

PLANNING IN CONSTRUCTION - HOW ARE THE DIFFERENT PLANNING PROCESSES LINKED?

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There is a current debate among construction researchers that resources and materials are not efficiently coordinated between projects, which in the long-run can negatively affect productivity and profitability. Other industries have improved resource utilisation with a hierarchical perspective on planning and tactical planning, the MPC perspective (Manufacturing Planning and Control). Adopting this way of planning among construction contractors would allow for improved coordination and resource utilisation as an overview of the project portfolio is taken. However, this perspective is new to construction contractors and learnings need to be gathered for understanding MPC in a construction context. The purpose of this paper is by taking a MPC perspective to increase the understanding of how resources and materials can be coordinated within a contractor's project portfolio on a tactical level. The study is based on case studies within two Swedish contractors. The study presents a structure for how to include a tactical planning process within a contractor's overall planning and what the main components are of this process.

Keywords: material planning and control, resource coordination, tactical planning

INTRODUCTION

Already in 2002 did Dubois and Gadde describe the construction industry as decoupled. More recent reports from e.g. McKinsey (2017) confirms that it is still true. The lack of coupling is present both between the construction project and its subcontractors as well as between the project and the parent company and other projects. This hamper the possibility to have a successful coordination of resources on a portfolio level within the contractor, as resources are in many cases utilised from a common resource pool (Engwall and Jerbrant 2003). In multi-project environments, such as construction, it is important to link the planning of the individual projects to project portfolio planning (e.g. Engwall and Jerbrant, 2003). Portfolio management in construction today take place at a strategic level, by the contractor developing marketing business models and decisions of markets and products to develop, cf. Höök *et al.* (2015).

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Meanwhile, the operative planning is up to the single project, where emphasis on developing the production time schedule (Thunberg 2016). The effect is that the ‘parent’ company has little control over the planning of single projects (Dubois and Gadde 2002). Structured planning at a portfolio level linking the strategic portfolio management and operative project planning seems to be missing in construction today. This makes questions, such as: “According to available resources which projects should we tender to maximize profits for the company as a whole?” hard to answer. And there is a risk contractors take on projects requiring resources that are occupied by other projects causing delays, having severe effects on the contractor’s reputation and profitability. Another effect of the lack of planning at portfolio level, also called tactical planning, are lack of information sharing between projects (e.g. Dubois and Gadde, 2002).

There are several trends going on in construction for the moment increasing demands on planning and coordination between projects; i.e. standardization of activities and materials, the boom of construction in e.g. Sweden, and the globalisation of the industry. The need of standardization is driven among others by the use of different logistics solutions such as terminalis and resource pools, which need to be planned on tactical level for serving several projects with materials. The standardization of activities and materials is complicated by the autonomy of each project. The boom of construction creates problems employing personnel for white-collar specialist functions, increasing the importance of improving the utilisation of these. The globalisation leads to longer supply chains creating a need for central purchasing securing supply to several projects at the same time to reduce costs (Frödel 2014). To deal with these trends and improve coordination between projects there is a need to start planning at portfolio level within contractors.

In the manufacturing industry, planning has been a major research area for a long time and an effective manufacturing planning and control system (MPC) is seen as key to the success of any company (Vollmann *et al.*, 2005). MPC is concerned with planning and controlling all aspects of manufacturing and coordination with suppliers and customers (Vollmann *et al.*, 2005). Planning in this paper is seen in accordance with the MPC system as hierarchical, with processes at different planning levels; strategic, tactical, and operative. Tactical planning processes are in manufacturing companies seen as a key process enabling holistic planning by balancing demand and supply, enforcing integration and coordination among company functions, business strategy, and operational planning and in the supply chain (Tuomikangas and Kaipia 2014). As mentioned, the construction industry today is lacking an equivalent process to the tactical planning processes used within manufacturing. Thus, the purpose of this paper is by taking a MPC perspective to increase the understanding of how resources and materials can be coordinated within a contractor’s project portfolio on a tactical level. The work is of a more conceptual nature and focus on the technical and process parts of planning and not the human and organisational (Jonsson *et al.*, 2013). The study is based on two case studies within two Swedish main contractors studying the development of planning at project portfolio level: One taking the resource perspective and one taking the material perspective.

