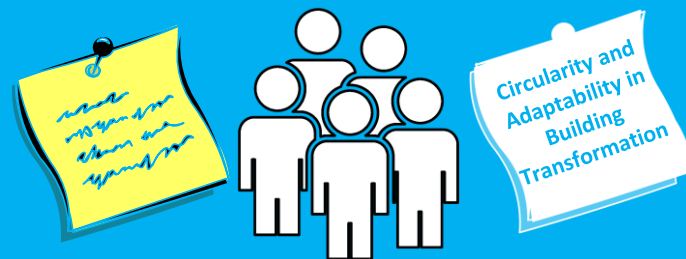


# Co-Development of a Framework for Circular Building in Adaptive Reuse

*A Participatory Research*

Report of outcomes of a co-creation workshop



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# 1. Summary and Main Outcomes

## 1.1 What is in this report?

This report provides you with main outcomes of a facilitated co-creation workshop on 19-April, 2023. The workshop had a twofold objective, namely *validating* and *expanding* a framework for circular and adaptable transformation of buildings.

Before presenting the main outcomes, the report introduces the underlaying concept of this research – the *circular building adaptability* (CBA) – and its 10 determinants. Right after this introduction, the first version of the framework is presented. The original version of the framework is followed by results and brief discussions of the workshop outcomes as per the 10 determinants of CBA. Photos of the participants' reflections on the strategies is provided in appendix section of this report.

## 1.2 Main Outcomes

The main outcomes can be summarized as follows:

- Eleven strategies were put forward and mapped to the determinants of the framework, while one strategy was excluded from the framework. These strategies comprise 4 passive, 3 active and 4 operational strategies.
- The interactive session also contributed to the exploration of other contextual considerations such as barriers and enablers to the strategies and other limitations.

The co-creation workshop contributed to adding new strategies which have not been defined before by the researcher, neither through the reviewed literature nor the conducted case studies. This could be attributed to the fact that promoting circularity and adaptability in building transformation is still emerging in a sort of pilot projects whereas innovations are still being developed and experimented. Ultimately, the Dutch building industry has been seen as a pioneering arena in terms of promoting circularity in buildings (Tserng *et al.*, 2021), which can also be a reason why the participants could put forward new strategies.

## 2. Overview of the CBA Concept and its Determinants

### 2.1 What is meant by *Circular Building Adaptability (CBA)*?

Hamida *et al.* (2022) defined circular building adaptability (CBA) as “the capacity to contextually and physically alter the built environment and sustain its usefulness, whilst keeping the building asset in a closed-reversible value chain.”. CBA was conceptualized in response to the observed limitations with the concept of building circularity to align contextual aspects pertaining to the long-lasting utility of the building assets.

### 2.2 Determinants of *Circular Building Adaptability*

Hamida *et al.* (2022) expressed CBA with 10 determinants as shown in Figure 1. Table 1 presents a brief description of the CBA determinants.

