The Use of Modified PPC Measurement in Design Management

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Abstract

PPC (Plan Percent Complete) is a measurement tool in Last Planner which has been used mainly in production phase. However, there are some other studies in which PPC measurement has been used in design phase and we believe it has an important role there too. The aims of this study were to test 1) how modified PPC measurement fits to the design management, 2) how to develop and measure PPC for this project 3) what are the participants' opinions on this modified PPC. A modified PPC (task list) was used in this study. A total of six measurements were done. Five project participants were included in the measurement and their opinions on the modified task list were recorded. *Measured* PPC values varied from 30 % to 100 % and the average was 73 %. According to the participants, a task list had a positive effect on their work. The conclusion was that the modified PPC measurement seems to be an appropriate tool for design management. It was accepted by designers and will be used in future projects. However, BIM needs to be connected to the task list more closely. More data is also needed to set a target value for PPC in design phase and to find out how PPC predicts project success.

Introduction

Percent Plan Completed (PPC) is a tool in Last Planner to measure the percentage of completed tasks: PPC=(number of competed tasks/total number of tasks planned to do)x100% [1]. Last Planner is widely used especially in production, but in to some extent also in design. However, there is still the question if we need some different method for design? There are three factors which distinguish production control during design from the production control during production [2]: 1) uncertainty of ends and means, 2) speed of execution, and 3) complexity of work.

Uncertainty is inherent in design. Design options emerge from discussions and thoughts, and cannot be fully predicted beforehand. This obviously reduces the possibility to predict task sequences. *Speed of execution* affects how much there is time for preparing. The greater the speed of execution the larger buffers in design are needed. It means that, for example in the structural design the loads and dimensions must be over-estimated because there is no time to define them precisely. *Work complexity* is the number and types of dependencies between tasks. Design task can be reciprocally depended and this requires different type of planning [2].

In design, iteration can add value but in production it is waste. Iteration in design can be either positive or negative. In a positive iteration value is added but a negative iteration produces waste. The latter should be minimized in design [3].

In design there are several preconditions that should be handled in order to complete the design tasks. These six preconditions are [4]: 1) connecting tasks, 2) expectations and demands, 3) dialog, 4) decisions, 5) manning and 6) methods/tools. [5]

As said, PPC measurement has been used in design too. Fundli & Drevland [5] measured PPC in an apartment block project. 12 measurements were done during 17 weeks the average result on PPC was 81 % while the goal was to complete 85 % of the tasks. The reasons for not completing the tasks were: lack of personnel/priority 37 %, lack of information 27 %, unrealistic scheduling 23 %, lack of decisions 13 %, and wrong methods/tools 0 %. In another project 18 measurements were performed. The average of PPC was 41 % ranging from 18 % to 86 %. They also measured the PPC of drawing delivery. In the first project the result was 91 % of nine measurements in 10 weeks. The reasons for not delivering in time were: lack of personnel/priority 80 % and lack of decisions 20 %. In the second project the PPC for drawing delivery was in average 60 % of 22 measurements. The effect of PPC on motivation was also asked, and 77 % of the participants considered PPC measurement to be highly motivational or to have some effect on the drawing delivery. 46 % of the participants considered PPC measurement to be highly motivational to complete weekly planned tasks. An equal percentage considered it to have some effect on their motivation [5]

Similar results have emerged in another study where the average PPC of drawing delivery was 80 % and for completing planned task PPC varied from 50 % to 100 %. The reasons for not delivering drawings on time were: lack of information 44 %, lack of personnel/priority 28 %, lack of decisions 17 % and unrealistic scheduling 11 %. The reasons for not completing the planned tasks were: lack of personnel/priority 43 %, lack of information 27 %, unrealistic scheduling 18 %, lack of decisions 12 % [6].

