Prospectus

Retro-Prospective Construction Delay Analysis Methodology
(Technical Topic)

Actor-Network Theory & Punctualization in Boston's "Big Dig"
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Sociotechnical Problem

Hourigan, a construction and development firm based in Richmond, Virginia, has experienced delays and disruptions during several of their recent projects. In order to analyze these delays, attribute blame, and determine cost compensation, delay analysis may be performed. Delays can have a direct impact on the profitability of a project, so it is imperative that delay analysis is performed correctly and objectively (Braimah, 2013, p. 507). There are two types of delay analysis: retrospective, which evaluates how events caused delay in the scope of the whole project, and prospective, which aims to assess delay events as they occur throughout the course of the project (Singhal et al., 2018). Currently, Hourigan assesses delays retrospectively but seeks to be able to identify and prevent delay events as or before they occur. However, it was determined that prospective analysis does not provide any advantage over retrospective analysis, as they do not "necessarily produce the same answer" (Fluor v. Shanghai Zhenhua Heavy Industry Co, Ltd., 2018). To address this problem, my Capstone team and I aim to develop a retro-prospective analysis, in which we retrospectively analyze recent projects by Hourigan in order to develop a methodology to prospectively analyze delays in future projects, so that delay and disruption may be mitigated.

Any construction project features several stakeholders, such as the project owner, the contractor, and subcontractors. All these stakeholders work together, either directly or indirectly, towards the completion of the project. These human actors can cause delays and disruptions to the project, but other non-human actors, such as weather or "acts of God" can also be to blame (Keane & Caletka, 2015). For example, the Central Artery/Tunnel Project in Boston, also known as the "Big Dig", a large construction project infamous for almost a decade worth of delays and a cost overrun of over $10 billion, had several non-human actants that contributed to the delays.

Because of this, the science, technology, and science (STS) framework of actor-network theory must be considered during the analysis and evaluation of a construction project. If it is not, reoccurring delay events will continue to negatively affect construction projects contracted by Hourigan. By considering how human and non-human actants interact and form networks between each other, we can more effectively generate a methodology for identifying and mitigating delays as or before they occur.

The desired retro-prospective analysis methodology must take both technological and social factors into account. Below I outline how the technical solution may be generated to be used in Hourigan's future projects. Additionally, I explore actor-network theory and the concept of punctualization in the context of Boston's "Big Dig" to better understand the interaction between human and non-human actants and how it may be translated to the smaller scope of Hourigan's projects.

Technical Problem

Construction projects are frequently delayed by multiple impacts and by multiple parties (AACE International, 2011). Delay analysis may be performed either prospectively, assessing delays along the critical path as they occur, or retrospectively, assessing delays in the scope of the entire completed project. The critical path of the project is defined by the longest path, in time, taken to complete the project (Levy et al., 1963). It is the role of a forensic schedule analyst to employ the use of delay analysis techniques (DATs) to calculate the project delay and often work retrospectively to attempt to identify how much delay is attributable to each party involved in the construction process, so that time and/or cost compensation can be decided. These DATs are necessary in the analysis of delay and disruption claims, as delay and disruption can have a direct impact on the profitability of a project from the perspective of all stakeholders, such as project owners, contractors, and subcontractors (Braimah, 2013, p. 507). No single DAT can be applied in every situation, as different circumstances call for different techniques, and often several DATs are used in concert (Urwin, 2018).

Hourigan is a construction and development firm based in Richmond, Virginia. They act as the general contractor for construction projects and experience delays during those projects. They employ DATs retrospectively to discover who is responsible for occurrent delays and/or disruptions. While this analysis can be beneficial in analyzing delay claims, several techniques are subjective, subject to manipulation, or require adequate records of the project, which is often lacking in practice (Muhamad et al., 2016). Mistakes in analysis could negatively impact Hourigan financially if they are found to be responsible for some delay, or legally, in some cases. Prospective analysis has been advocated for, as detection of potential problems and analysis of the potential effects could help all stakeholders address and attempt to prevent delay events before they occur (Gorse et al., 2005, p. 1139). It should be noted that prospective analysis should not be preferred over retrospective analysis, as a recent United Kingdom court case Fluor v. Shanghai Zhenhua Heavy Industry Co, Ltd. determined that "a prospective analysis… does not necessarily produce the same answer as an analysis carried out retrospectively" (2018). Thus, the goal of the technical project is to develop a retro-prospective analysis methodology that best applies to Hourigan and the construction projects that they undertake.

