

Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences



Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Ivo Agricola
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Studio	
Name / Theme	Design and Construction Management
Teachers / tutors	First mentor R. (Ruben) Vrijhoef Second mentor P. (Peter) de Jong
Argumentation of choice of the studio	During my study, I never stopped wondering how and why the construction process contained so many inefficiencies and mistakes. By observing during internships and numerous conversations with colleagues and professionals I learned that its partly due to a lack of innovation and project instead of process thinking. The way it is always done feels safe and the risk involved in innovation is often a bridge too far. During this research, I want to learn more about the traditional process, both the benefits and the downsides. I want to analyse an alternative method and observe what the difficulties of implementation will be. Test my own abilities to deal with these difficulties and deliver a model that can be used to show alternatives for dealing with costs.

Graduation project	
Title of the graduation project	The cost benefits of alternative logistical solutions in a construction process.
Goal	
Location:	The Netherlands
The posed problem,	The implementation of innovative logistical solutions is limited due to a lack of tools to prove the financial benefits. An important step in the development of these new logistic solutions is proving their value by measuring the impact on efficiency and costs (De Bes et al., 2018). New calculation models are needed to predict the

	<p>construction cost effect in an early phase of the project and after the project to prove the financial benefits of innovative logistical solutions. The distribution of construction logistics cost is based on the contractual agreements amongst the owner, main contractor and suppliers. However, the total cost of the project will be transferred to the owner who needs to pay for the project in the end. Therefore, this study would adopt the perspective of Yuan Fang and Thomas Ng (2011) to consider the construction logistics cost from the owner's viewpoint. The benefits of including Construction Consolidation Centres in the process are not limited to just the logistical process and hold the potential to have a positive effect on labour productivity during construction. Therefore, all the cost in the process from purchasing the materials till they are fixed in place on the construction site will be included in the new model. Financial benefits for society as a consequence off ecological benefits, however, will be excluded from the model due to time limitations in this research process.</p>
<p>Research questions and sub questions</p>	<p>Main research question</p> <p>To what extent can the construction costs be modelled in an early stage of a project to predict the impact of alternative construction logistic solutions?</p> <p>Research sub questions</p> <ol style="list-style-type: none"> 1. Which definitions and aspects of activity-based costing need to be included in the model? 2. Which information should be available in the early stages of the project to provide input for the model and which generic cost data sources can be used? 3. How to accurately model and predict the financial impact of using a Construction Consolidation Centre in an activity-based costing model? 4. What Output should be generated by the model to create added value in the processes following the early stages of the project? 5. Which conditional factors determine the implementation of the model?
<p>Research Objective</p>	<p>The aim of this research is to increase the chance of implementation of Construction Consolidation Centres in construction practise. To do so an alternative framework for cost accounting by main contractors and suppliers will be created. This framework should provide insight into the effect of the implementation of a Construction</p>

	<p>Consolidation Centre on the costs of a construction project in an early phase of the process.</p> <p>The first objective of the research is to provide insight into the effect of the Construction Consolidation Centre on the total costs of a construction project with an activity-based costing model. This part is focussed on providing a framework that describes what data is needed from involved parties to calculate the costs in an early phase of the project. How these costs can be modelled and how the output of the model can be useful in the decision-making process.</p> <p>The second objective of the research is to provide insight into the conditional factors for the implementation of the model in the project organisation by the companies that are part of the supply chain. Increasing awareness and adjusting the proposed model to these factors could increase the chances of implementation in practice.</p>
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Process

Method description

- 1. Which definitions and aspects of an activity-based costing need to be included in the model?*

Answering this question will provide the basis for the development of a new model, either by adopting one from literature or combining multiple existing models to an entirely new model. To answer this question, a literature study of available activity-based costing models for construction logistical projects and the elements of these models will be conducted.

The result is a conceptual framework for the development of a new model and a list of the cost factors that will be included in the new model.

