of damages in a Swedish context, resilience in forest resource management in an Australian context, and a case study on an architectural design for resilience in an Australian context). 2 rounds of open discussions were then held to discuss the following questions: *(1) How can timber/wood contribute to sustain (local) community, tradition & culture? (2) What are enablers for a resilient society?*

As a result, the following was suggested: The international earthquake- and disaster-engineering communities need to invest cooperative efforts to arrive at unified methods to produce new urban environments. The International Network of Timber Engineering (INTER) can be a model of cooperation with an emphasis on promotion of reliable standardization considering "design beyond safety" to achieve resilience. Structural timber should play a central role to help reduce emissions and waste. It is imperative that these efforts pursue the design of structures that minimize damage and can be reused quickly after natural disasters. Experiences from areas such as Japan in dealing with large-scale disasters can provide a good foundation. It would be beneficial to develop a multinational comprehensive series of full-scale dynamic/ static tests to verify the design approaches.

Thematic workshop 4 – *Pathway* and *Resolution*

The *Pathway* and *Resolution* workshop was held on 22.11.2024 in order to answer the following question: *What is our Vision, and what is our pathway?* After reviewing the outcomes of the thematic workshops in the previous days, the following 7 topics were identified as globally common and critical among all discussed topics:

1. Carbon Neutrality & Circularity
2. Locality
3. Resilience
4. Buildings
5. Governance
6. Education
7. Forestry and Forest Value Chain

The participants were divided into small groups and each groups drafted a *Vision* and *Pathway* on an assigned topic. As the time of the workshop was limited, only drafts were produced during the actual workshop. The draft was further edited and consolidated as a *Resolution* afterwards. The *Resolution* is presented in the following chapter.

4 – RESOLUTION

This chapter describes the global *Vison* and *Pathway* of the 7 topics, identified from globally common and critical topics (see 3.4). Several *Vision* and *Pathway* statements were developed for each topic so that they complement each other to collectively provide a more detailed and comprehensive statement for each topic.

4.1 CARBON NEUTRALITY & CIRCULARITY

1. *Vision:* By 2050, carbon neutrality is achieved at national and regional levels. The construction sector, which effectively applies timber in city planning and building construction, is fulfilling its necessary role in the carbon neutrality effort.
   Pathway: This is achieved by developing commonly agreed evaluation methods of the carbon footprint of construction. This entails the establishment of a standardized carbon accounting method for wood-based construction products throughout the forest value chain including carbon sequestration in forests and end of life of the products.

2. *Vision:* Engineering technologies and socio-economic systems are deployed for fostering circular use of wood resources.
   Pathway: This is achieved by developing methods and technologies for the long-term use of timber and wooden buildings, optimal resource allocation based on material qualities and product performance requirements, and reuse of wood-based construction materials. The benefit of those solutions should be quantified and motivated by a comprehensive evaluation method which considers both environmental and economic performances.

4.2 LOCALITY

1. *Vision:* Construction systems, which are tailored to the local culture and climate, have been established and local economies are vitalized by utilizing local wood resources.
   Pathway: This is achieved by assessing local resources (locally sourced timber and local

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industries etc.) as well as the characteristics of local culture and climate. Timber construction technologies that leverage the potential of local resources should be developed.

2. *Vision:* Local wood resources are sustainably produced and utilized while their local demand and supply is well-balanced.
   Pathway: This is achieved by fostering collaborations of local forest and wood-working industry to develop management systems for regional wood resources. They should quantitatively and dynamically ascertain the volume of local timber supply and reflect it to the wood processing systems which are simultaneously optimized based on the demand in the local market.

4.3 RESILIENCE

1. *Vision:* Design methods are available for enabling wood constructions to mitigate unforeseen disasters and accidents with the considerations of unique risk probability of each region.
   Pathway: This is achieved through sharing knowledge internationally among experts and companies regarding large-scale disasters and deterioration, updating safety standards, elucidating mechanisms for phenomena lacking sufficient knowledge (e.g., changes in joint performance after long-term use, performance degradation after repeated earthquakes), and proposing technical solutions.

