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CASE STUDY – LEAN PROJECT MANAGEMENT IN A MULTI-PROJECT ENVIRONMENT

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ABSTRACT

Lean project management approaches such as the Last Planner System (LPS) have already been proven their worth in numerous case studies. Lean project management generally contributes to the optimization of schedule execution and the project-related resource utilization. However, this often ignores the fact that a company usually strives to optimize its use of resources at the corporate level. Therefore, a specific approach was developed and tested in a case study in cooperation with a medium-sized company. This study utilizes the Design Science Research (DSR) approach, drawing on existing approaches to problem solving. The developed Multi-Project LPS (MPLPS) approach shows significant potential for cross-company resource optimization after only a few weeks of application.

KEYWORDS

Last Planner® System, collaboration, pull planning.

INTRODUCTION

A major challenge for construction companies is to optimize the allocation of resources across projects. Large construction companies frequently use software to support this process. Medium-sized companies often have to find another way for cost reasons. In the company considered in this case study, one employee is responsible for resource allocation. This person must try to find an optimum in exchange with the individual construction sites. By optimizing the use of resources in the form of machines, materials and personnel on one construction site at the expense of another, this can lead to a situation where, at the end of a fiscal year, the company's results do not correspond to what would have been possible in the best case. The company in question recognized this problem and attempted to find a solution that would at least identify bottlenecks in resource planning at an early stage. Such an approach would be a first step towards the cross-project optimization of resource utilization within a company. To develop this in the present case study, the so-called Design Science Research (DSR) approach is used. The basic procedure is shown in Figure 1.

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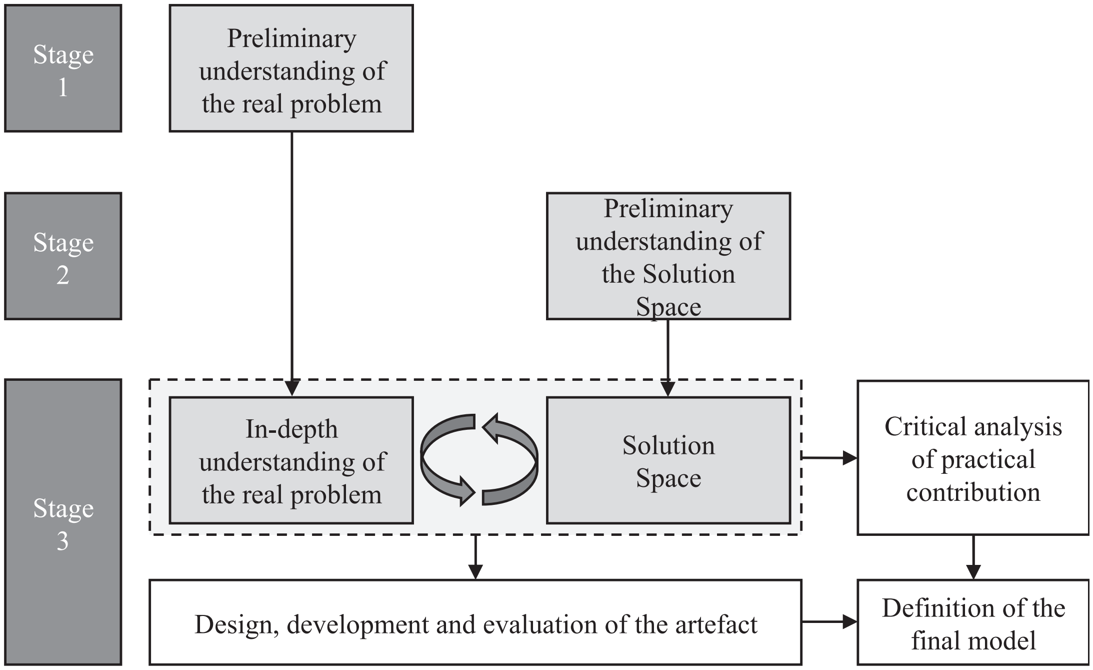

Figure 1: A visualization of the method and structure of this paper (Dresch et al. 2015; Hamerski et al. 2019).

