RESEARCH PROPOSAL FOR IMAGINE THAT INC. (EXTENDSIM)

Buffering strategies in transportation construction projects

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Eric Forcael (1)

(1) Eric Forcael, PhD Candidate, Dept. of Civil & Coastal Engineering, University of Florida, USA.

ABSTRACT

Uncertainty is an inherent part of production systems. In construction processes, production variability emerges as one of the most typical representations of uncertainty. The negative impacts of variability over construction processes demands effective solutions to mitigate its effects on the accomplishment of projects. One of the tools to deal with variability in construction processes is the incorporation of buffers, which can help reducing the negative impacts of variability on projects. Despite the fact that buffering strategies have been developed for production environment in construction, there is no evidence of specific applications of these strategies to highway projects. Therefore, this study presents a new approach of buffering strategies applied to transportation construction projects.

INTRODUCTION AND REVIEW OF THE LITERATURE

The National Highway System consists of 160,000 miles of highways (The Federal Highway Administration, 2009), being the largest highway system in the world; therefore, it is important to support each initiative that can help to improve the management of transportation projects. In this way, in construction management, as a whole concept which includes not also transportation projects but also all type of construction works, several initiatives have been undertaken in order to improve the way through projects are managed. Within these initiatives, several techniques and tools have been developed; one of them is simulation. More than thirty years ago, Halpin (1973), worked on some of the first methodologies for construction simulation and, nowadays, construction simulation has effectively been applied to building projects (González et al, 2009), earthmoving projects (Peña-Mora, 2008), tunnels (Al-Battaineh et al, 2006), among others. Some of these simulations have sought to deal with variability[1] in construction and its effect in the

[1] Quantity of nonuniformity of a class of entities, which can induce (or potentially not), negative impacts on the productivity of a process; therefore, it must be managed (Hopp and Spearman, 2000).

productivity of projects. In the same way, some models have been developed, in order to improve the overall project performance, through reducing variability (Thomas, 2002). Specifically in transportation projects, due to the importance of productivity within these construction works, some researchers have studied the productivity level in this type of projects (Ellis and Lee, 2006). Simulation, variability (and its effects on productivity) and transportation projects have been analyzed during the recent years; however, all these have not been studied nor as a whole neither specifically from the point of view of the impact of variability on transportation construction projects.

In relation to variability, according to Hopp and Spearman (2000), variability exists in all production systems and can have an enormous impact on performance. On the other hand, in construction, variability is one of the main factors that influence the deterioration of project performance (Koskela, 1992 and 2000). Based on a new production philosophy known as Lean Construction (Howell, 1999), variability management in construction can be addressed from two perspectives: minimizing variability by solving singularities or developing lean principles to stabilize construction workflow (Yu et al, 2007). In order to consider the singularities related to variability, buffering strategies have been intended (inventory, capacity and time). Both variability and buffering strategies are always present in a project; however, they must be understood and applied rationally in order to obtain a balance between them (González et al, 2009).

There are diverse types of buffers which can be applied to construction simulation: Inventory buffers, mainly characterized by raw materials, Work-In-Process (WIP) and finished goods; Capacity buffers, characterized by redundant labor; and Time buffers, with the main objective of managing production schedules and deliveries on due dates (Hauge and Paige, 2002). The

application of each buffer depends on the type of project and production circumstances, among other variables. Therefore, the first part of this research seeks to determine the appropriate buffers which can be applied to transportation construction projects. Once these buffers have been determined, the second phase of this research is to model the transportation construction process and then to simulate this process in order to establish the effective size and location of buffers. Finally, the third phase of this research is to validate the models and buffers suggested through a case study.

RESEARCH PROBLEM

The problem to be researched will be addressed based on the following research questions:

a) Are there more appropriate buffers than others to be applied to transportation construction projects?
b) Is it feasible to reduce the negative impacts of variability over transportation construction projects, through incorporation of buffering strategies?
c) Is it possible to develop a conceptual methodology to manage buffers in transportation construction projects?

