Increasing efficiency in the project preparation phase: A guide to implementing lean construction management in underground car park renovations

Maximilian Pfadenhauer, BEng
Advisor: assoz. Prof. Dipl.-Ing. Dr. sc. ETHZ Florian Gschösser
Unit of Construction Management and Tunnelling
University of Innsbruck
ibt@uibk.ac.at | *www.uibk.ac.at/ibt*

ABSTRACT: This master's thesis examines the increase in efficiency in the project preparation phase, i.e. service phases one to seven, through the implementation of lean construction management methods (LCM methods) in maintenance work, in particular underground car park renovations. In the empirical part of the thesis, the LCM methods are tested for their practical applicability using the practical refurbishment project of the Operngarage in Munich. The focus of the work is on improving efficiency, cost-effectiveness and processes in the planning phase of refurbishment projects. In addition, an analysis of project implementation and optimisation possibilities is carried out.

KEYWORDS: Construction management, construction execution, LEAN, LCM, project preparation phase, maintenance

1 INTRODUCTION

In Austria, approx. 75% of existing buildings are older than 30 years [1], in Germany even 80% are older than 25 years [2]. This also includes underground car parks and multi-storey car parks, which are the focus of this paper.

Most underground car parks are built in reinforced concrete. According to DIN 1045 - Annex F, or ÖNORM B 4200, an average service life of approx. 50 years is assumed for reinforced concrete components. In order to maintain the building fabric and ensure safe use - not only for the underground car parks themselves, but also for superstructures - there is a need for periodic maintenance.

The use of LCM methods in refurbishment projects, especially in existing buildings, is currently not very popular or applied by most construction companies.

The aim of this master's thesis is to investigate the application and optimisation possibilities of lean construction management methods in the planning phase, i.e. in service phases 1 to 7 of refurbishment projects (underground car parks).

2 MAIN BODY

This paper begins with an overview of the current standards, guidelines and damage patterns in concrete and reinforced concrete. In addition, the methods of structural analyses for the damage patterns mentioned are presented. In the further course, the different repair variants for the damage patterns mentioned are presented.

In a further step, a revised and expanded diagram is used to illustrate the process in the various performance phases [3]. The individual processes, which can be assigned to the respective service phases, were recorded using the Fee Structure for Architects and Engineers (HOAI). The diagram focuses in particular on the processes to be observed in the preparation phase, i.e. phases one to seven, for reinforced concrete refurbishment measures (in underground car parks).

Fig. 2-1: Presentation of the service phases according to HOAI with a focus on repair work - Revised version [3, p. 668]

2.1 Lean Management

Lean management is a further development of the Toyota Production System (TPS), which was developed by Toyota in the Japanese automotive industry in the 1950s. Studies have shown that the implemented principles have a significant positive effect on work processes, workflows and the economic efficiency of companies. The applied principles from the TPS have been further developed for other companies. In their book 'Lean Thinking', Womack and Jones coined the term lean management and identified the following five principles:

- Define value
- Identify value stream
- Create flow
- Introduce pull principle
- Strive for perfection

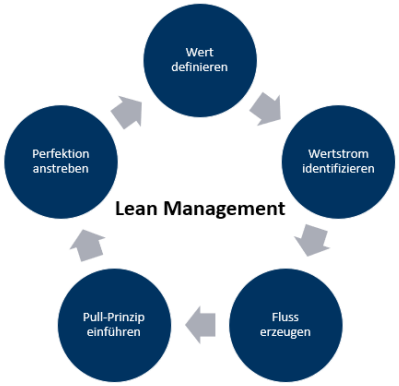

Fig. 2-2: The Five Lean Management Methods [4]

2.2 Lean Construction Management - Theoretical application in refurbishment work

Over time, the underlying principles have been continuously developed and adapted to the specific requirements and circumstances of the construction sector, which has led to the development of the term 'Lean Construction Management'.

The master's thesis presents the central points of lean construction management:

- Last Planner System (LPS)
- Value Stream Mapping (VSM)
- Value Stream Design
- Cycle planning and cycle control
- 5S method
- Visual Management

This chapter provides a general description of the methods. It also examines the extent to which the methods can be used in the preparation phase (service phases 1-7) for refurbishment work. The methods applicable in theory are explained in relation to the respective service phase and their applicability is explained [4][5].

2.3 LCM in phases 1-7 using the practical example of the opera garage (Operngarage) in Munich

In order to test the theoretical principles examined for their practical and actual applicability, a case study is carried out as part of this final thesis in cooperation with the engineering firm IPG from Landshut/Ergolding. It analyses the Munich Opera House underground car park project in more detail, with the underground car park serving as a practical example for investigating LCM methods in the planning phase.

As part of this analysis, interviews were conducted with project managers, project technicians and other project participants who were involved in the project during the various service phases of the preparation phase for the IPG company. In this context, it was analysed to what extent the LCM methods mentioned in theory were used and applied in practice in this project.

In a further step, the extent to which delays that occurred in the already completed construction phase could have been avoided through more consistent application of the LCM methods was analysed.

3 CONCLUSION

It has been demonstrated that the principles of lean construction management can be applied in a targeted manner to all work phases from the first to the seventh, although the intensity of application varies in each case. Specific LCM methods can be derived for each phase, which help to optimise the refurbishment project in terms of efficiency and transparency.

During the planning phase of the Operngarage, it was also possible to analyse that the LCM methods are used partly consciously and partly unconsciously. It can be stated that the majority of the methods are used in the opera garage project and that optimisation is only required in some service phases.

4 OUTLOOK

For future refurbishment projects, especially in underground car parks, the potential of LCM methods will therefore continue to increase significantly. Further integration and optimisation of current LCM methods in the entire planning process, from design to execution, could consistently help to minimise delays and avoid cost overruns.

The IPG engineering office, which already has a solid foundation in the application of LCM methods, also has the potential to organise future projects more effectively and efficiently by applying the LCM methods described.

5 REFERNECES

[1] Bundesanstalt Statistik Österreich, *Zensus Gebäude- und Wohnungszählung 2021: Ergebnisse zu Gebäuden und Wohnungen aus der Registerzählung.* [Online]. Verfügbar unter: https://www.statistik.at/fileadmin/user_upload/Zensus-GWZ-2021.pdf (Zugriff am: 29. Juli 2024)

[2] WEKA Media GmbH & Co. KG, *Der Gebäudebestand in Deutschland.* [Online]. Verfügbar unter: https://www.sirados.de/blog/der-gebaeudebestand-in-deutschland (Zugriff am: 29. Juli 2024)

[3] M. Schröder, *Instandhaltung von Stahlbeton: Anleitung zur sachkundigen Planung und Ausführung*, 8. Aufl. Tübingen: expert, 2022

[4] J. P. Womack und D. T. Jones, *Lean thinking: Ballast abwerfen, Unternehmensgewinne steigern*, 3. Aufl. Frankfurt [u.a.]: Campus-Verl., 2013

[5] M. Fiedler, Hg., *Lean Construction - Das Managementhandbuch: Agile Methoden und Lean Management im Bauwesen*. Berlin, Heidelberg: Springer Berlin Heidelberg; Imprint; Springer Gabler, 2018