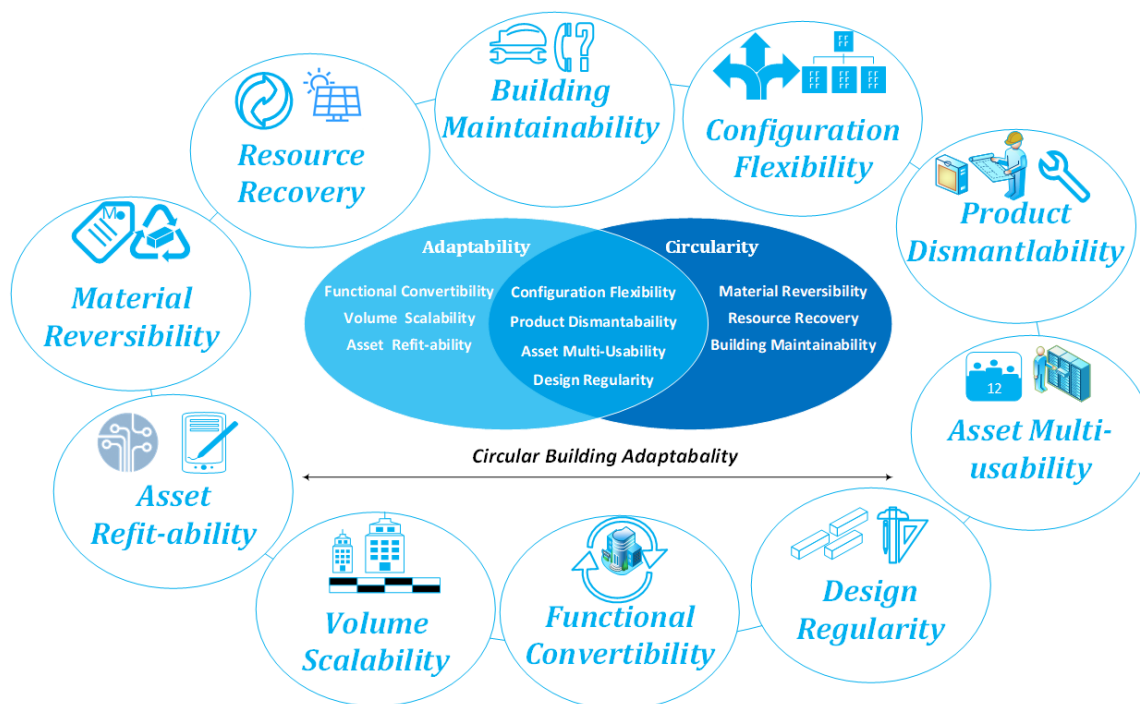


Figure 1: Determinants of CBA

## 2. Overview of the CBA Concept and its Determinants

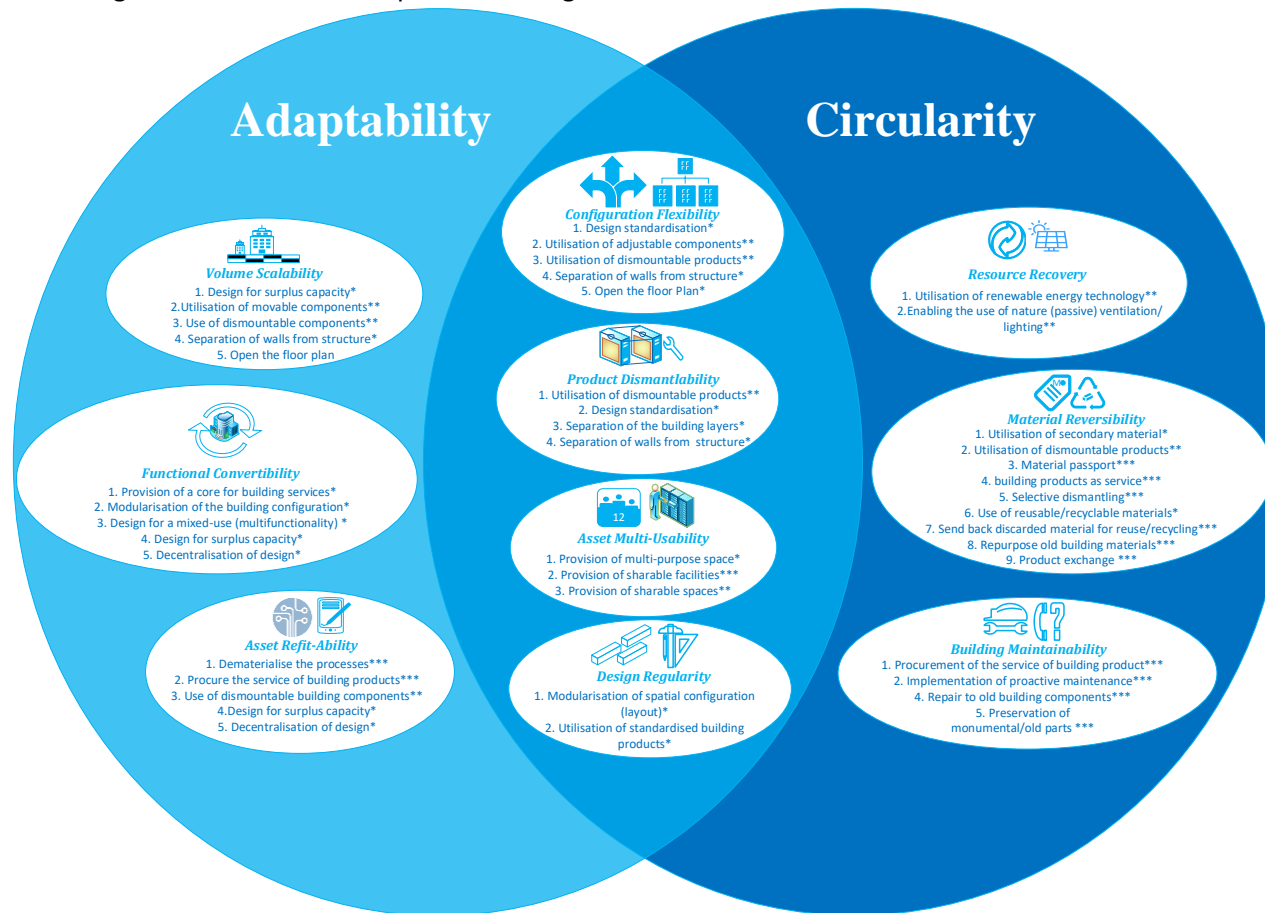
**Table 1:** Description of the CBA determinants