In our company, Fira Oy, we see design management as a complex network of reciprocal needs and demands between project participants. These needs and demands are e.g.: information of old structures, the demands of end-users and other participants, information from other designers, demands from authorities, etc. Compared to the list presented by Fundli & Drevland [5] these needs and demands are the same as the three of six preconditions: connecting task, expectations/demands and decisions. After these needs and demands are solved designers are able to continue with less negative iteration. Solving these needs and demands can be seen as work released, because it releases a designer to either start or continue his work. For example, an electrical designer needs information from an architect on where to put a switchboard, and from end-users about the gadgets they are going to use. As far as this information is unavailable design cannot continue. When these small needs and demands accumulate the design begins to slow down the whole project. We believe that by controlling these needs and demands between participants the design process can progress as planned. The aim of this study was to test how modified PPC (task list) measurement applies to the design management, how to develop and measure PPC for this project, and what are the participants' opinions on this modified PPC.

Case study background

The measurement was done in a Design-Build project, which was a target-value, 18 million Euros, renovation project. It consisted of three different parts: a shop, a parking hall and sheltered accommodation. The existing building was modeled using laser scanning. At the time of these measurements the project was at design phase. The point-cloud model enabled the use of Building Information Model (BIM) for the new structures. All designers (architect, HVAC, plumbing, electrical, structural, sprinkler) modeled their parts. The BIM was also used to stimulate the conversation and understanding among project participants.

Intensive Big Room

Intensive Big Room (IBR) was used to coordinate design management. IBR consists of weekly sessions each lasting 3 to 4 hours. IBR is a modification of Big Room and the reason for using it was the size of the project. In a relatively small project it is not possible to have the participants in the same room for the whole length of the project. The basic idea of IBR is the same as in Big Room - a big space where smaller groups can work together or separately to solve a problem- but the use of the IBR is periodical, not continuous [7].

PPC measurement method

At the time of writing this paper 12 IBR sessions have been arranged. In six of them PPC was measured. Because of the lack of appropriate method the measurement was not used in the beginning of the IBR sessions. We remodeled PPC to better suit the purpose of IBR. The way Last Planner was used also differed slightly from the one used normally. Participants did not have post-it notes and there was no special session of doing last planning. Instead, needs and demands emerged from conversations between participants, needs of procurement or master schedule, and were gathered to the task list. The tasks were written down on a worksheet (Excel) and attached to the minutes. In this study term "task" is defined as "an unsolved issue, change in the BIM, blueprint, piece of information or draft that has to be executed before given date". Despite of variations between tasks they were not weighted according to their relative importance. Many of the tasks were related to the BIM because the quality of modeling was checked every week by a general contractor.

During the IBR the tasks given in previous IBR were marked completed or not completed. If the tasks were not completed the reason for not completing the tasks was asked. The reasons were:

- *Unrealistic scheduling:* Completing the task was not realistic in the given time period.
- *Lack of information:* Some information necessary to complete the task was missing.
- *Lack of decisions:* Decisions necessary for the task were not made.
- *Lack of personnel/priority:* There were no resources to complete the task or the person completing the task prioritized other project or task.
- *Wrong method/tools*: A software problem.
- Other.

Percentages of tasks completed were calculated. The number of tasks per participant was also calculated to show each participant's workload. It also documented the amount of tasks from which the percent was calculated.

Surveying method for opinions about the task list

Opinions about the task list were asked from six participants based on following claims: 1) Task list was useful for me, 2) Task list increased motivation to complete a task, 3) I want a task list to be used in the future, 4) Task list included all the essential things, 5) Task list helps me remember tasks planned to do for next IBR. Participants were asked to express their opinion to the claims according to the Likert scale: 1=Strongly disagree, 2=Disagree, 3=Neither agree or disagree, 4=Agree and 5=Strongly agree.

Results

Results of the PPC measurements are shown in Figure 1. The PPC varied from 30 % to 100 %. The average percent of completed tasks of five participants (architect, structural, plumbing and HVAC, electrical designer and general contractor) from week 1 to 6 are shown in Figure 2. Figure 3 shows the percent of completed tasks for each participant during the whole measurement period. Percentage varied from 60 % to 80 % the architect having the lowest and the construction engineer the highest. The average percent of completed tasks was 73 %.