2. *Vision:* Owed to improvements in retaining strength and repairability in case of damages, restoration and continuous use of wood constructions is easy even after they have been damaged in a disaster, or their components have deteriorated.
   Pathway: This is achieved by defining and maintaining the required strength of structural components in damage situations and by developing structural systems that can maintain and assure the performance of joints and members after structural repairs.

3. *Vision:* Buildings have flexibility to adapt to changing needs over their service life, and long-term use of buildings is widely practiced.
   Pathway: This is achieved by identifying performance criteria for adaptive construction methods such as partial building replacement or relocation, while developing methods to evaluate technical, economic and environmental viability of adaptation measures.

4. *Vision:* Forest resources are conserved against threats such as pest infestations, storm, flooding, and bushfires.
   Pathway: This is achieved by predicting damage patterns and growing risks by the global climate change and by developing monitoring technologies and conservation methods for forest protection.

4.4 BUILDINGS

1. *Vision:* Buildings are constructed by rationally balancing technical performances (structural performance, durability, environmental impact, energy efficiency etc.) and economic performances (economic value, and construction costs).
   Pathway: This is achieved by developing quantitative methods to comprehensively evaluate structural performance, energy performance, environmental impacts, economic impacts, and construction efficiency, which enables multi-criteria assessment of multifaceted aspects.

2. *Vision:* Buildings are designed with an emphasis on reuse and adaptability, taking resource circulation into consideration.
   Pathway: This is achieved by addressing technical challenges required for buildings to function as "material banks," such as developing construction methods that are easy to dismantle and reconstruct, establishing performance assurance methods for reused components, archiving digital building information ("digital twin"), and devising non-destructive methods to assess deterioration.

3. *Vision:* Wooden buildings are designed to have a positive impact on users' physiological and psychological wellness, as well as their overall well-being.
   Pathway: This is achieved by collaborating with other disciplines such as cognitive psychology and physiology to advance the comprehensive understanding of wood and wood-based spaces and establish quantitative evaluation methods for well-being.

4.5 GOVERNANCE

1. *Vision:* Appropriate incentives, regulations, and financial support are led by local and national

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governments, promoting the construction of buildings that contribute to carbon neutrality.
Pathway: This is achieved by developing methods to quantitatively evaluate and plan the impacts on construction demand of introducing incentives or penalties via carbon credits and carbon taxes, as well as legal regulations or relaxations for wooden buildings and financial support.

2. *Vision:* Renewable forest resources are appropriately distributed among various industries (such as construction, pulp and paper, and energy) in line with their demand, which contributes to the stability of global supply-demand balance of wood resources.
Pathway: This is achieved by promoting quantitative understanding of wood demand across different industries and correspondingly rationalizing resource processing and allocation plans on the supply side to efficiently provide wood recourses.

3. *Vision:* Even in regions with limited timber resources, the use of wood materials and construction of wooden buildings are facilitated through international cooperation and trade.
Pathway: This is achieved by developing a more international and open timber market system, for example by introducing preferential measures that incentivize exports of timber to regions with scarce forest resources.

4. *Vision:* Communication among stakeholders in forestry, sawmilling, and construction—as well as the broader timber and wood-building sectors—is streamlined for a rational coordination of production systems.
Pathway: This is achieved by forming cross-sectoral networks and developing information-sharing platforms to facilitate communication and collaboration among stakeholders.

4.6 EDUCATION

1. *Vision:* Not only those in the construction and forestry industries but also the general public and end users understand the advantages of a "wood-based society."
Pathway: This is achieved by introducing educational activities on wooden architecture and the timber industry in public schools, thereby increasing societal awareness of sustainable wood resource use.

2. *Vision:* New technologies, information, and knowledge regarding timber and wood constructions are easily accessible, and general technical standards in the global wood construction sector are continuously to updated.
Pathway: This is achieved by offering educational programs on wood constructions to students and professionals for upgrading their knowledge and skills either free of charge or at low cost.

