Root Cause Analysis Towards Lean Collaboration Between Production Line and Factory Planning

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ABSTRACT

Cooperative processes are critical in complex projects involving stakeholders from different branches. The need to coordinate tasks and exchange information between production line and factory planning are key challenges for industrial plant construction management. Inefficient collaboration leads to increased cost and time, low quality, reduced output, loss of competitiveness and income and unfavorable image. This paper presents root causes of collaborative problems between production line and factory planning. The study integrates lean project management principles and root cause analysis methodology. This methodology is applied in a qualitative case study that builds on project data from production line and factory planning work environments including the results of brainstorming session, online-survey and comparative analysis of industrial plant planning projects using different levels of lean project management ICT.

INTRODUCTION

"Implementing lean thinking is a cultural change that requires leadership…Because in the end it is all about people."

Orest J Fiume, Member of the Board of Directors of the Lean Enterprise Institute, Leader in Lean Thinking and Lean Education

"Lean thinking" represents a cultural change and focuses on continuous maximization of customer value and reduction of waste. Nowadays corporations face the challenge to create lean collaborative procedures for complex multi-disciplinary project management. Plant organization is an example with an extremely intricate structure of participants with simultaneous information exchange between departments. Deployment of lean methodology to address the collaborative issues demands modification of the entire lifecycle workflow: from overall definition and basic evaluations to the concept, detailed planning, preparation, construction, operation and maintenance. Therefore, the implementation of a new company philosophy has to be reasonable and well structured. "What are the root causes of inefficient collaboration and can *lean thinking* be the optimal and required solution?" – is the question corporations face today. According to the limited number of organizations integrating lean methods

into project management, the answer to this question is still not adopted the main stream international business structures.

PRACTICAL AND THEORETICAL POINTS OF DEPARTURE

The approach used for research is based on the integration of phases of the root cause analysis of the problems in the existing collaborative procedures between production line and factory planning and examination of implementation of lean principles in the management environment in the context of industrial building construction projects. Practical and theoretical points of departure include observation of production line and factory planning phases and analysis of the development of lean in manufacturing, construction and project management.

The typical challenges faced when implementing new work methods from the manufacturing sector in construction and project management include complexity of organizational system, unique products, high performance and running costs, immobility, dependence on prerequisite of the suboptimal conditions and other building and maintenance characteristics (Koskela, 2000). Slow adoption of the tools and methods such as the Toyota Production System can be explained by the difficulties in identification of value flow and waste in projects (Avraham Y. Goldratt Institute, 2009). Therefore it is critical to define the indicators of success of process related elements, such as effectiveness and speed of task fulfillment.

However, the significant results of the companies using concurrently integrated technologies such as digital factories, last planner, lean project delivery systems and collaborative contract agreements show the advantages of taking risks towards effective changes. The benefits of lean processes in manufacturing can be demonstrated by reduction of product development time-to-market by 75 percent with increased productivity up to 160 percent by Wiremold Company and reduction of defects from 8.0 to 0.8 per machine in the Lantech Corporation (Prakash D., 2011). While implementing lean principles in the construction sector Swedish construction leader Skanska was able to reduce up to 30 percent the project duration and up to 70 percent the time needed to rectify defects (Koskela, 2000). According to the research results of Herman Glenn Ballard, the Last Planner system for production control improves the reliability above the 90 percent in site installation (Ballard, 2000). Inspiring examples of successful application of lean principles in manufacturing and construction demonstrate the need to further research and deploy efficient collaboration work practices in production line and factory planning.

RESEARCH METHOD

In terms of the research an in-depth qualitative case study was conducted (Eisenhardt, 1989). The aim of the study was to address the question: “What are the root causes of inefficient collaboration of production line and factory planning?” The study was performed in the context of an international corporation providing engineering and consulting services in manufacturing engineering, vehicle engineering, power train, design, electronic solutions and other branches. Information about the case study projects was collected during the period from the 1st February till the 31st May 2013.

The research uses a multi-method approach and integrates brainstorming, online-survey and examination of case studies into the root cause analysis. The brainstorming session led to the identification of the effects of inefficient collaboration between production line and factory planning and illustrated the defined root causes. An online survey was developed in order to answer the open questions and to detail the results from the brainstorming. Simultaneously with the online survey the three projects from Europe, Asia and North America were selected. These projects represented the spectrum of different implementation levels of lean project management tools to analyze the objective quantitative information about the collaboration of production line and factory planning. The tool used for the case study analysis is the complex web based lean production planning system offered by Strategic Project Solutions (SPS). The key principle of lean collaborative tools is transparency and interdependency of the activities of all participants, collection and analysis of the statistical information about the entire workflow, and documentation of the root causes of the unfulfilled tasks. All these characteristics form the opportunities for continuous improvement procedures.

