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	Ivan Moiseenko
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Telephone number	
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Studio	
Name / Theme	Business models for robots in construction
Teachers / tutors	1dt mentor: Ruben Vrijhoef,2d mentor: Peter de Jong
Argumentation of choice of the studio	My choice of this studio is based on long involvement into hospital design. In July, 2016 I graduated from Politecnico di Milano as MSc in Architecture with design project of modular general hospital in one of the Russian cities. In order to continue my research I chose the topic of economic feasibility of modular construction in hospitals to understand logistic, managerial and financial drivers behind modular construction.

Graduation project	
Title of the graduation project	Economic feasibility of prefabricated solutions in healthcare design and construction industry.
Goal	
Location:	[Project Location]
The proposed problem,	To which extent are prefab solutions in healthcare design and construction processes are more economically feasible than traditional methods?
research questions and	**Main Research Question:** To which extent are prefab solutions in healthcare design and construction processes are more economically feasible than traditional methods? **Sub-Research Questions:** To what extent is prefab used in current situation in healthcare sector?

	To what extent is enlarging the amount of prefab elements feasible considering the design and construction process? Which parts of the healthcare facilities are mostly suitable for implementation prefab solutions in a cost-effective way?
design assignment in which these result.	Assessment model

Problem of flexibility in hospitals is considered as one of the main ones in modern healthcare design and development. Modular construction is one of the effective strategies and real solutions to the demand for flexibility in hospital development, which is quite high in this typology of design and construction industry. Due to quick obsolescence of hospital building, based on rapid development of technologies, reorganization, extension and redevelopment of hospital environment is needed. Modular construction, then, allows to expand existing hospital facilities in a shorter period of time, without disruption of the daily work of the main hospital, with up to 90% of complete of the module in the factory, which increases the quality of the final product and allows to install the equipment and to test different parameters of the module during its design and production phases. It also dramatically reduces the waste during the production process and allows to recycle up to 85% of the module after the end of its use.

For all reasons mentioned above, as well as based on my involvement in hospital design for almost 5 years already, I chose this topic for my graduation project in MBE department of TU Delft. In July, 2016, I graduated as MSc in Architecture from Politecnico di Milano, with the design project of modular general hospital in one of Russian cities.

The nature of my research is a hybrid, in fact. Due to relatively unusual nature of my research, I start with in-depth literature review in order to understand the nature of modular construction processes and different aspects of life cycle of modular building, particularly based on Japanese experience, since their modular construction industry is one of the best one in the world. In order to answer to my main research question as well as my sub-questions I use three strategies. First strategy is deep literature analysis of existing and developing modular construction systems, understanding of different aspects of their life cycle and production process. In particular, in-depth analysis of Japanese case study is presented in my P2 report, since Japanese prefabricated industry is the most developed one. Second strategy is interviews and consultations with practitioners and firms, which are specialized in modular construction. In particular, I already made interviews with De Meeuw company, specialized in modular construction, EGM architects, the largest architectural bureau in The Netherlands specialized in healthcare design, and with Karel Dekker, theoretician of modular construction systems. All these findings help to answer to my main research question as well to sub-questions. Third strategy, related to second part of my graduation project, is an empirical research, consisted of the design of assessment financial model which explains drivers, costs and benefits of modular construction. This model is based on all findings figured out by me during literature review and interviews and, and can be partially tested on my Milan design case, since it was impossible to find a real case during preparation of P1 and P2 reports, based highly confidential nature of all

aspects related with financial data of construction projects. In other words, no one firm agrees to disclose any real case studies from their practice. The expected result of this research, then, is the model shows drivers, costs and benefits of modular construction in hospital development.

Process

Method description

Methods and techniques to be used in my research:

Extensive in-depth literature study of modular construction and production processes

Interviews with different stakeholders and parties involved in modular construction process (see part 2.5)

Empirical research with assumptions, hypothesis and testing of literture findings on Milan design case.

It is important to mention, again, that this research, as a whole, is hybrid research. Firstly, the hypothesis of financial effectiveness and feasibility of modular construction in hospitals is stated, and, then, it is tested by literature review and empirical research.

