ZAŁĄCZNIK NR 2

Thesis title: Innovative architectural strategies for shaping an ecological and aesthetic living environment using construction waste and demolition materials
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Key words: reuse, building materials, circular economy, construction and demolition waste, recycling

ABSTRACT

The dissertation addresses the topic of utilizing construction waste and demolition materials in the design of new architectural projects within the context of creating a sustainable built environment. It responds to current ecological challenges, such as the overexploitation of natural resources and the waste management issues caused by the construction industry. Thanks to its influence on the design process, through the creation of appropriate design strategies that consider extensive material reuse, the work has the potential to reduce the carbon footprint and bring construction closer to a circular economy.

The primary objective of the dissertation is to explore the challenges and opportunities associated with using reclaimed building materials in architecture and to critically evaluate the available knowledge in this field. Analyzing the process of material reuse at the design stage, along with extensive research into the potential and actual opportunities for acquiring such materials, has enabled the identification of design strategies aimed at incorporating both existing construction waste and that which will be generated in the future during renovations and demolitions of buildings not originally designed with reuse in mind. The research includes a critical review of literature, legal regulations, and statistical data on waste management. It also incorporates survey studies among users and representatives of the construction industry and an analysis of 65 case studies of projects utilizing reclaimed materials. These efforts aim to understand the current state of knowledge and identify best practices for integration into the design process.

The dissertation is structured into eight chapters. The introduction explains the rationale for the topic, the current state of research, research hypotheses, objectives, and methodology. The second chapter discusses the historical development of circular economy strategies and their impact on construction, emphasizing the environmental degradation caused by the building industry. Chapter three reviews existing material and design strategies for reducing construction waste. Chapter four explores legal, economic, and systemic conditions at both national and European levels. This includes an analysis of national statistical data and the effects of existing legal regulations on material reuse opportunities, supplemented by surveys and structured interviews with construction industry professionals. In chapter five a comparative analysis of 65 selected projects that use secondary materials examines applied strategies, such as repurposing materials or adopting reverse design processes. The study also classifies construction materials based on their properties and reuse potential. The chapter on proposed design strategies introduces a comprehensive approach to circular economy-inspired architecture. Three strategies are proposed: creating a closed-loop building ecosystem, utilizing integrated prefabricated modules, and developing a pattern language for reclaimed materials.

The dissertation emphasizes the environmental benefits of using secondary materials, including carbon footprint reduction, natural resource conservation, and decreased construction waste. It highlights the immense potential of reclaimed materials as a response to environmental protection

and sustainable development challenges. However, achieving this requires technological adaptation, legal adjustments, and collaboration among all stakeholders in the construction process.

The study also offers guidelines and strategies to support the implementation of a circular economy in construction, such as promoting selective demolition, establishing storage points for reclaimed materials, and developing certification systems to enhance trust in material quality. It identifies technical, economic, and legal barriers to broader application, such as unclear certification regulations, logistical challenges, and limited availability of high-quality components.

The dissertation underscores the critical role of architects and designers in advancing sustainable construction. They must consider the potential and constraints of secondary materials early in the design process, including issues related to availability, quality, transport, and storage. Designing with recycled materials requires a shift in approach, as these materials often dictate the project's concept, reversing the traditional sequence of design decisions. Finally, the dissertation highlights the need for continued research on optimizing logistics, selecting secondary materials, developing life cycle assessment (LCA) tools, and analyzing the economic and social feasibility of these solutions. It also stresses the importance of education and raising awareness to promote the acceptance of secondary materials in construction.

The study demonstrates that a multifaceted design approach, based on the proposed strategies and supported by systemic and legal solutions, should play a significant role in reducing the environmental impact of the construction sector while maintaining high aesthetic and functional standards in architecture.