As the figure shows, the first step in DSR is to identify the problem and break it down into its core components. To do this, this case study examined individual projects of the construction company as well as the distribution of resources within the company.

A literature search was conducted in the second step to form the so-called solution space. In particular, the IGLC served as a platform for the research. The approaches identified in this way formed the solution space alongside fundamental approaches to lean construction, such as the LPS.

In the third step, the extent to which the solution space provides solutions for the problem under consideration was tested in an iterative process. The aforementioned medium-sized company, which agreed to participate in the cross-company test, served as the data supplier. Within the framework of individual projects, it was possible to test the benefits of individual approaches from the solution space before these could gradually be put together to form a holistic solution approach. This process results in a multi-project management approach according to lean principles.

This study summarizes the development process results and presents the results of the first applications, the so-called Multi-Project Last Planner System (MPLPS). Finally, the results are summarized, and possible limitations of the investigation are pointed out.

STAGE 1: PROBLEM SPACE

PROJECT OVERVIEW

The research began in early 2022. The construction company considered here had 10 ongoing projects at that time. Table 1 provides an overview of these projects. The projects were mainly high-rise construction projects and a large part of them were in the remodeling sector. The company provided access to all of the projects as well as access to all of the documentation. Access consisted of the authors being able to attend all resource planning meetings and were given access to all data associated with this.

Table 1: project overview

Project	Project size (Million €)	Project art
1	3	new building
2	5	rebuilding
3	3	rebuilding
4	1	rebuilding
5	11	new building
6	5	new building
7	8	new building
8	1	rebuilding
9	2	rebuilding
10	4	rebuilding

IDENTIFIED PROBLEMS

The first weeks of the development process were used to analyze the main problems and to understand the problems identified, as provided for in the DSR. In many cases, problems cannot be reduced to a single cause. It was therefore necessary to focus on individual aspects. The results of this analysis process are the following problems, which need to be solved, as far as possible with the help of the model developed here:

- Problem 1: Resource bottlenecks are often not recognized until they have already occurred.
- Problem 2: Resource allocation requires a lot of coordination work by the resource manager.

In the following, the so-called solution space will be discussed first. This is the result of a literature research on similar and related problems. In the following step, an artifact is proposed based on the presented solution space, which solves the problems presented here, if possible.

STAGE 2: SOLUTION SPACE

PROJECT-SPECIFIC RESOURCE OPTIMIZATION: LAST PLANNER SYSTEM

The Last Planner® System (LPS) is a method for increasing productivity and stabilizing workflows. It was developed by Glenn Ballard and Gregory Howell and involves all project stakeholders in schedule and subcontractor control. The idea of LPS is to take a backward look at scheduling. (Ballard 2000)

First, the entire project is considered and milestones are defined for individual process phases. In a second step, a week-by-week phase schedule is used to define tasks to maintain the flow of work in the coming weeks. (Fiedler 2018) Last Planner meetings are used to check the targets set in the work plans, identify any errors and their causes, record the reason, and include the consequences in schedules and milestone plans. The interval of the meeting depends on the size of the project (e.g., weekly). When errors occur, such as incomplete or faulty work, the affected project participant can stop production. "This person is referred to as the Last Planner." (Heidemann 2011)

CROSS-PROJECT OPTIMIZATION

There are numerous lean approaches for optimizing individual construction sites, such as the LPS. The application of these approaches has already been tested and their efficiency has been proven. For the holistic optimization of an organization, there have been initial publications including case studies in recent years. In this context, the three-level approach by Dlouhy et al. (2018), which will be discussed in more detail here, and the multi-project lean management approaches by Bellaver et al. (2022) and Hamerski et al. (2019) are particularly worth mentioning.

Figure 2 shows the 3-level model of customer-oriented construction production according to Dlouhy et al. (2018). According to the authors, the model provides a transparent regulatory framework for structuring construction processes. It organizes an organization's resource and work planning processes into three hierarchical levels, with the level of detail increasing from top to bottom. The processes are closely linked. The following work steps must take place at the three levels:

Macro level: The macro level of the 3-level model represents the basis for communication with the client. The level of detail is reduced to a level that it is sufficient for strategic decisions relating to the entire construction process. The information for this level in turn comes from the levels below it.