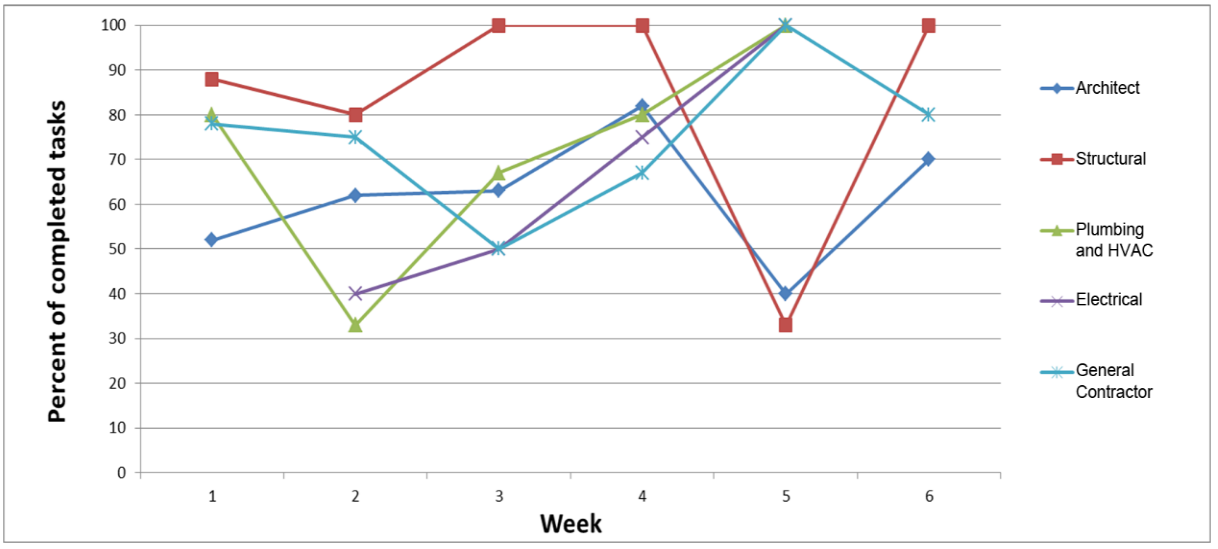

Figure 1. Percentage of completed tasks during the six week measurement period. The percentage is shown for five participants.

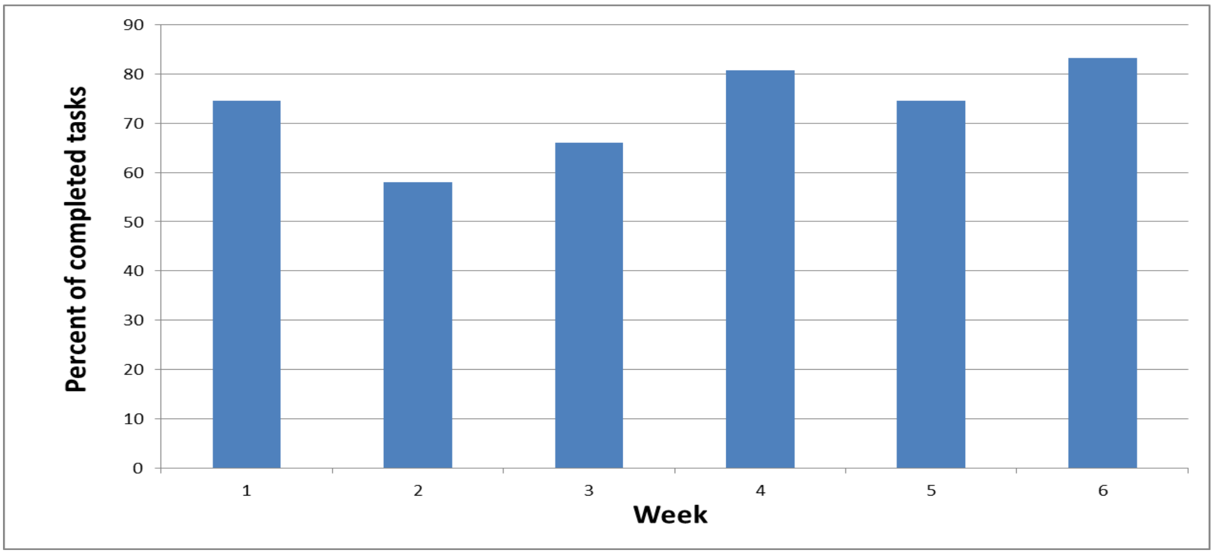

Figure 2. Average percentage of completed task for five participants from week one to six. There is a slight increasing trend towards the end of the measurement period.