Determinant	Brief description
<i>Configuration flexibility</i>	The capacity to reconfigure the layout of spaces without utilising external resources and producing waste.
<i>Product dismantlability</i>	The capacity to dismantle components and products in a building without inflicting damage and producing waste, so that they can be reused in the building or another building
<i>Asset multi-usability</i>	The capacity to offer a multiplicity of the use of building assets, so that maximising the efficiency of their utilisation
<i>Design regularity</i>	The capacity to provide a regular pattern in the spatial layout and composition of the physical assets in the building, so that facilitating the reuse and remanufacturing of the building components and products afterwards
<i>Functional convertibility</i>	The capacity to y to repurpose the function of a building or part of it, so that promoting its longevity while keeping its value
<i>Material reversibility</i>	The capacity to efficiently provide, utilise and reuse the materials in the building within a reversible value chain.
<i>Building maintainability</i>	The capacity to prolong the utility of the building assets and sustain their performance
<i>Resource recovery</i>	The capacity to regenerate the building resources in a manner that reduces the use of new materials and energy consumption
<i>Volume scalability</i>	The capacity to increase and decrease the size of a building and its spaces in a response to the demands of user or organisation, so that alleviating the shortage and redundancy in the spatial use of the building.
<i>Asset refit-ability</i>	The capacity to efficiently provide state-of-the-art building assets and technologies, while avoiding waste generation or over-invested solutions.

### 3. A Framework for Circular and Adaptable Building Transformation

## 3. A Framework for Circular and Adaptable Building Transformation

Based on an integrative review of relevant literature and an exploration of relevant case studies, **Figure 2** presents a guiding content-wise framework that was developed to provide strategies for circular and adaptable building transformation.



**Figure 2:** A framework for circular and adaptable building transformation

## 4. Workshop Outcomes

### 4.1 Strategies for Promoting Configuration Flexibility

According to the interactive discussions among the participants, it was concluded that the previously defined 5 strategies for promoting configuration flexibility are valid (Figure 3). However, the participants indicated that configuration flexibility could be hindered by the high cost of using moveable products. The participants also indicated that the possibility to promote configuration flexibility depends on the project client and the physical condition of buildings.