Standard level: The standard level has a medium level of detail. It is used to map the construction coordination processes. The macro level provides information and specifications that are adapted to the project at this level. Construction processes are in turn planned and coordinated at this level. Individual processes and their interfaces are optimized. In this way, a stable execution flow can be ensured.

Micro level: The micro level represents the lowest and most detailed level of the 3-level model. Its purpose is to represent the processes that actually take place at the value creation level and to help control and monitor the work performed on a short-cycle basis. It receives instructions from the standard level and, conversely, passes on data and information to the two upper levels.

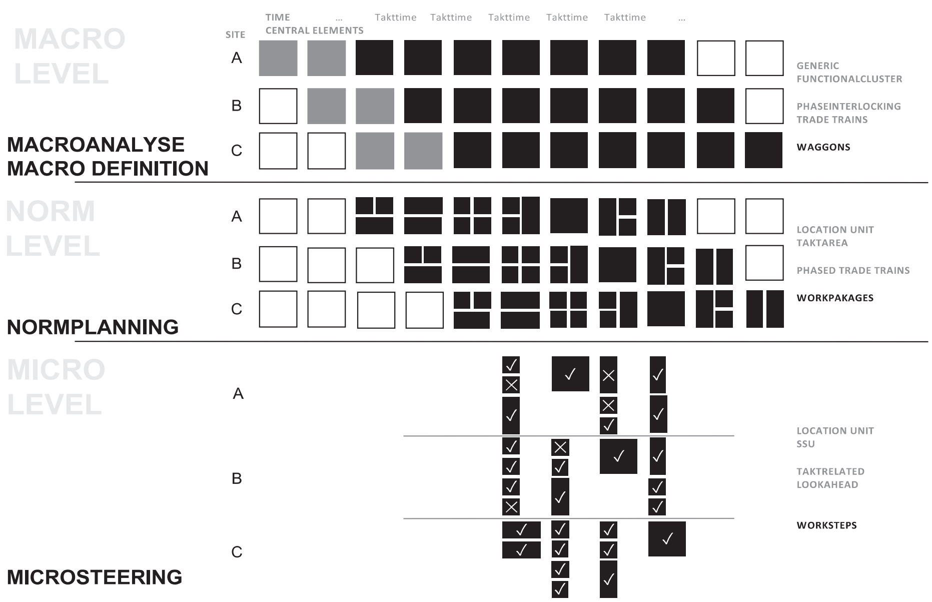

Figure 2: The three-level model (Dlouhy et al. 2018).

These approaches to the cross-project level first show at the principle level how such optimisation could take place. What is missing, however, is a concrete solution or implementation approach, which is the focus here.

Integrated production systems (IPS)

The implementation of lean construction often leads to problems in companies. Through various reorganization projects, companies are to be adapted to the Japanese model, and expectations are very high. In many cases, these innovations do not produce any real improvement, which ultimately leads to demotivation of the entire workforce. (Lay et al. 2005)

However, the fault lies not in the nature of the projects or their tools, but in the way they are implemented. Two fundamental problems can be identified that are responsible for the false start of Lean Systems. The first is the lack of stabilization of the new projects. If they do not bring success, they are immediately replaced by other projects. The second mistake is the lack of coordination between different approaches. For example, new types of production systems can strongly influence existing systems. The individual projects within the TPS concept must also be coordinated so that they do not work at cross-purposes. (Lay et al. 2005)

IPS are therefore introduced at the point of implementation. Its goal is to bring together all the concepts of the company in a meaningful way and to eliminate conflicting goals. An IPS is thus not a stand-alone tool. Rather, it is a regulatory instrument for coordinating the introduction of an existing production system. On the one hand, it creates transparency; on the other hand, it combines the strengths of all structures in order to improve the economic efficiency of the company. (Lay et al. 2005)