- 2. Which information should be available in the early stages of the project to provide input for the model and which generic cost data sources can be used?*

The objective of this question is to understand the cost predicting process in practice. This knowledge will help with aligning factors named in literature with the characteristics and availability of information in practice. To answer this question, an analysis of the information that should be available in the early stages of the project to provide input for these model will be conducted. A document review of traditional models and input for these models and interviews with multiple experts will be used to answer this question.

The results form a base for the input guidelines for the new model.

3. How to accurately model and predict the financial impact of using a Construction Consolidation Centre in an activity-based costing model?

Answering this question will result in a new activity-based costing model that can be tested in a case study of a past project. The model will be tested with the “traditional process” of the selected sub-contractor. Verification that the model will generate the same outcome as the traditional process if the input conditions stay the same and first insights of the model if conditions change to a situation in which the Construction Consolidation Centre is included in the process.

The result of answering this question is a tested and functioning concept of the new activity-based costing model.

4. What Output should be generated by the model to create added value in the processes following the early stages of the project?

Answering this question generates insight into the necessary output of the developed activity-based costing model. To answer this question the model will be tested in a current case with a scenario that a Construction Consolidation Centre will be included in the project. The output of the model for this scenario will be discussed with experts and the added value of the model output will be verified.

The result of answering this question is a functioning time-drive activity-based costing model that generates useful output for the involved parties.

5. Which conditional factors determine the implementation of the model?

The final step in the process is qualitative research into the conditional factors that determine the implementation of the new activity-based costing model within the organisation of the construction project. Answering this question will increase the change of implementation of the new activity-based costing model in future projects of involved companies and other interested market parties. To provide an answer to this question a review of literature on the topic and interviews with experts involved in the case study project will be conducted.

The result of answering this question is a list of conditional factors that need to be met for the successful implementation of the new activity-based costing model.

Subquestion	1	2	3	4	5
Methods and techniques	-	Case Study	Case Study	Case Study	Case Study
Data collection	Literature review	Document review Interviews	Document review Interviews	Document review Interviews Expert panel	Literature review Document review Interviews
Data source	Search engines	Past case to test/verify the model	Past case to test/verify the model	Current case to apply the adjusted model	Search engines Experts
Data analysis	Selection of definitions and aspects	Selection of necessary input for the model	Selection of necessary input for the model	Selection of useful output of the model	Selection of the conditional factors for the implementation of the model

Literature and general practical preference

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Reflection

The research is part of the Design and Construction Management sector of the Management in the Built Environment master. The theme of the research is managing construction logistics for improved environmental and economic performance. The focus of this research is the financial side of the implementation of innovations in construction logistics. In the past years, various students did research on this topic. The research is connected to previous research done by TNO in collaboration with companies involved in the development of logistical Hubs in the Netherlands. Examples of these companies are Kondorwessels Materieeldienst and Dura Vermeer. The development of the model proposed in this research plan could potentially be beneficial for the development of these logistical Hubs. Due to the specific expertise of these previously mentioned companies, it's a logical decision to approach them for case study data and an internship. As a result of special circumstances, the meeting will take place in a few weeks from now. In this meeting a past case to develop and test the model and an active/future case to use the model will be selected.

Scientific relevance

This research proposal is based on a gap in the literature. This gap can be bridged with the proposed development of a new costing model and a framework for implementation. A selection of the authors that explicitly named the gap in their work is summarized in this chapter. An extensive review of the literature presented in this chapter is included in the theoretical framework.

Construction logistics needs to be implemented during the design and procurement phase of the construction project to create an effective plan. The purchasing department of the contractor can play an important role in this process. A change from purchasing on project bases to purchasing on added value for the supply chain is necessary (De Bes et al., 2018). In their research, TNO analysed nine construction projects and concluded that; successful experiments in sustainable construction logistics not yet led to the implementation of the new methods in the inner-city construction sector. Multiple large contractors are aware of the necessary change in mindset and the need of new financial models that can show the effect of innovative solutions and the new division of revenue within the supply chain (De Bes et al., 2018).