**Legend:**

\* Passive design strategy

\*\* Active design strategy

\*\* Operational strategy

Strategy defined from theory

Strategy defined from theory and found in practice

Strategy defined from practice

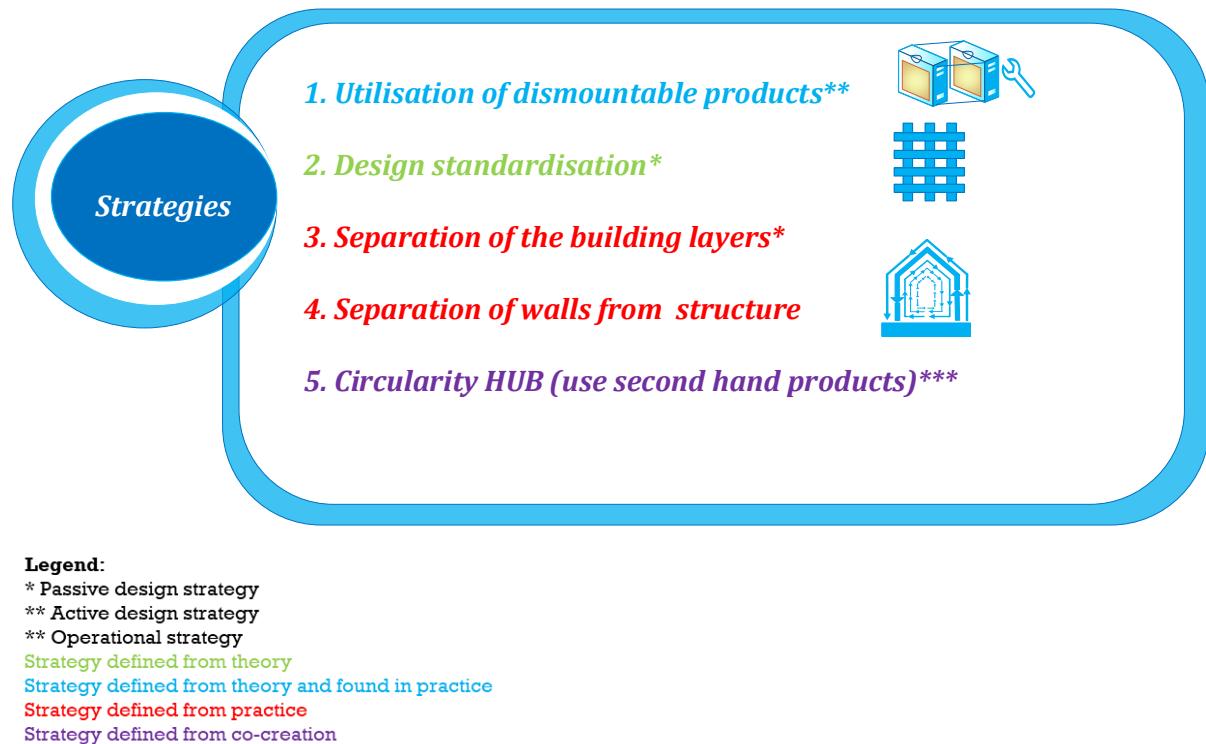
Strategy defined from co-creation

**Figure 3:** Strategies for promoting configuration flexibility

As shown in Figure 3, two strategies were added by the participants, namely scale up the design of the building (from individual to the great portfolio) and circularity HUB “use building components as a service then sell them” – market place.

### 4.2 Strategies for Promoting *Product Dismantlability*

The outcomes of the workshop indicate that the defined literature- and case studies-based strategies for product dismantlability are to some extent valid (Figure 4). The interactive discussions contributed to adding an operational strategy to this determinant, namely circularity HUB – “use second hand products” as stated and written by the participants.



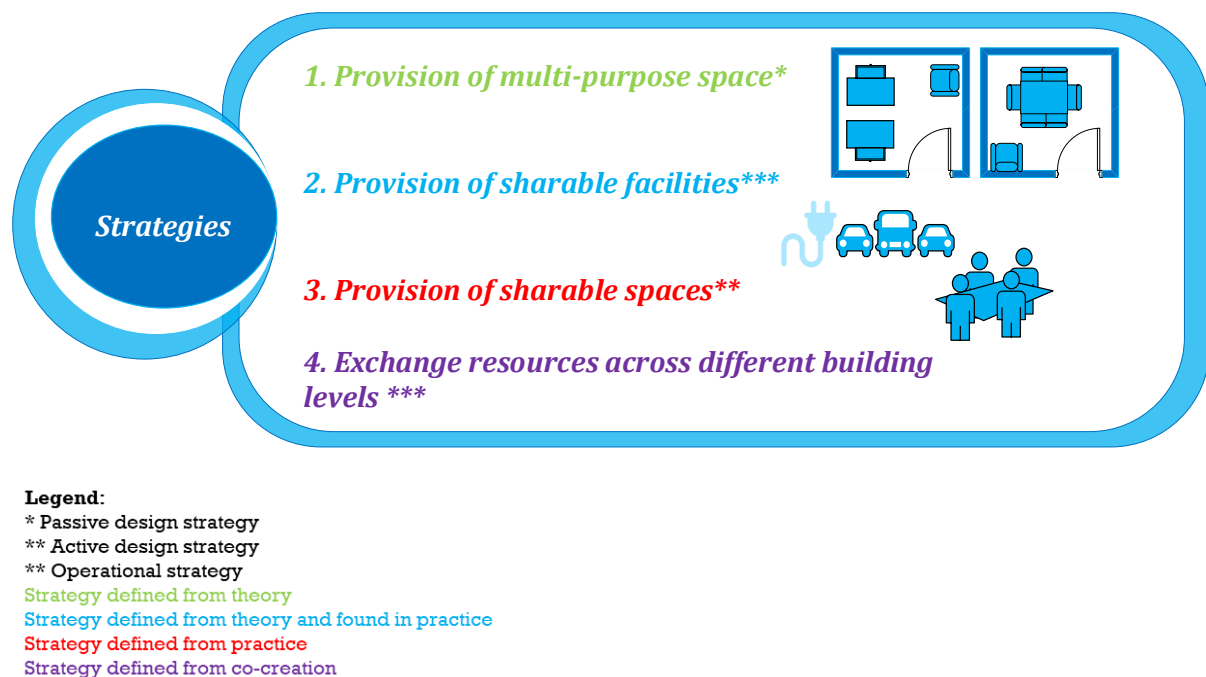
**Figure 4:** Strategies for promoting *product dismantlability*

On the other hand, the discussions resulted in pointing out other considerations with regard to the second and third strategies. For design standardization, the participants indicated that it can be facilitated through an alignment in the scale of building products. Regarding the separation of the building layers, the participants pointed out that it is not always possible, meaning that it depends on the physical condition of buildings.



### 4.3 Strategies for Promoting Asset Multi-usability

The outcomes of the discussions among the participants pointed out that the previously defined 3 strategies are valid (Figure 5), yet two considerations were expressed about the first two strategies. For the provision of multi-purpose spaces, the participants indicated that the requirements may hamper this strategy, while technology utilization may facilitate it. Regarding the provision of sharable facilities, the participants considered it as a strategy that is beyond the project scale. Thus, the scale dimension was perceived as an important consideration for providing sharable facilities in building transformation.