Every company has a different history and combines different concepts and structures. Therefore, an IPS does not offer a one-size-fits-all solution. Instead, it responds individually to the existing systems, technologies and the associated corporate culture. (Lay et al. 2005)

The IPS is therefore not limited to manufacturing. It tries to extend the new ideas to all relevant areas. (Lay et al. 2005) This applies in particular to upstream and downstream areas such as planning, control and logistics. So, it covers the entire manufacturing process. (Spath 2003)

In addition, IPS has a modular structure. It can be clearly seen what the task of an element is and how it relates to the overall system. This creates transparency and facilitates the operation of the elements. (Lay et al. 2005) To reinforce this effect, it is necessary to define the business objectives. In this way, the modules can be built up more purposefully and, if necessary, linked together. (Spath 2003)

The components of an IPS can be divided into methods and tools. The methods form the basis of the system. They are working techniques, which consist of planned and comprehensible working steps. They specify how a specific tool must be used to reach the desired goal. (Gorecki et al. 2014)

Since a IPS is modular, it can consist of different methods and tools. If a company chooses the components that make the most sense for itself and assembles them into an individual IPS. Since there are many different methods and tools, only the most important ones will be described in the following chapters.

Figure 3: Tools and methods of IPS (Gorecki et al. 2014).

STAGE 3: ARTEFACT

RESULT OF DESIGN AND DEVELOPMENT OF THE ARTEFACT

Initial implementation

A fundamental distinction must be made between the initial setup and the short-cycle adjustments to the planning as the project progresses. In the following, the initial process of setting up the planning of a project will be discussed first. The basic idea of the 3-level model is that it can be used to control a large number of individual projects. In order to take advantage of the strengths of the approach, the following process must be implemented for all construction measures of the company in question.

The initial setup of resource planning for an individual measure is essentially based on the 5-step approach of the Last Planner system in the approach examined here. A special feature here is that the individual planning levels of the LPS are integrated into the levels of the 3-level model by Dlouhy et al. (2018).

According to the LPS, the first step is to perform an overall process analysis for the specific project. Framework data such as completion dates, lock-in periods, etc. are determined, and necessary work steps as well as initial dependencies are identified. The goal of this step is a master plan (milestone plan) with project-specific phase and area classification as well as process steps for each area and possible trade.

In the next step of phase planning, a schedule is created based on the master plan (milestone plan) using common scheduling software such as MS Project. A prerequisite for the functioning of the model presented here is that the software used allows the linking of several phase plans and the allocation of resources. Scheduling should be done on a weekly basis and not more precise.

This phase planning in turn forms the basis for the make-ready planning (6-week preview planning) in the next step. If possible, this should be done at the construction site by the respective trade managers. The 6-week preview can in turn be further specified at the start of the project in the form of weekly work planning (2-week detailed planning).

The make-ready planning (6-week preview planning) and the weekly work planning (2-week detailed planning) are to be integrated at the micro level of the 3-level model, since the optimization of the use of resources takes place here at the project level. At the standard level, the phase planning of the company's individual projects is combined again. By allocating resources, resource conflicts can be identified at this level and adjustments can be passed on to the micro level. Similarly, resource planning at the micro level allows for the automatic derivation of metrics that can be used at the norm level. The same is true for metrics that can be derived from master resource planning at the norm level to support strategic decisions at the macro level. The system used here does not provide for any further information at the macro level beyond key figures such as adherence to schedules.