DATA ANALYSIS AND FINDINGS

Brainstorming and root cause analysis. Ten participants of the brainstorming workshop represent key professional stakeholder groups, including architects, construction managers, production planners, process simulators, project managers, facility managers and environmental engineers. The input from the participants was compiled to create the root cause Ischikawa fishbone diagram illustrated in Figure 1.

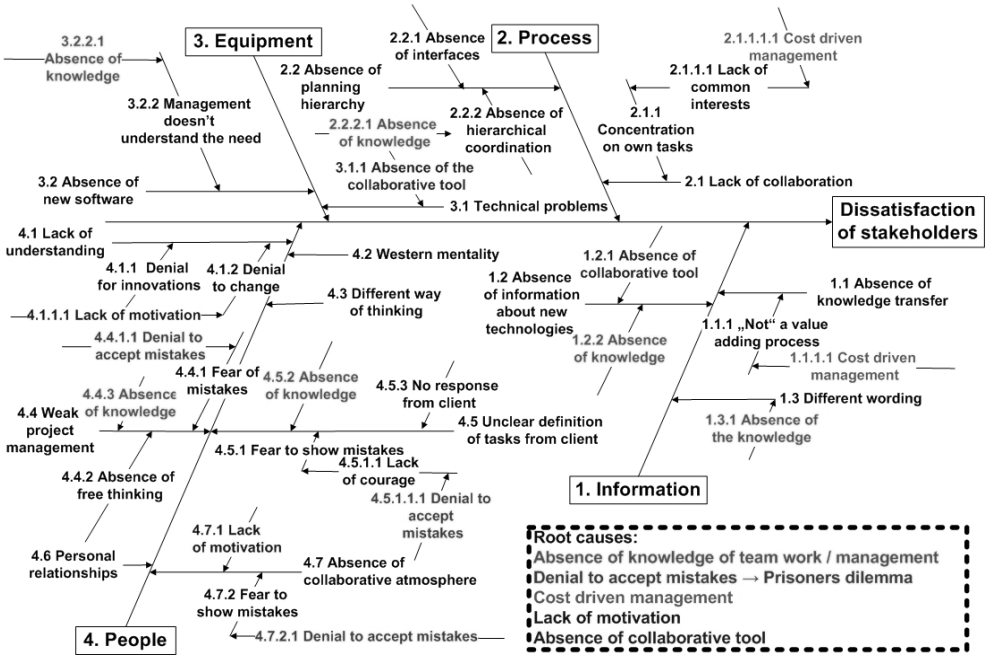

Figure 1. Ishikawa diagram based on the results of the brainstorming session

The brainstorming workshop highlighted the negative effects of unsuccessful cooperation between production and factory planning such as extension of work time, hindrance for the development and innovation, increased

project costs, low quality of completed work, termination of the employment contracts, loss of competitiveness, trustworthiness and income, negative references, reduced production output and unfavorable public image. The compound effect resulting from the miscommunication between production and factory planning is *dissatisfaction of stakeholders*.

The general groups of causes leading to negative outcome identified during brainstorming are: 1) absence of knowledge and experience in the spheres of project management and collaborative teamwork; 2) denial to accept mistakes, which leads to "prisoners' dilemma between employees"; 3) cost driven organizational system; 4) lack of motivation for collaboration and 5) absence of the collaborative tools.

Online Survey. In order to clarify open issues of the brainstorming session an online survey targeted to answer the questions demanding additional research was developed. The respondents of the focus group of specialists in the areas of production line and factory planning confirmed the hierarchical disparity between the departments of the organization, mentioned monetary factors and employees capacity as the basic indicators for metrics of projects success and pointed out the hierarchical structure of the company. Thus the negative effect of the hierarchical organization structure and interconnections between departments is intensified by the lack of abilities of the project management to track collaborative work practices and processes. The mentioned parameters lead to the situation, where already existing lean tools and techniques were not used by the employees, because of the lack of information and technical problems. The lost opportunity to improve the collaborative atmosphere showed on one hand the existing interest in the development, but on the other hand, the lack of the systemic organizational process to implement and execute new collaboration practices.

Analysis of three case studies. To provide evidence that supports the root causes identified during brainstorming and online survey, a case study analysis of three existing plant planning projects from Asia, Europe and North America was performed. A central aim of the case study analysis was to compare the level of usage of lean project management principles and processes based on the lean software that was deployed in two projects. The collaborative production planning and project management tools are able to assist efficient tracking of project execution according to process oriented key performance indicators, such as, commitment reliability, root causes for unfulfilled tasks, percentage of tasks completion without previous planning, daily resource utilization and statistics of the standard processes.