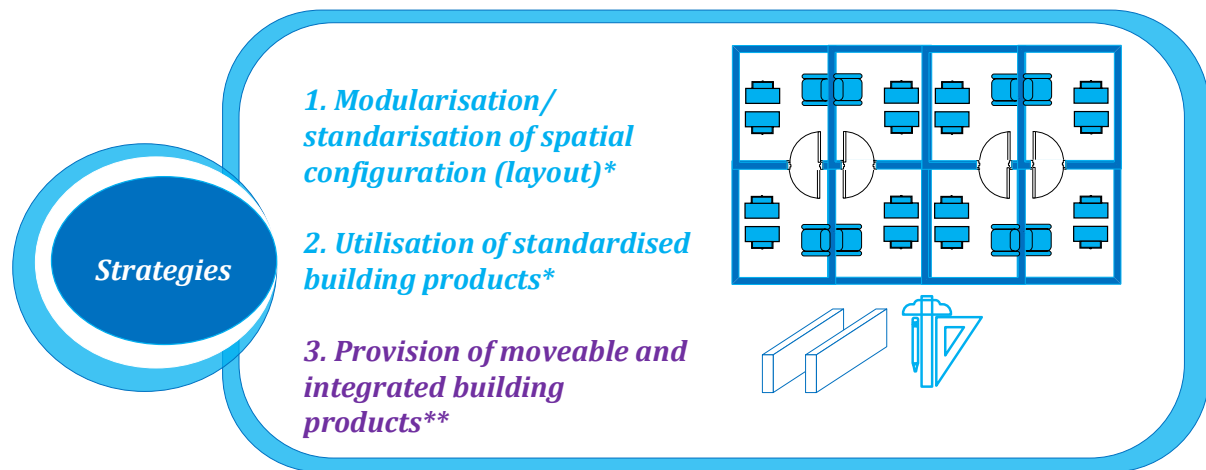


**Figure 5:** Strategies for promoting asset multi-usability

The participants indicated that providing sharable spaces adds a value to the property when it is being implemented in a form of rentable spaces in office buildings during the evening period. The interactive discussions also resulted in adding an operational strategy to promoting asset multi-usability in building transformation, namely exchange of resources across buildings and levels within the built environment.

### 4.4 Strategies for Promoting Design Regularity

The participants concluded that the previously defined two strategies for promoting design regularity – namely modularization/standardization of spatial configuration and utilization of standardized building products – are valid (Figure 6). However, the participants indicated that the applicability of both strategies depends on the condition and scale of buildings.



**Legend:**

\* Passive design strategy

\*\* Active design strategy

\*\* Operational strategy

Strategy defined from theory

Strategy defined from theory and found in practice

Strategy defined from practice

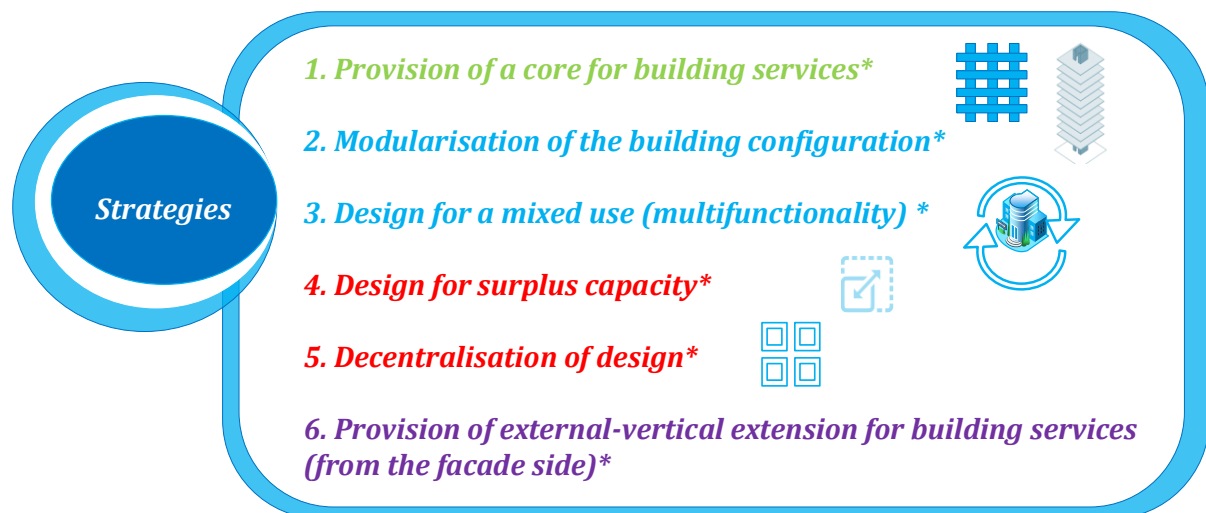
Strategy defined from co-creation

**Figure 6:** Strategies for promoting *design regularity*

The discussions among the participants also contributed to adding a new strategy for promoting building regularity in building transformation, namely provision of moveable and integrated building products. Different practical examples were given of such a strategy, including the use of: ceiling panels that include personalized products, panels that combine different building services systems and plug and play systems.