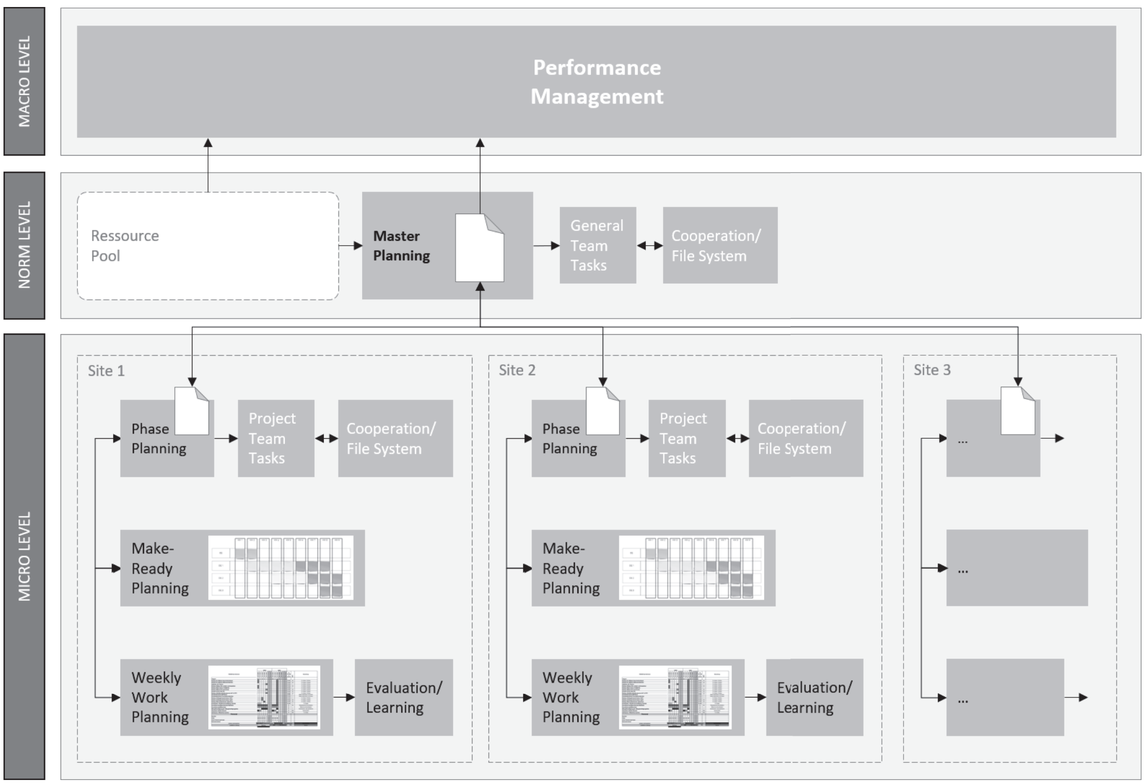

Figure 4: Initial implementation.

Adaptation process

The MPLPS provides that, where possible, a new week is added to the make-ready planning (6-week forecast schedule) and the detailed weekly work planning schedule, or the existing schedules are adjusted. This adjustment process continues to occur as part of the approach presented here. As presented above, this is part of the micro level. The specifics of the process presented here relate in particular to feedback to the norm and macro levels. The basic adaptation process is shown in Figure 4.

After the adjustment of the make-ready planning (6-week forecast plan) and the detailed weekly work planning according to the MPLPS takes place in the first step, the resource master planning on the norm level must take place in the second step. The adjustment of the resource planning must be carried out by the respective site manager. In order to keep the workload as low as possible, the level of detail of the resource master plan at the standard level has been limited to an accuracy of one week. Changes in the phase planning that occur at the micro level should also be identified in order to further reduce the workload. Once the resource master planning is synchronized with the already existing enterprise resource plan, information about resource conflicts is obtained. If this occurs, this information needs to be passed down to the micro level to make appropriate adjustments.

Adjustments to the macro level are automatic. The macro level can use the current metrics to make strategic decisions. The actions that result from these decisions are not standard processes and therefore are not directly addressed in the adjustment process.