THEORETICAL FRAMEWORK

Manufacturing Planning and Control (MPC)

The MPC system is hierarchical (strategic, tactical and operative level) with both a capacity/resource and materials planning perspective. These needs to be linked to each other, enabling materials and resources to ‘arrive’ at activity at the same time (Jonsson and Mattsson 2009). The planning levels within the MPC system have differing horizon

(the time-span covered), planning object (what to plan), and frequency (how often updated) (Jonsson and Mattsson 2009). The strategic planning has a long-term horizon and sets the boundaries for the mid-term horizon tactical planning, which sets the boundaries for the short-term horizon operative planning. The higher up in the MPC hierarchy, the lower level of detail and the more approximate the information (Jonsson and Mattsson 2009).

The analysis in this paper is structured based on the framework presented by Tavares Thomé *et al.*, (2012) which organises planning processes into the integration of setup and process parameters. The setup parameters deal with the scope and the basic principles of an MPC process. This refers to the *planning frequency*, *planning horizon*, and *planning object* (Jonsson and Mattsson 2009) and the process parameters are the *inputs*, *activities*, and *outcomes* together with *key performance indicators* (KPI) to measure the effectiveness and efficiency of the process (Tavares Thomé *et al.*, 2012). The inputs consist of plans, constraints, business visions and strategies, and goals (Kjellsdotter Ivert *et al.*, 2015).

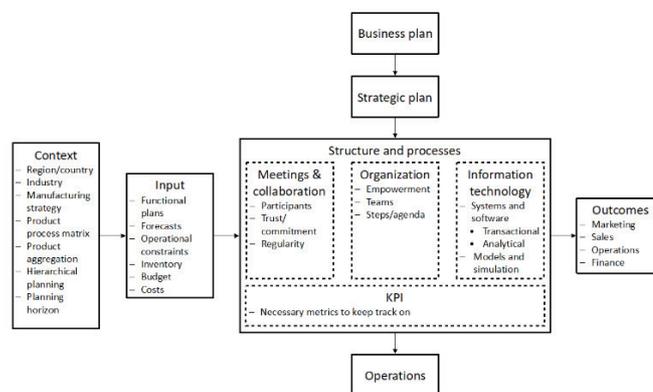


Figure 1: Planning framework (Tavares Thomé *et al.*, 2012).

Sales and operations planning (S&OP) process is commonly seen as a tactical planning process (Tuomikangas and Kaipia 2014). The aim with this process is to establish overall plans for sales, supply, and production (Jonsson and Mattsson 2009), by uniting different business plans into one integrated set of plans (Tavares Thomé *et al.*, 2012, Tuomikangas and Kaipia 2014). The S&OP process can be seen as a powerful tool to reach business targets where the main goal is profit maximization (Tuomikangas and Kaipia 2014).

The planning horizon is usually between 6 and 24 months to include any seasonal effects on demand (Jonsson and Mattsson 2009). Planning frequency is between quarterly to weekly and planning objects are often product groups (Jonsson and Mattsson 2009). The outcome of the tactical capacity planning for a traditional manufacturing firm is from a resource perspective a rough-cut capacity plan and from a material planning perspective a master production schedule (MPS) (Jonsson and Mattsson 2009). To develop the rough-cut capacity plan and the MPS ‘recipes’ of the needed resources and materials to produce a certain product are required. These are usually summarized into so-called Bill-of-Resources (BOR), resource profile, Bill-of-Materials (BOM), and product structure. Furthermore, the planning aims to mitigate for uncertainties in demand, capacity, and supply to maintain a high service level (Kjellsdotter Ivert *et al.*, 2015). Forecasts and other important upcoming changes are therefore important input to the tactical planning. Kjellsdotter Ivert *et al.*, (2015) have however shown that the tactical planning process have to be adapted to the specific context of the industry, such as the supply uncertainty of the food industry.