Literature and general practical preference

1. Mullens, A., M. (2011). Factory Design for Modular Homebuilding. Equipping the Modular Factory for Success. Constructability Press, Winter Park, FL

2. Lawson, M., Ogden, R., Goodier, C. (2014). Design in Modular Construction. CRS Press, Tailor & Francis Group

3. Bock, T., Linner, T. (2015). Robotic Industrialization. Automation and Robotic Technologies for Customized Component, Module, and Building Prefabrication. Cambridge University Press. 32 Avenue of the Americas, New York, NY 10013-2473, USA

4. Arup (2016). Circular economy in the built environment report

5. Moiseenko, I. (2016). Russian HOSPITALity. Strategies for Hospital Flexibility in Urban Context. Master thesis, Politecnico di Milano.

6. Capolongo et al. (2012). Architecture For Flexibility In Healthcare. Milano: FrancoAngeli s.r.l.

7. Wagenaar, C. (2006). The Architecture Of Hospitals. Belgium, NAi Publishers

8. www.ellenmacarthurfoundation.org, retrived at 21.12.2016

9. Kendall, S. (2005). Open Building: an Architectural Management Paradigm for Hospital Architecture.

10. McGraw&Hill Construction (2011). Prefabrication and Modularization. Increasing productivity in Construction Sector.

12. Bryman (2012). Social Research Methods. Oxford: Oxford University Press (4th edition).

Beside these literature sources I intend to consult the number of firms and practitioners involved in modular construction industry. In particular, I already conducted an interview with De Meeuw company, specialized in modular construction in general, and in its hospital sector in particular. I also met Karel Dekker, researcher and practitioner in modular and fill-in construction, who develops assessment financial models of modular and prefab construction projects. Another practice with whom I already consulted is EGM Architects, the largest healthcare-oriented design bureau in The Netherlands. All these interviews can be found at the end of my P2 report. During P3 and P4 phases of my research I am going to meet them another time and discuss details of the empirical part of my research and other important things which might affect the result of my graduation project.

Reflection

Relevance

Scientific relevance.

The topic of my graduation project, in a way, is quite practical. In a few words, I am willing to understand does modular solutions in hospital design and construction more economically feasible, or, simply speaking, cheaper, than traditional on-site construction process. Financial savings in modular construction in general, and in hospital development in particular, based on off-site methods, can make it more attractive for construction firms, contractors, developers, and, finally, for the end users. The huge increase of final quality of the completed building, based on inside production and assembly techniques, is another practical benefit of modular construction. Although previously mentioned aspects are quite practical, I believe my graduation project contains scientific relevance as well. One of the main components of modular and off-site construction methods is lean management, or, in

other words, reduction of the resources along the life cycle of the building, from design to refurbishment (see part 2.2). Savings in materials, used in construction process, overheads, labor costs, while increasing the quality of the final product, is the crucial goal of modern construction industry
(source: Arup, Circular economy in the built environment report, 2016). In this regard, the famous moto of Miss van der Rohe, “Less is more”, becomes really important and practical by applying modular construction process to construction industry. Circular economy, as the global concept, with lean management as a part of it, is another scientific approach comes from my research (see part 2.1). The resources of our planet are limited, and with growing population of Earth, we need not only use its resources in the most effective and sustainable way, but rather re-use and recycle them in order to not throw away a lot of resources which might be used again. Modular construction, for sure, perfectly matches this global concept of circular economy and can bring added value to development of this philosophy, which becomes one of the main ones in XXI century (source: www.ellenmacarthurfoundation.org).

Societal relevance.

Potential societal relevance of the research lies within the concept of circular economy mentioned in previous paragraph. Since circular economy, and lean management as part of it, has an aim to reduce the waste of resources during the production and life cycle process of the building, implementation and enlargement of modular construction technologies in construction industry might save energy, materials and labor resources, which can be used in other places. That is why this research is addressed to almost all target groups in our society.

Utilisation relevance.

This research aims to show economic benefits of modular construction. That is why, if these benefits will be clearly identified and presented, utilisation, or, simply speaking, increase of the percentage of modular construction might take place in construction industry of particular region. Construction companies, developers as well as construction suppliers are direct agents of further implementation of modular construction in general, and in hospital development in particular. Since this research demonstrates organisational processes which take place in factories for modular construction, organisational models for such business can be extracted by entrepreneurs from this research. Overall,

demonstration of potentials of modular construction and its benefits in different fields (lean management, circular economy, higher quality, shorter construction period, etc) will be a trigger for practical implementation of these technologies in construction sector of particular region, with participation of different players.

