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Holistic Urban Development: Incorporating Both Global and Local Optimization

Authors : Christoph Opperer

Abstract : The rapid urbanization of modern societies and the need for sustainable urban development demand innovative solutions that meet both individual and collective needs while addressing environmental concerns. To address these challenges, this paper presents a study that explores the potential of spatial and energetic/ecological optimization to enhance the performance of urban settlements, focusing on both architectural and urban scales. The study focuses on the application of biological principles and self-organization processes in urban planning and design, aiming to achieve a balance between ecological performance, architectural quality, and individual living conditions. The research adopts a case study approach, focusing on a 10-hectare brownfield site in the south of Vienna. The site is surrounded by a small-scale built environment as an appropriate starting point for the research and design process. However, the selected urban form is not a prerequisite for the proposed design methodology, as the findings can be applied to various urban forms and densities. The methodology used in this research involves dividing the overall building mass and program into individual small housing units. A computational model has been developed to optimize the distribution of these units, considering factors such as solar exposure/radiation, views, privacy, proximity to sources of disturbance (such as noise), and minimal internal circulation areas. The model also ensures that existing vegetation and buildings on the site are preserved and incorporated into the optimization and design process. The model allows for simultaneous optimization at two scales, architectural and urban design, which have traditionally been addressed sequentially. This holistic design approach leads to individual and collective benefits, resulting in urban environments that foster a balance between ecology and architectural quality. The results of the optimization process demonstrate a seemingly random distribution of housing units that, in fact, is a densified hybrid between traditional garden settlements and allotment settlements. This urban typology is selected due to its compatibility with the surrounding urban context, although the presented methodology can be extended to other forms of urban development and density levels. The benefits of this approach are threefold. First, it allows for the determination of ideal housing distribution that optimizes solar radiation for each building density level, essentially extending the concept of sustainable building to the urban scale. Second, the method enhances living quality by considering the orientation and positioning of individual functions within each housing unit, achieving optimal views and privacy. Third, the algorithm's flexibility and robustness facilitate the efficient implementation of urban development with various stakeholders, architects, and construction companies without compromising its performance. The core of the research is the application of global and local optimization strategies to create efficient design solutions. By considering both, the performance of individual units and the collective performance of the urban aggregation, we ensure an optimal balance between private and communal benefits. By promoting a holistic understanding of urban ecology and integrating advanced optimization strategies, our methodology offers a sustainable and efficient solution to the challenges of modern urbanization.

Keywords : sustainable development, self-organization, ecological performance, solar radiation and exposure, daylight, visibility, accessibility, spatial distribution, local and global optimization
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