Modelling of real-world processes will often require a description of all involved activities with stochastic durations, each linked together in a precedence logic. If resources, such as labour, material, and equipment, are required to perform the activities, an activity-based costing(ABC) technique must be developed that can accurately accommodate the inherent variability of the process to accurately predict the costs (Back, Maxwell, & Isidore, 2000). The aim of an ABC system is to provide complete traceability of actual costs within a process for better cost management. If the construction industry endeavours to improve the efficiency and effectiveness of their operations, it is necessary to fully understand the behaviour of their processes (Back et al., 2000). Applying these types of quantitative analysis to the construction logistics process will allow construction companies to understand, prior to investment and implementation, how the selected processes will respond to change.

Yuan Fang and Thomas Ng (2011) applied the ABC method to a case example for a precast concrete wall supplier. They concluded that the ABC method could be beneficial for tracing consumed resources back to the consuming activity and subsequently to a particular cost element. The model could also help construction managers and planners with the optimization of the construction and material delivery schedule. This would result in the most cost-effective solution, which could, in turn, help them to establish a competitive tender price for a project. The authors, however, do stress the need for further development of the model. Verification with experts from contractors and suppliers in a real project is necessary to test the applicability of the model in other projects and with other materials.

Social relevance

Construction logistics in urban areas can be a source of hinder and nuisance for the people in the city. Traffic jams, produced noise, and pollution of the air by the emission of carbon dioxide and Particulate matter are examples of the problems caused by construction and logistical processes. Case examples in which innovative logistical solutions like a Construction Consolidation Centre were included in the project, showed reductions of nearly 70 per cent in logistical movement around construction sites (De Bes et al., 2018) (Transport for London, 2008). Which drastically reduced the caused hinder and nuisance. Increasing the implementation of innovative logistical solutions by developing a new financial model will benefit the people in the city.

Apart from the reduction in nuisance, the implementation of the Construction Consolidation Centre also proved to reduce the number of construction materials damaged, lost, stolen and over-ordered compared with typical construction projects (Transport for London, 2008). Reducing the materials used for construction will reduce the impact on the earth's limited resources. Lack of production capacity at suppliers of construction materials is one of the barriers in dealing with the demand for construction activity (ING Economisch Bureau, 2018). A reduction in material orders as a result of using the CCC could help to (partly) solve these problems. Proving a significant reduction in construction waste was difficult due to measuring problems (Transport for London, 2008). Dealing with the produced waste in the CCC, however, led to creative solutions to reduce waste and stimulate repair and reuse of pallets for example. Again, lowering the impact on the earth's resources and benefiting society.

The innovative logistical solutions also had a positive impact on labour productivity on site. Reductions of 20 to 25 per cent are proved in several projects (De Bes et al., 2018). Together these results could lead to increase construction capacity, which will be beneficial in solving some of the challenges the sector is facing. Two examples of these challenges are;

The energy transition. As a result of the 2015 Paris Agreement, the Dutch government included a reduction of 55% greenhouse gas emission by 2030 and a 95% reduction by 2050 in comparison to 1990 in a new Climate Bill (Tweede Kamer, 2016). As a result of the transition, the construction sector will need to produce higher quality buildings which will use significantly less energy. By the year 2020, all new build buildings need to be Almost Energy Neutral (BENG). The guidelines for BENG include a maximum energy need of the buildings, maximum use of fossil fuels and a minimum

share of renewable energy (Rijksdienst voor ondernemend Nederland, 2018). The transition will also stress the need for an upgrade of the existing building stock.

The demand for newly built dwellings. Besides the challenge of increased quality and the challenge of upgrading the current housing stock, there is a large demand for newly built dwellings. Growing numbers in households, demand by elderly people and starters as well as a shortage of approximately 175.000 dwellings in the rental sector are part of this demand (AD, 2019). In the spring of 2018, the Dutch government stressed the need for a million new homes by 2030 (NU.nl, 2018).

Contributing to an increased change of implementation of innovative logistical solutions like the Construction Consolidation Centre by developing the proposed costing model and framework for implementation could for these reasons be beneficial to society.