Based on the previous research questions, the followings are the hypotheses of this research:

1. There are some specific buffers which are more appropriate than others to be applied to transportation construction projects.
2. Appropriate buffering strategies reduce the negative impacts of variability over transportation construction projects.
3. A conceptual methodology to manage buffers in transportation construction projects can be developed.

OBJECTIVES

The main objective of this research is to establish buffering strategies to manage the negative impacts of variability in transportation construction projects.

The specific objectives are the followings:

i. To determine the suitable buffers to be applied to transportation construction projects. As a part of this objective, in order to determine these appropriate buffers, the main variables which incorporate variability into this type of projects will be determined.
ii. To establish whether the selected buffers can reduce the negative impacts of variability over transportation construction projects.
iii. To create simulation models, in order to determine the optimum size and location of buffers which can help to reduce the negative impacts of variability over transportation construction projects.
iv. To suggest a conceptual methodology to manage variability through using buffers, in transportation construction projects.

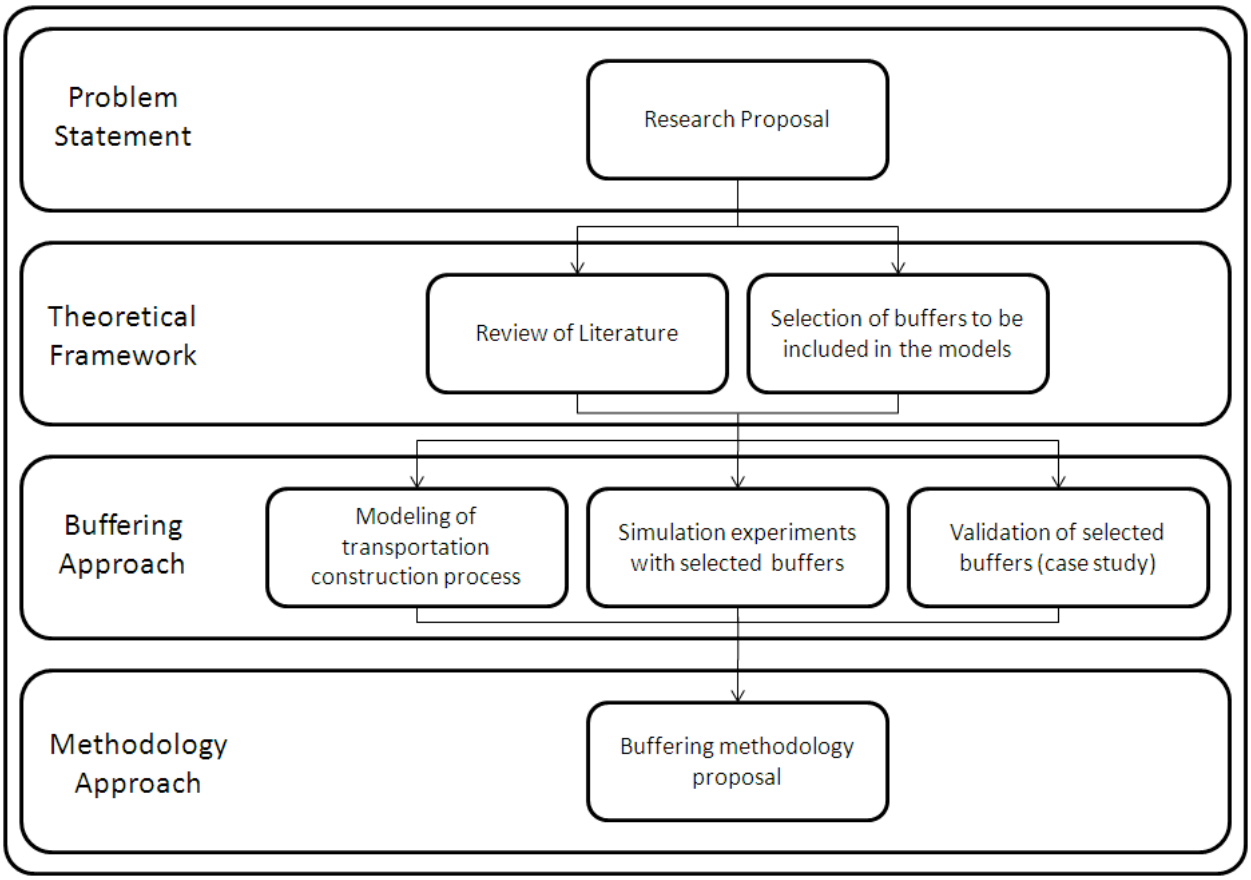
METHODOLOGY

The present research will be conducted according to the following phases:

