Moving from single to multi-functional infrastructure: Insights from European cases

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1. Research Problem Statement

Infrastructure projects are often constructed to deliver a single function in response to a well-defined objective. There is a need for these projects to evolve and add new secondary functions as they have long lifecycles and interact with society in different ways throughout the period (Ninan et al., 2020). In addition, these projects seek to maximize the value to society by diversifying its functions and providing multiple benefits concurrently (Hansen et al., 2019). Hence, infrastructure projects are moving from single to multi-functional projects. Multifunctionality involves carefully balancing different functions along with their spatial segregation (von Haaren and Reich, 2006). Multifunctional infrastructures can contribute to resilience as they are flexible, diverse, and connected to the broader urban fabric (Ahern, 2011; Meerow & Newell, 2017). We build on the theoretical notion of resilience in which a multi-functional infrastructure bridges and connect geographical nodes by renewing, complementing or adding new components to current infrastructure. For instance, the energy crisis will replace, renew and expand current energy grids and therefore a new hydrogen pipelines could parallelly enable a full electrification and digitalization of transportation. Thus, this research seeks to understand how multifunctional infrastructure projects are operationalized. Specifically, we ask 1) What are the additional functions possibly to add to infrastructures? and 2) Why are these functions added? Such a study will help us theorize the relationship between infrastructure, its function, and the context.

2. Brief Research Methodology and Approach

To answer the research questions, we adopt a multiple-case study approach as it enable us to consider different cases that are critical for theory generation (Yin, 2015). We choose the European context for this research as the region has already constructed most of its infrastructure and is seeking opportunities to maximize its value for society. Also, there is a focus on upgrading existing infrastructure rather than creating new ones in the European context (Hertogh et al., 2018). Thus, we considered multiple case studies of infrastructure projects which moved from single to multiple functions in the Netherlands, Austria, and Sweden. We created case studies of approximately 1000 words each for infrastructure projects such as the Oresund bridge, Port of Rotterdam, Katschberg tunnel project, etc., by studying documents, news articles, and other sources relevant to the 21st century (Sergeeva et al., 2022). We then carried out a cross-case analysis and analyzed the cases for its added functions, why these particular functions were added and how they were operationalized. Thus, we used a grounded theory method (Strauss & Corbin, 1998) to generate a theory from multiple case studies.

3. Key Findings

From the empirical data, we noted that different secondary functions such as energy generation, creating a network, aesthetic appeal, etc., were added to an infrastructure's primary function. Multiple ecological, social and economic functions can be strategically considered in developing urban infrastructure (Madureira & Andresen, 2013). Energy generation was seen to be the most commonly added secondary function as it served the energy needs of the infrastructure and was easier to add in the form of solar panels. Additional functions were added for diverse reasons such as creating more value, minimizing damage due to declining primary function, future-proofing infrastructure, getting societal acceptance of the project, as well as for making the best use of urban space. Conversion of existing infrastructure and re-use of brownfields are recommended by Burton (2000) for efficient use of urban space and our study extends this literature by highlighting what different functions can be added and how.

4. Implications

Infrastructure projects have to reinvent and make themselves relevant to changing times by adding secondary functions. This research emphasizes the importance of focusing on the back end of infrastructure projects as they strive to adapt, renew, and generate more value for society. We propose that there is a need to fully theorize and conceptually explain how societal

resilience will take place in Europe. We believe that renewal, expansion and replacement of past technology can be understood better by examining the idea of multi-functional infrastructures. Research on case studies of multifunctional infrastructure would help us understand how to operationalize multifunctional infrastructure by removing roadblocks. Diversity is considered a general principle in city-making (Jacobs, 1961). More research is required to promote multiple functional infrastructures as well as increasing synergies and avoiding conflicts between these functions.

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