Each case study illustrates one of three scenarios of usage of lean tool from implementation throughout the project (Case Study A), to partial implementation (Case Study B), and no implementation (Case Study C). General information about case studies is presented in the Table 1.

The Table 1 shows, that in spite of the advantages of the internal project the Case Study C was delayed for more than year and cost overruns reaching the level of 51% demonstrate the urgent need for changes in the project management system. This necessity is supported by the 12 months delay of the Case Study B, though for its execution lean production planning and project management

platform was partially used. Depending on the different type and amount of available information specific analysis approaches for each case study were developed including observations of special characteristics of data as shown in Table 2.

Table 1. General information about the case studies

Parameter	Case Study A	Case Study B	Case Study C
Level of usage of Lean Project Management Software			
Usage of collaborative production planning and project management tool	Used for the entire project duration	Used periodically by several teams	Not used
General project information			
State of the project	in progress	in progress	finished
International/ National	International	International	National
Amount of the analyzed tasks	2081	2180	NA
Indicators of success			
Delay of the start of production	NA	Preliminarily 12 months	13 months
Cost overrun	Project in progress	Project in progress	51%

Table 2. Analysis fulfilled for each of the case studies

Case Study	Groups of Analysis
Case Study A and B	Organizational structure/ Final Milestone/Master level Milestones/ Task Statistics/ Root Cause Analysis/ Standard Processes/ Completed Not Planned Tasks/ Participation of the Client in Project management
Additionally for Case Study B	Dynamics of milestone tracking without lean collaborative tool
Case Study C	Organizational structure/ Delay of Start of Production/ Outsourcing Model

The analysis of the Case Studies A and B is based on the use of lean tool for production planning and project management.

Key findings of the analysis of the Case Studies A and B are presented in the Figure 2.

The parameters 67% and 75% of delayed milestones indicate in a predictable way the potential delay of the Start of Production Date. The Root Cause Analysis demonstrates that the most delays of the Case Study A were caused by directive reasons, which included the delayed information from the client. This finding shows the lack of general understanding of the value stream process by the customer. The detailed statistics of delays and time reserves for more than 200 days illustrates systematic failures in the planning phase of both

projects and absence of the replanning procedures. The number of tasks which were completed without planning (56% for the Case Study A in particular) serves as another indicator of the lack of structured, systematic, and continuous planning and replanning process.

