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Towards a New Paradigm for Management of Complex Engineering Projects: A System-of-Systems Framework

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Abstract
The objective of this study is to propose a system-of-systems framework and network-based methodology for predictive assessment and proactive management of performance in complex engineering projects. Complex engineering projects consist of different interconnected networks of processes, activities, stakeholders, resources, and information. The traditional project management paradigm, which identifies complex engineering projects as monolithic systems, has failed to capture the interdependencies and dynamic interactions at the interfaces between different entities and networks in complex projects. In this research, a system-of-systems (SoS) framework is proposed towards creation of tools and techniques for integrated management of complex engineering projects. In the SoS framework, complex projects are conceptualized as meta-networks composed of interconnected networks of human agents, information, resources, and tasks. The interdependencies at the interfaces of different agents, information, resources, and tasks are abstracted and represented as multiple types of links. Risk and uncertainty in engineering projects are translated into perturbations in project meta-networks. Project organization's vulnerability to resist and resilience to cope with the impacts of risk and uncertainty are modeled and captured as emergent behaviors in project system-of-systems. Based on the proposed framework, the emphasis of project management is shifted from ex-post correction of performance variation to ex-ante assessment and proactive management of performance outcomes based on investigation of project organization's vulnerability and resilience. The application of the proposed framework is shown in a case study. In the case study, various scenarios related to different uncertain events were simulated to quantitatively investigate the vulnerability and resilience of the project and evaluate the impacts of different planning strategies on mitigating vulnerability and enhancing resilience.

Biographies

Ms. Zhu is a Ph.D. candidate of Civil Engineering at Florida International University. In her Ph.D. research, she investigates emergent properties in complex construction projects using system-of-systems thinking. Her research aims at better assessment and management of performance in complex construction projects. She can be reached at jzhu006@fiu.edu.

Dr. Mostafavi is an assistant professor at OHL School of construction in the College of Engineering and Computing at Florida International University. He obtained his Ph.D. in Civil Engineering from Purdue University. His research expertise is in the area of sustainable and resilient infrastructure systems, system-of-systems modeling, and construction engineering. He can be reached at almostaf@fiu.edu.