The structure of S&OP activities has been described by many authors (Grimson and Pyke 2007, Jonsson and Mattsson 2009) and typically consists of the following five activities: 1) Forecast generation: the marketing and sales department or other responsible departments produce a forecast for the coming planning period's demand; 2) Demand planning: the marketing department prepares a preliminary plan for future sales and delivery volumes. The delivery plan is based on the forecast and refers to the volumes that the company wishes to sell and the delivery per period; 3) Supply planning: the production department and those responsible for the procurement of raw materials will prepare a preliminary production plan expressing the volumes that are to be produced for each period during the planning horizon; 4) Pre-S&OP meeting: the managers of the marketing, production, procurement, and logistics departments meet in a reconciliation meeting during which any adjustments to the production and delivery plans are made; 5) S&OP meeting: the top management meets, unresolved issues are raised, and the plans are settled.

Planning in Construction

Planning in construction borrows its content from general project management theory (Winch 2010) and includes portfolio management, programme management, project planning, and scheduling (Wysocki 2012). In a construction context a programme is often translated to a multi-project environment where several projects should be managed and coordinated. Wysocki (2012) gives a business perspective on portfolio management by defining it as all projects managed by the company. The strategic plan and demand forecasts is input to portfolio planning to identify suitable projects to run or tender on. The project portfolio yields a long-term resource plan and input in planning of a certain project. Portfolio planning sets the boundaries for the project planning. It is therefore necessary to have information about available resources and what materials are needed and when. This can however be hard due to the fragmented contractor and supplier basis and temporary organisations (Betts and Ofori 1992).

Project planning in construction can be separated into pre-construction planning and on-site planning (Johansen and Wilson 2006). The first comprises selection of project team, creation of the project documentation system, initiating the purchasing of materials, development of the time schedules and milestones, and other pre-project-execution activities (Menches *et al.*, 2008). The on-site planning comprises ensuring that planned activities can be fulfilled, schedule adherence, material procurement, weekly meetings, etc. (Johansen and Wilson 2006). This is complicated by the several planning phases in the project and different uncertainties related to the project (Johansen and Wilson, 2006). What also can be necessary to consider is the situation of having "unique" project and what the off-site conditions might be (Murphy 2013).

Another important part of planning is to coordinate the work with other project participants, like confirming that all participants share the same view of the project goals (Fellows 2009). Effective planning should ensure that all involved actors know what to do, when to do it, and whether the required resources are available. Fellows (2009) describes that coordination is most often absent in construction projects, which leads to unshared goals between participants and unsuccessful projects. As Zwikael (2009) pointed out, a project plan also includes procurement and material plans that are dependent on the project plan. These need to be developed early in the project (Johansen and Wilson 2006). This is however, complicated by the temporary supply chains (Modig, 2007).

Synthesis and Research Question

From the description of the planning practice in construction today it can be seen that this focus on how to manage projects. Questions such as resource utilisation and material supplies are presented as important, however they are not considered on higher planning level than the project. This shows that there is a lack of both practical and theoretical studies on how material and resources should be coordinated from a tactical point of view in construction. The framework offered by Tavares Thomé *et al.*, (2012) can be used as a starting point in discussing tactical planning within construction. However, as Fernie and Tennant (2013) argues, adopting practices from other industries into construction is non-trivial. There are aspects and characteristics of the construction industry that need to be considered, such as the temporary organisations (Modig 2007) and the project driven processes (Winch 2010). Therefore, the tactical planning processes from the MPC structure needs to be analysed from a construction point of view to make it fit within this context. To answer the purpose, it is thus necessary to examine what tactical planning is within construction as well to recognise what is to be planned. To do this a research question is developed: *What are the main components of a tactical planning process in construction and how should it be structured?*