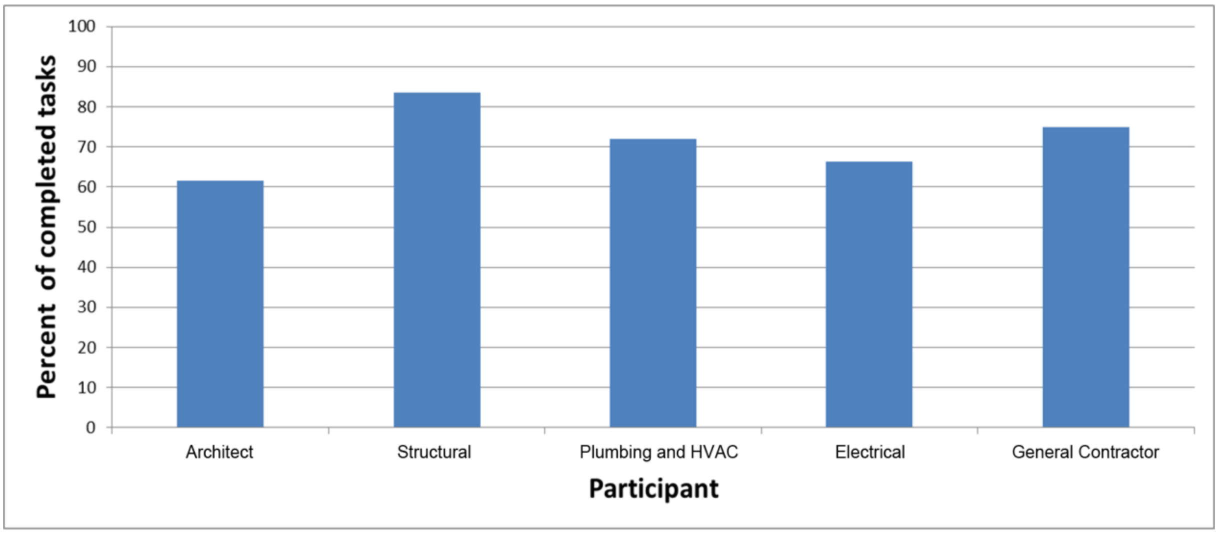

Figure 3. Percentage of completed tasks for each participant during the whole measurement period. Percentages varied from 60 % to 80 %, the architect having the lowest and the structural engineer the highest.

In Figure 4 the numbers of tasks are shown for each participant. There is a slight decrease in the number of tasks for the architect during the measurement period. However, the architect still has the highest number of tasks during the whole period. The other participants have more constant numbers of tasks during the measurement period.