1. Research proposal.
2. Review of literature.
3. Selection of buffers to be included in the models.
4. Modeling of transportation construction process (including the selected buffers).
5. Simulation experiments with selected buffers.
6. Validation of selected buffers (case study).

7. Buffering methodology proposal.

This is the graphical representation of the previous phases:



To carry on the above-mentioned phases, specifically all related to simulation, ExtendSim 7 (Image that Inc., 2009) will be used. This software has been chosen for several reasons, such as powerful visualization, innovation and capability to handle highly complex systems in an easy way. After selecting the most relevant buffers in transportation construction projects, the next step is to model the whole process associated to transportation construction projects. As a part of this modeling process, the location and size of these buffers will be determined in order to decrease the negative impacts of variability on the construction process.

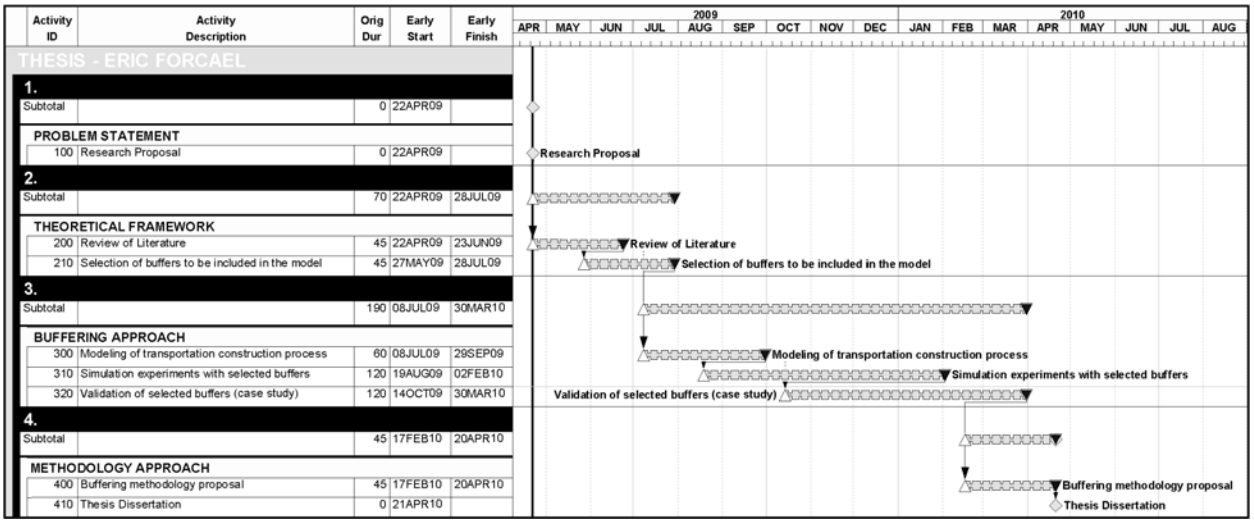
IMPLICATIONS AND CONTRIBUTIONS

Being the largest highway system in the world, the National Highway System of US becomes a nationwide priority. On the other hand, hundreds of highways have exceeded their cycle life; therefore, each proposal that tends to improve the construction processes of this type of projects will be welcomed, not only for the government but also for the users of these highways.

Through this research and specifically by means of ExtendSim, this study seeks to contribute to construction industry in the following ways: Implementation of an easy way to simulate transportation construction projects and their associated buffers; Development of a new approach to schedule this type of projects through simulation and finally; Reduction of the negative effects of variability on transportation construction projects.

SCHEDULING

Finally, the following is the scheduling proposal for this research:



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