3. *Vision:* An international network of forestry and wooden-building experts exists, making it possible to provide a high standard of education internationally through collaboration.
Pathway: This is achieved by a new international network of educators with a particular focus on education through specialized sessions at international conferences such as at WCTE (World Conference on Timber Engineering).

4. *Vision:* Timber industries in various countries promote national and international education and certification.
Pathway: This is achieved by referencing existing education initiatives for professionals provided by WoodSolutions [8], Swedish Wood [9], NZTD (New Zealand Timber and Dunnage Limited) [10], WoodWorks [11], etc., and developing and adopting a certification system that is easy to implement, taking both international standards and regional characteristics into consideration.

5. *Vision:* The general public has easy access to outstanding wood-based spaces that foster familiarity with and deeper understanding of timber.
Pathway: This is achieved by promoting attractive wooden construction in public facilities such as elementary schools and libraries, providing spaces where people can have a first-hand experience with high-quality built environments with wood.

4.7 FORESTRY AND FOREST VALUE CHAIN

1. *Vision:* Forest management techniques adapted to local characteristics are established, ensuring both sustainable resource production and the preservation of biodiversity.
Pathway: This is achieved by innovations in forest management technologies such as quantification of appropriate logging and reforestation, development of forest monitoring systems with digital technologies, development of methods to maintain

healthy forests under climate change, and quantification and managing of biodiversity index.

2. *Vision:* Logs are sawn with a high efficiency and timber boards are graded with a high precision.
   Pathway: This is achieved by developing efficient sawing techniques and high yield grading technologies that minimize waste and utilize materials according to their actual properties.

3. *Vision:* A sustainable balance is achieved between forest area conservation and economic utilization of forest resources.
   Pathway: This is achieved by developing quantitative methods to model forest regeneration cycles and timber demand. Such a model should enable long-term forest management planning.

5 – CONCLUSIONS

Throughout the series of local and global workshops, a global *Vision* and *Pathway* of "Urban Transition with Wood for Enhanced Resilience of Cities and Forests" was discussed and formulated by international participants from various stakeholder groups. Participants engaged in active exchanges and articulations of opinions that highlighted differences and commonalities among different regions. From this, seven topics were identified as common and key areas for further development. For each topic, a *Vision* and *Pathway* was drafted and compiled as *Resolution*.

To successfully draft a *Resolution*, it was critical to conduct well-planned and well-facilitated physical (not digital) workshops with a clear goal and focus. It was also crucial to ensure sufficient duration of the workshop days and sufficient time for reflection between each thematic workshop. The discussions were greatly enhanced by conducting study trips and interactions with local representatives which provided tangible inspirations and wider perspectives for drafting the *Resolution*.

The workshop series also facilitated the establishment and consolidation of the expert community. Holding numerous in-person workshops and seminars enabled participants to learn about each other's interests and discover new opportunities for future collaboration. It provided a great opportunity especially to early-career researchers and graduate students to interact with leading researchers and practitioners.

The *Resolution* is a basis for future international research and educational collaborations within and beyond the expert community of the project. Collaboration can be launched through international grants, student exchanges, visiting scholar programs, exchanges in international workshops, conferences, etc.

6 – ACKNOWLEDGEMENT

The organizing group gratefully acknowledges Tohoku Forum for Creativity at Tohoku Univ. and the Green Innovation Center at Okayama Univ. for its funding and administrative support. The hosts of study trips are acknowledged for their contribution. Prof. Santiago Pujol (Univ. of and Canterbury), Dr. Alex Shegay (Univ. of Auckland) and Dr. Yosuke Komiyama (Kyoto Univ.) are acknowledged for leading and summarizing a workshop. Ms. Naoko Namiki, Ms. Akiko Hori, and students at Tohoku Univ. are also gratefully acknowledged for administrative and logistical support.

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