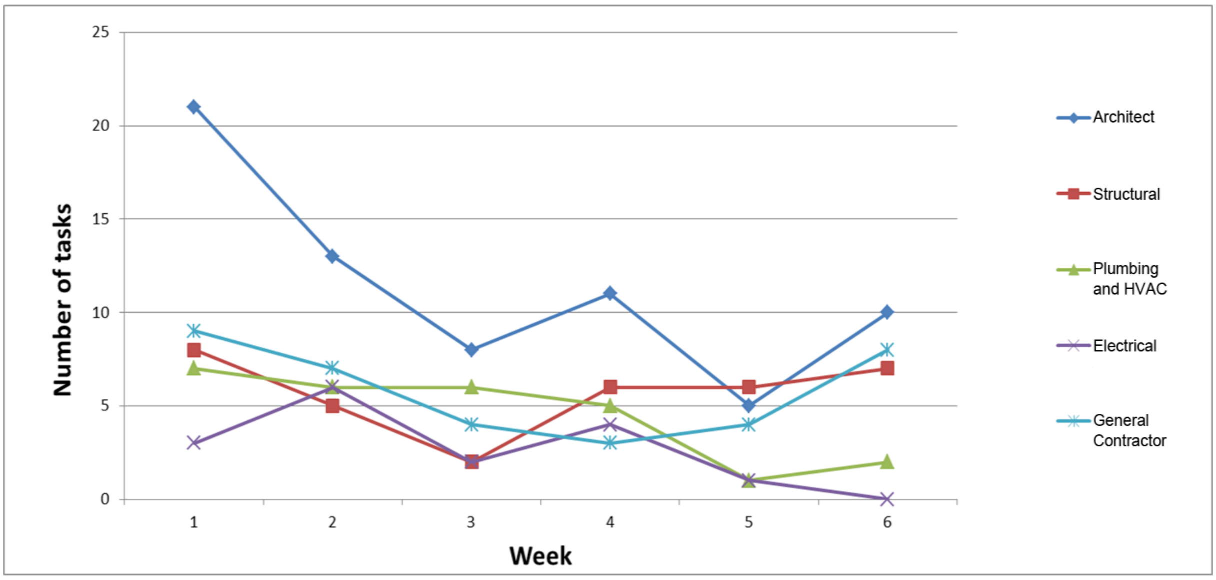

Figure 4. The number of tasks for five participants during the six week measurement period.

The total number of tasks for each participant during the measurement period are shown in Figure 5. The architect had almost 70 tasks and the electrical designer roughly 15.

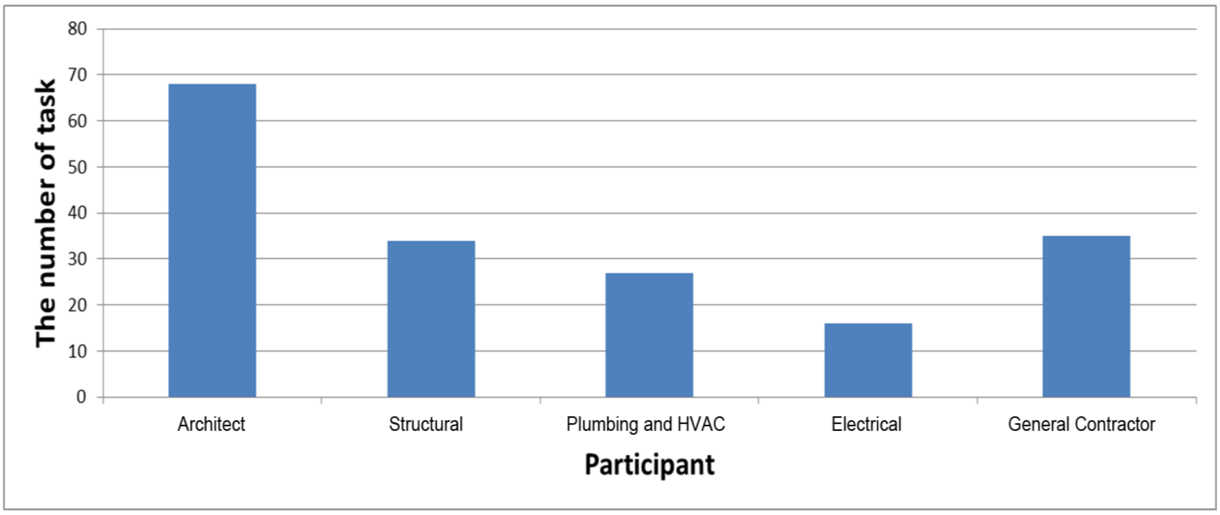

Figure 5. The total number of tasks for each participant during the measurement period.

The reasons for not completing a task are shown in Figure 6. There were six categories in total but unrealistic scheduling or wrong tool/methods were never the reason for non-completion.