Time planning

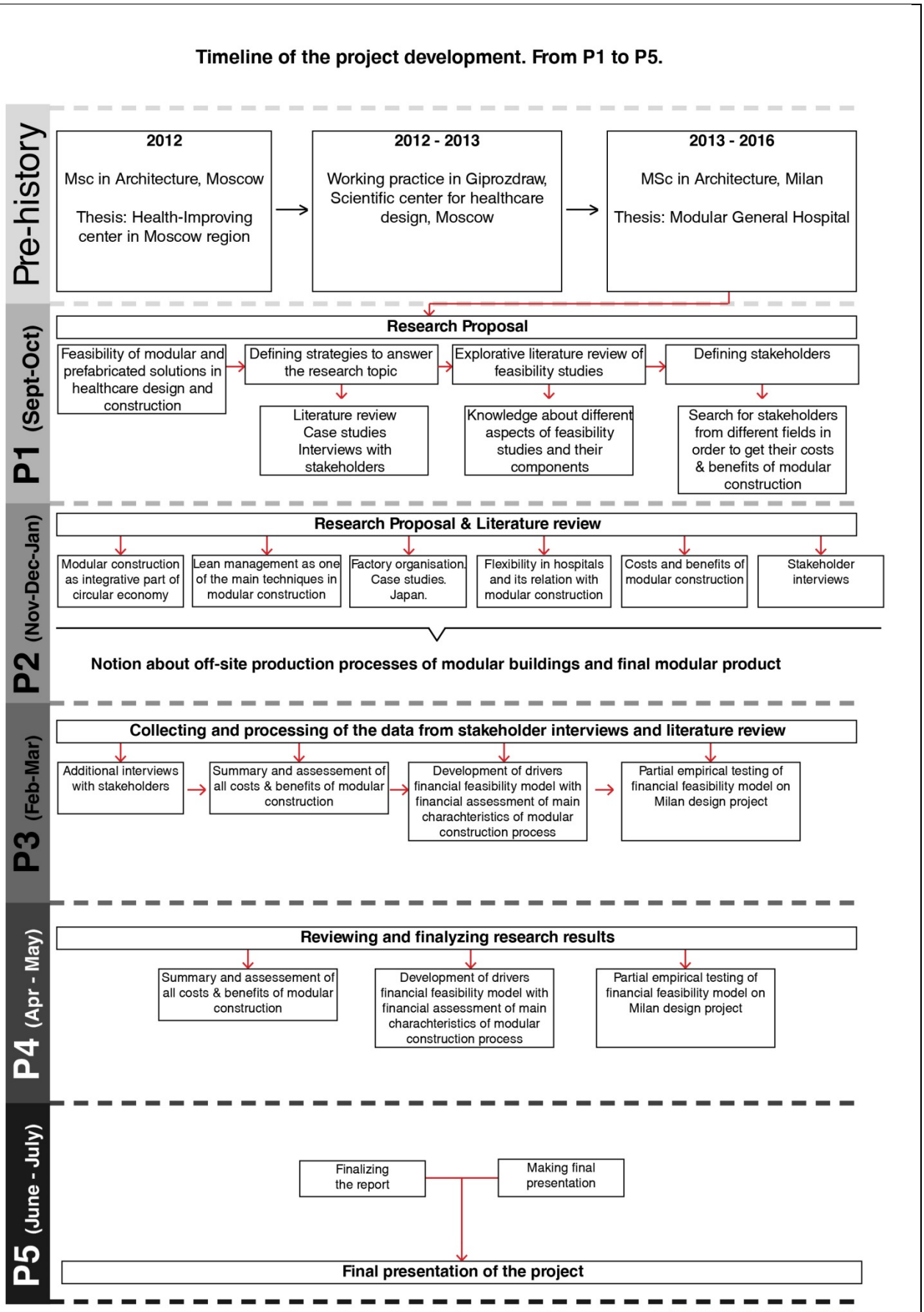

Figure 1.11. Detailed phasing of the research (source: Author, 2016)