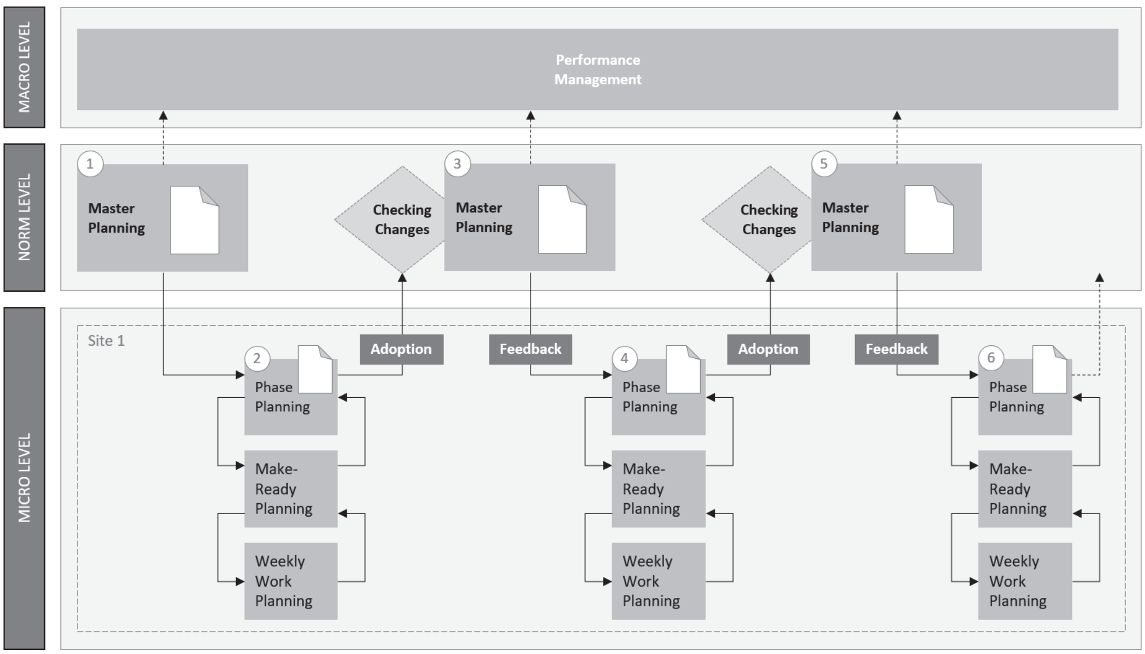

Figure 5: Adoption process.

PRELIMINARY EVALUATION OF THE ARTEFACT

The artefact is still being optimized. A final model could not yet be created. Nevertheless, the artefacts and the current state of the artefact presented here have been repeatedly evaluated in the course of the DSR with respect to solving the problems of the problem space. This can be summarized as follows:

- Problem 1: The developed artefact can effectively identify resource bottlenecks with sufficient lead time.
- Problem 2: Resource allocation is structured by using this artefact. This does not reduce the effort but transforms it into an orderly process.

Only gaps regarding the resources that are the subject of the resource pool can be identified. A resource pool that is too large may lead to too much administrative work. Therefore, the user must weigh up how much administrative effort is reasonable.

The benefit with regard to problem 2 cannot be quantified directly. A structured process does not directly lead to more effectiveness. However, it is the first step on the way to process optimization.

LESSONS LEARNED

The main innovation of the approach considered here is the linked application of LPS on several projects. It is therefore not necessary to report on the experience gained in applying LPS, but to focus in particular on the experience gained at the norm-level. The points that are of importance for the application beyond this are discussed below in bullet points:

- Currently, there is no software solution available that automates the interfaces. The current software solutions that can be used to manage resources do not allow pull planning. As a result, the interfaces must be transferred manually.
- In order to reduce the need to adjust the standard level resource planning when micro-level changes occur, the accuracy of standard-level planning has been reduced to one week.
- One person in the organization is required to take primary responsibility for managing and verifying compliance. The approach developed here helps to find a solution for resource allocation that does not have resource bottlenecks. What it does not do is find the optimal resource allocation solution. This still requires the expertise of the users.

The next step could therefore be to formalize this process further. The individual work packages could then be combined into an optimum overall process with the aid of a production planning system such as is used in stationary industry.

CONCLUSIONS

Optimizing resource utilization across multiple sites is a problem that is too rarely addressed. Approaches such as LPS often only aim to optimize the use of resources on one construction site. Alternative approaches such as the 3-level model help with cross-company optimization. In order to test this, a proprietary approach combining both methods was developed and tested in a medium-sized company. The approach showed great benefit in the context of the company, although its use is associated with considerable effort due to the numerous interfaces that have to be maintained. Therefore, an attempt should be made to find a software solution that digitizes the model.

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