### 4.5 Strategies for Promoting *Functional Convertibility*

The outcomes indicate that the previously defined strategies for functional convertibility are valid (Figure 7). However, the economic dimension has been perceived as a determinant of the feasibility of 3 strategies, namely: design for a mixed-use, design for surplus capacity and decentralization of design. Thus, the participants indicated that valuation should be carried out to determine the feasibility of these strategies. The participants also concluded that the design for a mixed-use (the third strategy) might be hindered by regulations while innovations may facilitate its application.



**Legend:**

\* Passive design strategy

\*\* Active design strategy

\*\* Operational strategy

Strategy defined from theory

Strategy defined from theory and found in practice

Strategy defined from practice

Strategy defined from co-creation

**Figure 7:** Strategies for promoting *functional convertibility*

For the first strategy – provision of a core for building services, the participants concluded that the original structure of existing buildings has a direct bearing on the possibility to apply this strategy. The interactive discussion among the participants also led to add a new strategy for promoting functional convertibility in building transformation, namely providing an external-vertical extension for building services (from the facade side).

### 4.6 Strategies for Promoting Material Reversibility

The outcomes of the workshop indicate that the majority of the previously identified strategies for material reversibility are valid (Figure 8), except the third and fifth strategies. For applying material passports, two participants indicated that it might be hindered by the so-called “sort-term thinking”, referring back to their previous experience in circular building transformation. Regarding selective dismantling, the participants concluded that it is a physically challenging strategy to apply in existing buildings.



Figure 8: Strategies for promoting material reversibility

For the majority of the strategies, the participants indicate that the level of details is an issue; thus, they perceived the documentation as an important requirement for material reversibility. Keeping old building materials was a newly added strategy by the participants.

### 4.7 Strategies for Promoting *Building Maintainability*

The outcomes of the interactive discussions indicate that all the previously defined strategies are valid for promoting building maintainability (Figure 9). Moreover, it was concluded that the fifth strategy – preservation of monumental/old parts – could be mandatory in case of preserving or conserving heritage buildings.

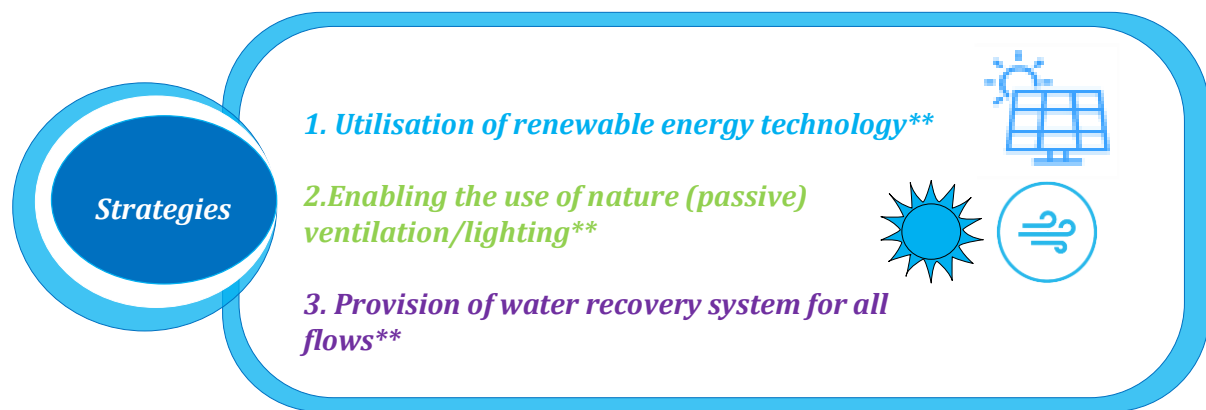


Figure 9: Strategies for promoting *building maintainability*

The interactive discussions resulted in adding a new operational strategy, namely applying/updating material passports during building alterations. However, the participants concluded that lack of awareness is apparently a barrier to apply/update material passports during building alterations.

### 4.8 Strategies for Promoting *Resource Recovery*

The outcomes of the interactive discussions indicate that the previously defined strategies are to some extent valid (Figure 10), yet an environmental concern was expressed about the first strategy – utilisation of renewable energy technology. Particularly, one participant indicate that this strategy is not 100% circular, though it is effective for operational energy, referring to the fact that not all PV panels are made of reusable or recyclable materials.