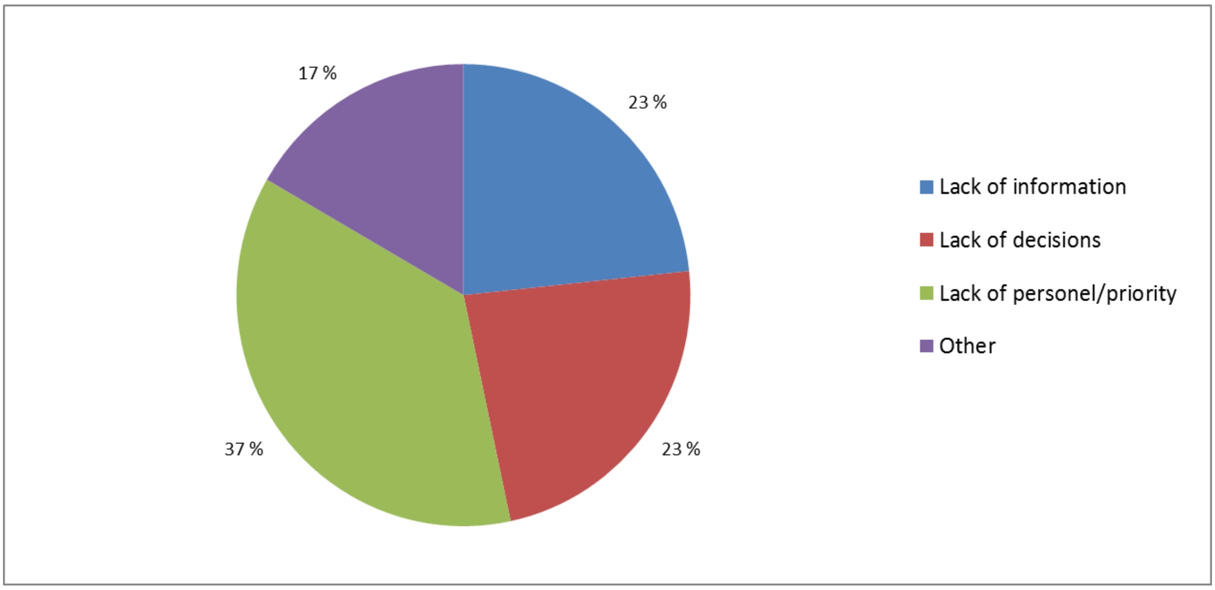

Figure 6. The reasons for not completing the task.

When asking the opinions to claims about the task list, only four participants answered. The averages for opinions are in Figure 7. Despite of motivational effect, participants agreed or strongly agreed to the claims about the task list.