METHOD

This study is based on two case studies within two different Swedish main contractors. The research is grounded in the basic assumption of contingency theory, where the structure and processes of an organization must fit its context (characteristics of the organizations culture, environment, technology, size or task) if it is to perform well (Drazin and Van De Ven 1985). The case study methodology is a valid choice when the context and experiences are critical to understanding the phenomenon (Barratt *et al.*, 2011). The case companies are contractors participating in a research project about developing IT-tools and processes for tactical planning within construction. This gives the researchers unique insight in each company and how planning is performed. It should be mentioned that this research is of conceptual nature. This is the first part of theory making and means that focus is on gathering understanding and defining important concepts for improving or revising in future studies (Meredith 1993).

Main contractor A (MCA) is a small to mid-sized Swedish construction company. In contrast to many other construction companies in Sweden MCA does not have own craftsmen resources. Instead they procure crafting services for each construction project. This makes MCA a pure coordinating actor in a construction project with all services (except the coordination function) outsourced to subcontractors, in line with the construction management project form (CM). Main contractor B (MCB) is one of the three major construction companies in Sweden. The MCB group's business is divided into four business areas Building, Infrastructure, Property Development and Industry. MCB is organised in departments. A department serves a certain geographical area and plan their own resources. MCB have their own craftsmen.

Data has been collected through semi-structured interviews, company documents and workshops within the research project. Semi-structured interviews in particular can be a suitable method by which to obtain the respondents' perspective on a topic. In total have five group interviews and three phone meetings been conducted with MCA and four group interviews and four phone meetings with MCB. Interviews have been structured according to the framework presented in Figure 1 discussing what the output should be, important input, activates to carry out, responsibilities, and KPIs. However, focusing on the specifics of the problem studied at the company. Persons interviewed have been

people involved in the current planning processes within the companies and a system developer. Each case has been discussed at two workshops within the research project, discussing the drafts of processes. Following the interviews and workshops, comprehensive documentation was developed for each case. As commonly suggested in case study research (Barratt *et al.*, 2011), a first case analysis was done by analysing the description at hand of the data within each of the cases, followed by cross-case analysis to identify commonalities for designing the tactical process in accordance with Tavares Thomé *et al.*, (2012). This resulted first in a process for each company to deal with the local problem focused upon in the research project. The cross case resulted in an understanding on how these two can be combined into a tactical planning process.

Case Descriptions

Main Contractor A (MCA) Materials planning: Within a project, an important part of the resource planning is the quantity survey. This starts during the tendering process with developing a rough time plan and the quantities of materials to be used. The next phase, if the tender is accepted, is to plan for the actual project. The project manager develops a new time plan and together with purchasers procure contractors and materials. The contractors get information about expected delivery period for their work package and the contractors develop their own time plan based on their own quantity survey. As can be understood, the same planning and the same quantity survey is repeated several times, however by different companies and persons. An overall process for coordinating the different plans from the different contractors is lacking today. The result of the many and uncoordinated planning and survey processes is waste of time and increased costs.

MCA has recently introduced a logistics solution, including a distribution terminal, to improve material flows to construction sites. This solution allows for consolidation of materials between projects and subcontractors. It also aids in smoothing out the lumpy demand pattern of materials and provides suppliers with reliable forecasts. It also helps the construction sites to better control the flow of materials and coordinate this with the activities on-site. For example, if one activity needs to be postponed, the scheduled delivery from the terminal can in comparison to a regular supplier-buyer setup be easily postponed. However, also the planning of the terminal and its utilisation can be improved. For the moment, the linkage between the project planning and the planning of the terminal is lacking. Thereby it is not possible for the terminal to develop forecasts for capacity planning purpose and the different projects cannot get information about available capacity in the terminal during the construction period or reserve capacity at the terminal.