**Legend:**

\* Passive design strategy

\*\* Active design strategy

\*\* Operational strategy

Strategy defined from theory

Strategy defined from theory and found in practice

Strategy defined from practice

Strategy defined from co-creation

**Figure 10:** Strategies for promoting resource recovery

The interactive discussion contributed to adding a new strategy for promoting resource recovery, namely providing water recovery system for all flows. It was discussed that this strategy will contribute to loop the water flow as a resource within the building.

### 4.9 Strategies for Promoting Volume Scalability

The interactive discussions among the participants indicate that the previously defined five strategies are valid for promoting volume scalability (Figure 11). For instance, it was mentioned that the first strategy – design for surplus capacity – might be needed to make the transformation feasible in the long term. One participant gave a practical example of the second strategy – utilization of moveable building components, namely using folding walls in meeting rooms and gyms. The participants concluded that the third strategy – use of dismountable building components – is effective and needed to promote volume scalability, as it could ease changes in the distribution of spaces.

The interactive discussion contributed to adding two more strategies for promoting volume scalability in buildings. First, making use of outdoor spaces was added as a coping strategy when the need for an extra space becomes inevitable. Second, connection of building through tunnels was proposed as another strategy for promoting volume scalability.

## 4. Workshop Outcomes

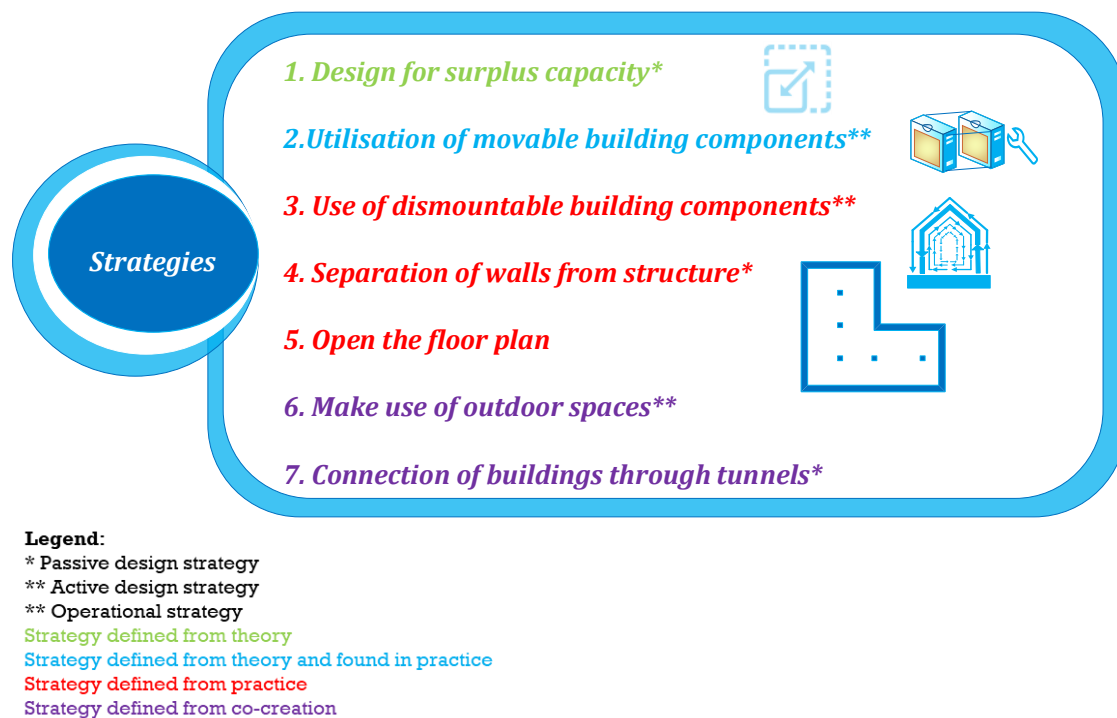


Figure 11: Strategies for promoting volume scalability

### 4.10 Strategies for Promoting Asset Refit-ability

The outcomes of the interactive session point out that four out of the previously defined five strategies are valid for promoting asset refit-ability (Figure 12). One strategy was excluded, namely the dematerialization of processes. The participants justified that exclusion by the absence of practical example of dematerializing resources in the context of buildings.