In order to produce this retro-prospective analysis methodology, we will apply statistical modeling and employ various DATs, yet to be determined, on three recent projects on which Hourigan was the general contractor. Analysis of project schedules will be conducted in the Primavera P6 Enterprise Project Portfolio Management software. We will retrospectively extract data from project schedules and identify what activities caused delays and analyze these delays and their impacts on the critical path to generate meaningful insight for Hourigan, so that they may manage, avoid, and overcome future challenges in a prospective manner.

STS Problem

The Central Artery/Tunnel (CA/T) Project in Boston, Massachusetts – also known as the "Big Dig" – has been described as "the largest, most challenging highway project in the history of the United States" (Commonwealth of Massachusetts, n.d.). The CA/T Project experienced several delays and severe cost overruns. In 1982, it was estimated to cost $2.6 billion and to be completed in 1998 (Transportation Research Board, 2003, p. 7). The project, however, was not completed until 2007 and cost $14.8 billion, mainly attributed to inflation and mitigation (Greiman, 2010). When adjusted for inflation, the initial $2.6 billion in 1982 would be equal to $5.75 billion in 2007 (Bureau of Labor Statistics, 2020). Mitigation accounted for almost a third of the cost, as the communities in Boston were compensated for the inconvenience of prolonged construction, as well as promised that parts of the roadway would still be operational and utilities would not be disturbed as excavation for tunnels took place (Gelinas, 2007). This mitigation also includes steps taken to reduce the Project's environmental impact. While these main factors contributed heavily to the delay and cost overrun of the CA/T Project, it must be noted that the scope of the project accounts for a significant portion of the delay. If the full scope of the CA/T Project is not considered, we would fail to understand the role of multiple actants, both human and non-human, in concert with inflation and mitigation, as it pertains to the delay.

I propose that it is inadequate to analyze each factor individually as it pertains to the delay and cost overrun of the CA/T Project; all factors must be considered with respect to each other and the project as a whole. When examining the full scope of the project, multiple actants are involved, such as thousands of stakeholders, 110 major contracts, nearby buildings, groundwater conditions, weak soil, and other environmental factors. Problems during construction also featured archaeological discoveries of Native American artifacts and revolutionary-era sites, uncharted utilities from old, incomplete drawings of infrastructure, and a "rodent plague of biblical proportions," which was in part due to an "usually mild winter" (Greiman, 2007; Lewis, 2001, p. 3; Mccown, 2002). To support my claim, I will employ the use of the science, technology, and society framework of actor-network theory (ANT). Law (1987) defines ANT as a "combination of social and technical engineering in an environment filled with indifferent or overtly hostile physical and social actors" (p. 235). I will also focus on the concept of punctualization, the linkage of complex actor-networks to form larger actor-networks, to analyze how multiple actants contributed to the severe delay and cost overrun of the Central Artery/Tunnel Project (Cressman, 2009, p. 7).

Actor-network theory studies the associations and interactions between human and non-human actants, also called "heterogeneous actors" (Cressman, 2009, p. 4). These heterogeneous actors are assembled by a network builder to accomplish a certain goal. ANT aims to view the network and its construction through the eyes of the network builder (Cressman, 2009, p. 3). Specifically, in the case of the CA/T Project, the network builder may be identified as the Massachusetts Turnpike Authority, who oversaw the project for much of its duration (Commonwealth of Massachusetts, n.d.). Because schedule data is not readily available or accessible, I must refer to secondary sources in the form of academic papers, news articles, and topical books to analyze the construction and subsequent performance of the actor-network of the Central Artery/Tunnel Project.

Conclusion

The technical report aims to produce a retro-prospective analysis methodology for the construction and development firm Hourigan to use on future projects. The methodology will be generated from retrospective analysis of their recent projects and by statistical modeling. The goal is that with the methodology, Hourigan may identify and mitigate events before or as they occur in their future projects. The STS research paper will explore a larger-scale construction project that experienced severe delay and cost overrun due to several actants, both human and non-human. It will utilize the STS framework of actor-network theory and the concept of punctualization to describe how all the actants interact and form networks, and how those relationships, or lack thereof, contributed to the delay.

The result of the technical report will help Hourigan with their socio-technical issue of construction delay, as delay affects all stakeholders of the project. The STS research paper will help give insight as to how networks are created between actants during a construction project, so that networks may be better controlled during a project to prevent or mitigate delay.

Word Count: 1703

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