The CM role of MCA requires planning processes facilitating coordination, where the planning process within the company are linked. This means that output from one planning process is the input to the next in line. To accomplish this, clarification of responsibilities are required. Despite the focus on coordination the CM implies, MCA is experiencing troubles with the connection of planning processes and a lack of understanding in who is responsible for what. Also, in relation to the terminal MCA is experiencing that material delivery schedules are “living their own life” disconnected from the overall project time schedule of the individual projects. Construction site managers are good in developing their plans and purchasers are good in developing their plans, but the link between them is missing. Also, it is not clear who should be responsible for what, who should develop and update the material delivery schedules, and who should consolidate schedules at the terminal.

Main Contractor B (MCB) Resource/Capacity Planning: MCB is today lacking a system that connects marketing (tendering) and resource planning. MCB would like to have an overview of the project portfolio, both ongoing production and tendering processes as well as coming tendering processes to avoid a situation with both too much resources as well as too little resources. This is especially relevant regarding white collar specialist resources as these are scarce as there is boom in construction in Sweden for the moment. Furthermore, such an overview of upcoming projects would make it easier to prioritize which projects to devote resources to.

MCB make their resource planning in power-project. Power project in MCB includes all production projects as well as the tendering process for upcoming projects, it allows for planning both from a project view and an individual person's view. The planning horizon is 6 weeks to 6 months. MCB also have a project portal presenting all the tasks that have to be made for different projects, such as risk management, tenders etc. This is however not connected to power-project. Projects become known to MCB either via a database or personal contacts. As soon as a project is known it is registered into the customer relationship management (CRM) system. In the CRM system information such as client, planned start of construction, tender date, possible hit rate, and project turnover are registered. The CRM system also covers the tendering process, making it possible to identify in what phase a project is, i.e. before tendering process starts, during tendering process or a production project.

Every week each department has a market meeting. At these meetings are the resource planning managers, the business managers, and the project managers present. Here the projects registered in the CRM system are studied to identify upcoming projects and what projects are in the tendering process. Furthermore, the progress of ongoing production projects is discussed. Based on available resources, identified through Power project are tendering decisions taken or suggested depending on the sum of the tender. For the projects who are in the tendering process are decisions taken if the tender should be submitted or not. In this meeting is also a manual what-if analysis made, historically have Excel been used to some extent as well. A decision to submit a tender can be made based on several reasons except economic. A tender can be submitted depending on if it suits the profile of a certain site manager, available specialist resources and if it is possible to finish the project within the given timeframe. The tendering process usually is between three and six weeks. The time from submitted tender until decision is between one to two months.

ANALYSIS

MCA and MCB have different reasons to start planning with a longer horizon and covering several projects. What is in common is that the need is a result of scarce or limited resources that have to be shared between projects. MCA identified their need to coordinate between projects during their work on improving the planning of material deliveries with the help of the new distribution terminal. To make the terminal capacity planning possible it is necessary with a tactical planning process covering all ongoing and upcoming projects that are to use the terminal. For MCB on the other hand, the need was identified because of the scarce availability of white collar specialist resources.

To allow for the resource sharing, the projects have to start sharing plans with each other. The sharing should not take place between each project, instead it should be on an overarching company or department level within the contractor. Figure 2 illustrates the connection between project and tactical planning. From the MCA case, sharing plans would also allow for decreasing the amount of quantity surveys as an overview of the

activities within each project would be created. Thus it can be seen that the tactical planning within construction need to link the resources and materials demands from different projects and the structure for how this can be accomplished is presented in Figure 2. Case MCB shows that it is important to include also the tendering process of each project in the project portfolio planning as this process consumes resources and the amount and types of resources consumed varies with the type of project and the contract form. It was seen in MCB case that each construction project can from a white-collar specialist planning perspective be seen to have three phases; before the tendering process starts, the tendering process and the production process. Figure 2 also illustrates that in all phases of the project the supply chain have to be considered. Decisions during tendering affect materials, suppliers, and subcontractors as well as during production, utilisation can be improved and collisions avoided by considering the supply chain on a portfolio level. Especially as suppliers and sub-contractors are shared between projects, which have been seen in MCA.