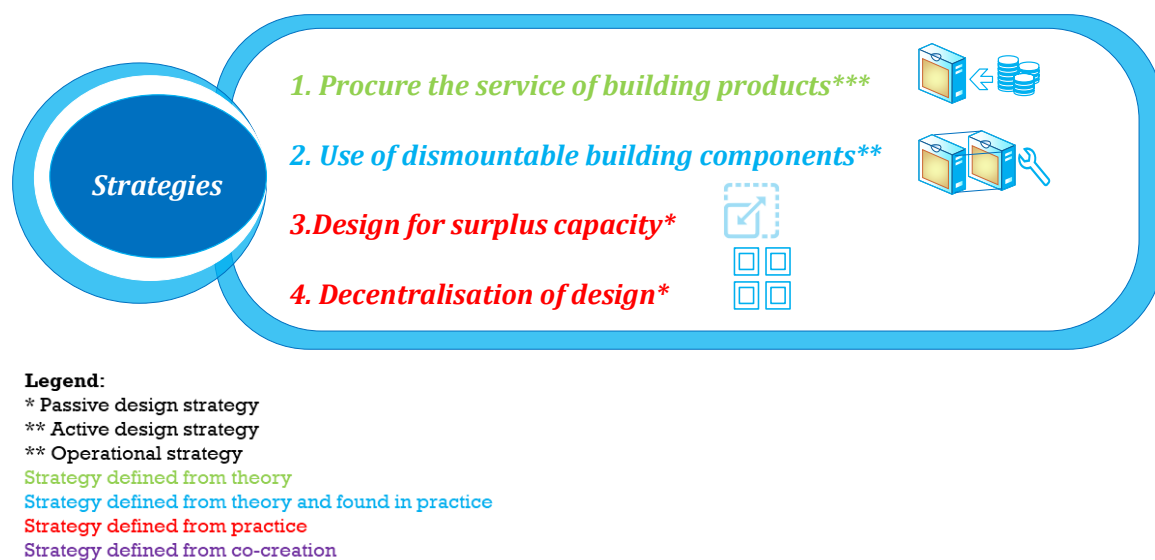


Figure 12: Strategies for promoting asset refit-ability

#### 4. Workshop Outcomes

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One participant indicated that the design for surplus capacity through the structure is effective to promote asset refit-ability. The participants concluded that it is difficult to predict future changes that can be facilitated through the decentralization of design. Thus, the participants concluded that the application of design decentralization should comply to certain criteria.



## 5. Appendix: Outcomes of the Participants' Interactive Session

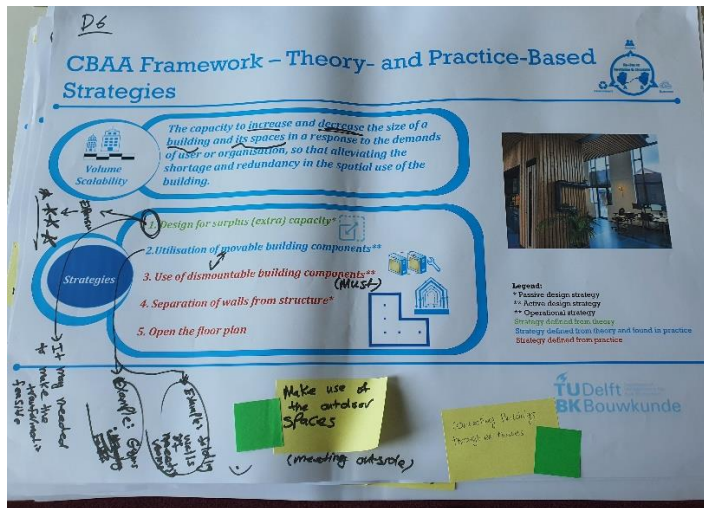


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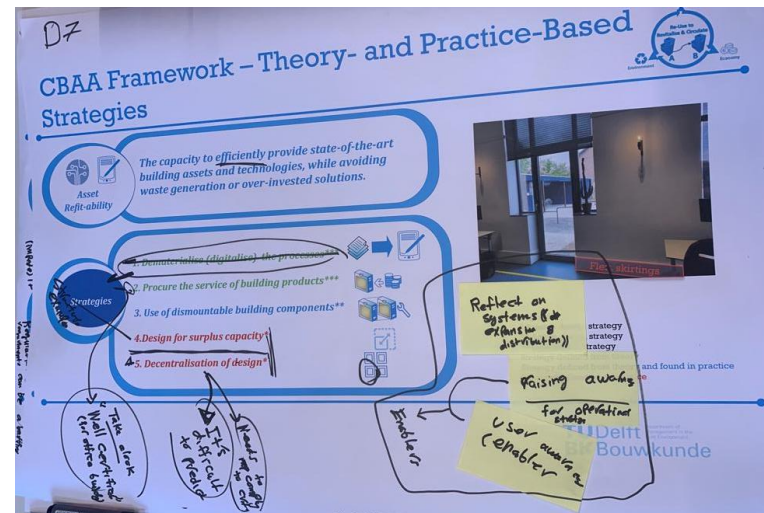




## 5. Appendix: Outcomes of the Participants' Interactive Session



Volume Scalability



Asset Refit-Ability

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- Tserng, H.-P., Chou, C.-M. and Chang, Y.-T. (2021), "The key strategies to implement circular economy in building projects-a case study of Taiwan", *Sustainability*, Vol. 13 No. 2, p. 754. <https://doi.org/10.3390/su13020754>