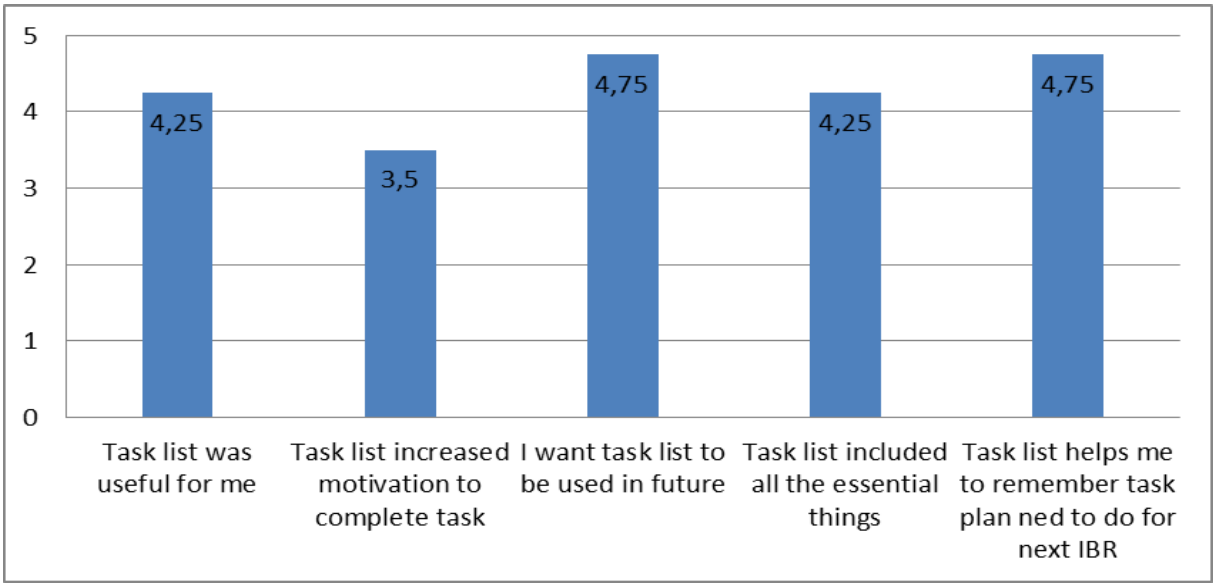

Figure 7. The averages for opinions of five claims about the task list.

End-users, a customer and a geo-engineer were also in the measurement. They are not shown on the PPC data because they had fewer than ten tasks during the measurement period, which would distort PPC. However, they are included in reasons for not completing the tasks because it does not distort the results. The total number of tasks during the measurement period for end-users, the customer and the geo-engineer were 8, 7, and 1, respectively.

Discussion

In total 6 measurements were done in this study. The number of measurement is small compared to what has been done earlier [5, 6]. The collected data is also too small to show what effect the PPC measurement had on the percentage of tasks completed. There is a slight increase in percentage from week one to week six but the data is too small for firm conclusions.

At the time of writing this paper we are unable to see how successful the project will be. We know that the project is on schedule and only few tasks have been late. These are due to mistakes in the master schedule, not because of designers failing to complete their tasks.

BIM was used in this study but its full potential was not used because of lack of resources. BIMCollab would be a good software to use in PPC measurement because with it tasks could be marked directly in the models. Now the location of the tasks had to be written down and the engineer had to find the location in BIM. This additional task is waste of resources that should be removed. Another benefit would be the visual management. By using BIM it would be possible to show the parts that cannot be designed because some critical information is missing. By clicking that part an engineer could see what information is missing. He could also add information to the objects in the model and other participants could see that in their models. The software should generate an automatic list of the needs/demands and the PPC measurement could be done based on this list.

The importance of the different tasks was not valued. Some tasks might be more critical than others. For example, the fire safety consultant and the end-users had only few tasks per week. However, their tasks were critical for the progression of design. PPC does not reveal those differences if measured as in this study. If the root cause analysis had been done, the real problem had maybe been revealed. Other possibility is to weight tasks according to their relative importance.

The number of tasks reveals the importance of participants regarding the progress on schedule. The architect had the most tasks during the whole measurement period. His part is critical in the progress of designing. In fact, some of the reasons for not completing a task by the electrical and the HVAC designers were the lack of information from the architect. The reasons asked in this study do not reveal the participant who should have been providing the information. That might be an interesting factor to reveal in future studies.

As shown in Figure 6, an unrealistic schedule was never the reason for not completing a task. The explanation for that might be that participants did not realize the meaning of it. We believe that scheduling was unrealistic especially for the architect who had the most tasks every week. In the future, the reasons have to be explained more carefully. Wrong tools/methods was never the reason either. This might be explained by the same reason as unrealistic scheduling, but it might also tell us that there are no problems in using BIM.

It seems that the task list was considered to be useful and it should also be used in future projects. Only four participants expressed their opinion about this so more data is needed to confirm the usefulness of the task list. According to the project manager the task list has been a helpful tool to stay on schedule.

Conclusions

The aim of this study was to test how a modified PPC (task list) measurement fits to design management, how to develop and measure PPC for this project, and what are participants' opinions of the modified PPC. The modified PPC is a potential tool for design management. The average PPC in this study (73 %) was in the range found by Fundli & Drevland (81 % and 41 %) [5]. The variation in PPC is large from week to week and between different designers.

This study also shows the number of tasks, not only percentage. This gives more insight to the work load of the participants. Participants considered the task list to be a good tool for design management. That encourages us to also use it in future projects.

More PPC measurement is needed to set a target level, and to indicate how meeting the target level predicts project success. We will continue measuring modified PPC in Fira on future projects. That will hopefully give us more information of the use of PPC, its relation to design management and project success and integration with BIM.

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