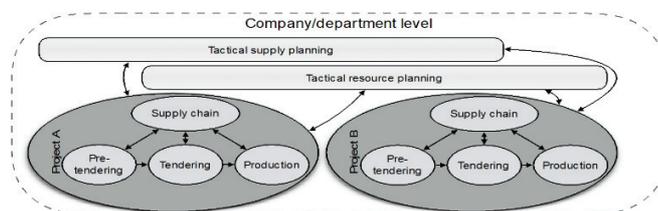


Figure 2: Illustrating planning on project level and connection to tactical planning

Following the structure of Tavares Thomé *et al.*, (2012) the main components of tactical planning: planning frequency, planning horizon, planning object, input, activities, outcomes, and KPIs' are here analysed.

Planning object: As resource and material demands are generated based on projects in the construction industry the planning object should be projects.

Planning horizon: As the planning object is projects and the need identified in MCB of seeing projects as divided into three phases; pre-tendering, tendering process and production process, should the planning horizon include at least the time frame of the tendering process and the production process. The longest horizon should cover all ongoing production projects, which in many cases are two to three years ahead.

According to MCB, the tendering process is usually between three and six weeks. Thus, to have a shortest horizon of about one month should cover ongoing tendering processes as well as upcoming tenders, i.e. projects in the pre-tendering phase.

Planning frequency: The tactical planning has to be a repetitive ongoing process in order to capture the progress of on-going production projects, be updated on accepted tenders and to handle new upcoming tenders. Both MCA and MCB have weekly meetings today and utilising these existing meetings should be suitable.

Input: The input needed and the input available differs depending on what phase the projects are in. A lot of the plans used in a project are created during the tendering process, thus production projects can share more information than tendering projects. Production projects have to deliver input in form of plans such as project time schedules, project material delivery schedules, and project resource plans. For projects in the pre-tendering and the tendering process it was in MCB identified that the time frame of the project, the turnover of the project, type of project, and contract type decides the resource needs within the project on an overarching level. In both MCA and MCB it was also seen that to start developing IT-tools, recipes of different roles in the projects and their

resource need in the different phases of a project had to be identified as well. In MCA, the quantity survey made during the tendering process was seen as a possible input to get an overview of the materials demand and supply.

Outcome: The outcome of the tactical planning process is for MCB a plan of what projects to tender on as well as a rough-cut capacity plan for the resources. For MCA the outcome is a rough cut capacity plan for the terminal as well as long-term materials delivery schedule for the different projects utilizing the terminal.

Organisation and structure: It can be seen from the above analysis that the materials and the resource planning not necessarily should be handled within the same process. This as the materials planning is connected to the purchasing function whereas the resource planning is connected to the market function. What functions/roles that should be included in the process therefore depends on the organisation of the individual company. KPIs: KPIs' should mirror the goal of the process. For MCB is the goal to improve profit margin of production projects and hit rate in the tendering process, whereas for MCB the goal is to improve utilisation of the terminal and decrease the costs for materials handling and purchasing.

CONCLUSIONS

The purpose of this paper is by taking a MPC perspective to increase the understanding of how resources and materials can be coordinated within a contractor's project portfolio on a tactical level. The paper identifies a need for a tactical planning process taking both a materials and resource perspective at a portfolio level within main contractors as such a process would improve resource utilisation as well as what projects to focus on. The paper presents a structure for how the tactical planning process can be related to existing planning processes within main contractors in Sweden today (Figure 2). It also presents what the main components of such a process should be in relation to the MPC structure. The paper is based on two case studies of tactical planning processes under development. Therefore, further studies are needed to verify the suggested structure as well as studies of implemented processes.

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