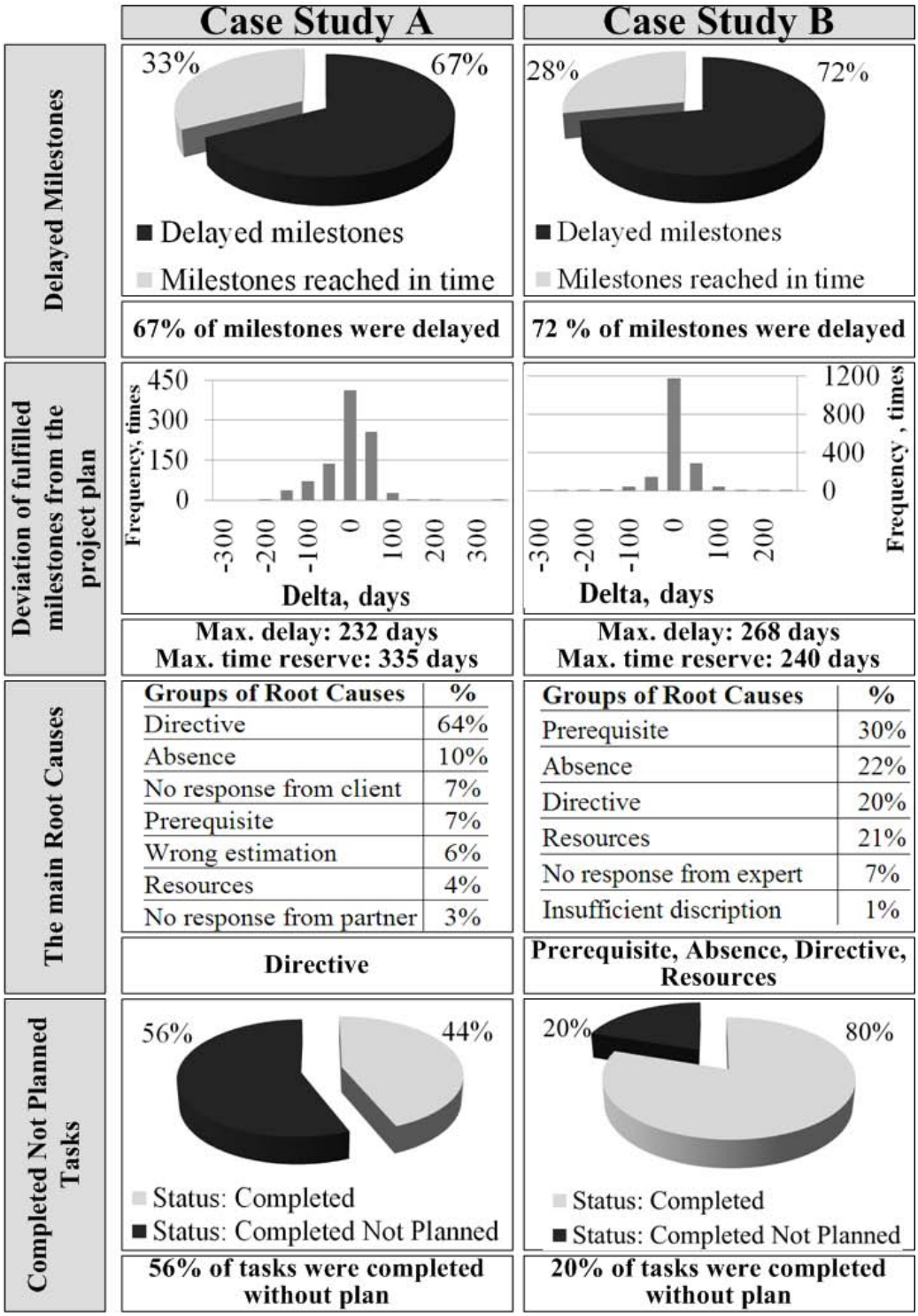

Figure 2. The main findings of the Case Study A and B analysis

The analysis identified the presence of all of the categories of waste including overproduction, underutilization of resources, waiting, transportation, inventory, excess motion and non-value adding processing.

Additional findings from the Case Study A analysis

One of the leading aspects of the lean approach is the focus on the last responsible moment for the final milestone, when the work has to be done. According to the project plan for the Case Study A the final milestone in the system was missing and the work packages of different teams were not connected to each other. Absence of the interconnections between the teams and the final milestone led to the lack of the time tracking function of the project management and appearance of the chains of tasks with abnormal time reserves, which highlight the waste of the underutilized resources. Missing time tracking system led to delays of the task completion, e.g., 205 days. In addition it was found that entire chains of tasks were completed without planning, which means, that the execution of these tasks was not controlled by the project management system and the reasons for the delays could not be analyzed and addressed. This prevented the chance for continuous improvement.

Additional Findings from the Case Study B analysis

Due to the client's decision, the use of collaborative production planning and project management tool was deployed only for some periods of the Case Study B. The additional analysis of the dynamics of the project B during the period when the collaborative program was not used shows a growing number of milestones with low and high risk and reducing number of milestones that were on track. This underlines, that without control of daily tasks, project management was not able to track timely completion of milestones.

Findings from the Case Study C analysis

Information used for the analysis of the Case Study C included partial documentation of the collaborative meetings and discussions with the project participant. The main root causes of the collaborative problems in this project were absence of coordination of information transfers between the partners, neglects of interests of construction departments by production planners, unclear definitions of responsibilities and interfaces between the departments, uncertain working schedule, changing workflow and absence of contacts between the last planners. Absence of the think tank led to missed opportunity to optimize the processes and analyze mistakes. Lack of measurable objective information about the Case Study C shows the disadvantages of the traditional project management systems hindering implementation of countermeasures for process improvements.

All of the findings of the analysis of the case studies illustrate lack of commitment in understanding and deploying lean project management processes and tools.

CONCLUSIONS

The paper presents case study analysis method that integrates lean project management principles and root cause analysis methodology. The study revealed anxiety and interest of the employees to improve work practices and processes

and confirmed the need for changes to prevent delays of tasks and cost overruns. The root causes towards lean collaboration of production and factory planning identified during the research are shown in Table 3.

Table 3. Identified root causes

Research tool	Root Causes
Brainstorming	1) Absence of team management knowledge 2) Absence of collaborative tool and 3) Lack of incentives for collaboration 4) Denial to accept mistakes and 5) Cost driven management
Online Survey	6) "Two classes system" and 7) Hierarchical structure of the company
Case Study Analysis	8) Lack of commitment in understanding the system of Lean 9) Absence of think tank

Hierarchical disparity between the analyzed branches, based on the cost driven management regards construction as the non-value adding process, what leads to the prevailing of the interests of the production branch over the factory planning and hinders the effective information transfer. The exceptional orientation on the financial indicators of success in projects and denial of management to accept mistakes brings prisoners' dilemma of employees, who are not motivated to improve their collaboration process. At the same time, the client's rejection hinders implementation of lean methods.

The lean countermeasures for improvement of collaborative processes must include a strategic lean transformation plan (Womack, 2003), implementation of contemporary tools for organization of collaborative processes and detailed regular analysis of the efficiency of work completion using the advantages of lean project management systems.

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