ABSTRACT

Infrastructure systems are the backbone of modern civilization, supporting our cities, economies, and way of life. Yet, they do not exist in isolation. They are continually influenced by a multitude of external social, economic, and environmental factors. These impacts may affect the structure of the built environment over time (i.e., through the evolutionary process) or the interplays between and within subsystems, thus causing emergent behaviors. In anticipation of the immense complexity of the built environment and the diversity of the influential factors, the major research challenge is finding an approach that yields engineering solutions to understand how, when, and why the evolutionary and emergent behavior of a system occurs. Answering such questions is the first step toward developing adaptive, preventive, or corrective plans and programs to enhance infrastructure resilience to external dynamics. This research proposes a framework to facilitate understanding the impact mechanisms of the external factors causing infrastructure evolution. Such knowledge is necessary to determine how a behavior evolves throughout a system. Given the diversity of the factors affecting the infrastructure system, an overwhelming amount of information needs to be continuously monitored and analyzed to comprehend the changing nature of the built environment. To address these challenges, the proposed framework uses multivariate analysis methods to identify and detect the most influential external factors driving the behaviors of the built environment system of systems. Dynamic factor models are developed to construct a composite index framework that (1) monitors and analyzes large volumes of information from numerous external factors impacting the system, (2) detects changes in the trends of the influential factors, and identifies how these changes originated within the system, and (3) analyzes how the internal system dynamics are influenced by external impacts.