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Introduction Of A Concept For Planning And Controlling Multi-Project Environments In Factories

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Abstract

Today more than ever, companies are forced to regularly initiate projects in their factories in order to ensure competitiveness through constant adaptation and change. Such projects are controlled and managed individually. Implementing many projects frequently leads to situations however, in which different projects overlap regarding their planning and control. Deviation in the projects' duration and scope further intensifies this effect. To manage environments consisting of projects with different scopes and timelines, companies make use of models for multi-project management (MPM). Due to their aim for general validity, existing models for MPM generally lack a specific focus on the targets and tasks of the factory environment. A new process model is therefore needed to effectively and efficiently plan and control a multi-project environment in the factory. Therefore, the project context and the interdependencies of the model's tasks shall also be taken into account. In order to build a process model for multi-project management, according to the requirements of the factory, insights from MPM as well as the production environment are needed. In this article an overview of the approach is given and first findings are presented. Based on analogies between models of MPM and production planning and control (PPC), an exemplary excerpt of a combined know-how catalogue is shown, laying the foundation for the further development of a holistic process model.

Keywords

Factory planning; project portfolio management; process model

1. Introduction

Producing companies are subject to constant change, which in times of globalisation is progressing even faster. This development can be seen in the increasingly shorter product life cycles [1–3]. Hence, the market environment is characterised by an intensification in competition and correspondingly higher requirements. Products must be developed, manufactured and marketed by companies in a shorter time [4]. Manufacturers are reacting to this trend by intensifying their project activities [5–7]. The manufacturing sector accounted for 26.1 % of the national gross value added in 2013 [8]. According to a survey conducted in the same year, the share of project work in total working hours was 41.9 % in the manufacturing sector, about nine percentage points higher than the other respondents. An increasing project orientation results in a highly complex and dynamic project landscape in production. Project management at individual project level alone cannot adequately assure the application of such a production environment. What is needed to deal with the entirety of such a multi-project environment is a complementary multi-project management (MPM) approach that makes it possible to design and steer the project landscape systematically and in line with the overall strategy [9].

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On a higher level, a project programme (in the following also referred to as programme) can represent a section of similar projects, which are dependent on each other or benefit from a symbiotic relationship, or their entirety [10]. A suitable programme organisation serves the purpose of achieving a superordinate objective as effectively and efficiently as possible [11,10]. The summary of all planned, approved and ongoing projects and programmes of an organisation or division form a project portfolio, responsible for the permanent overall planning and control [12]. Portfolios are cyclically monitored and controlled by the portfolio management which is responsible for deciding on the acceptance and prioritisation of project applications [13]. Figure 1 shows the different terms in their relation.

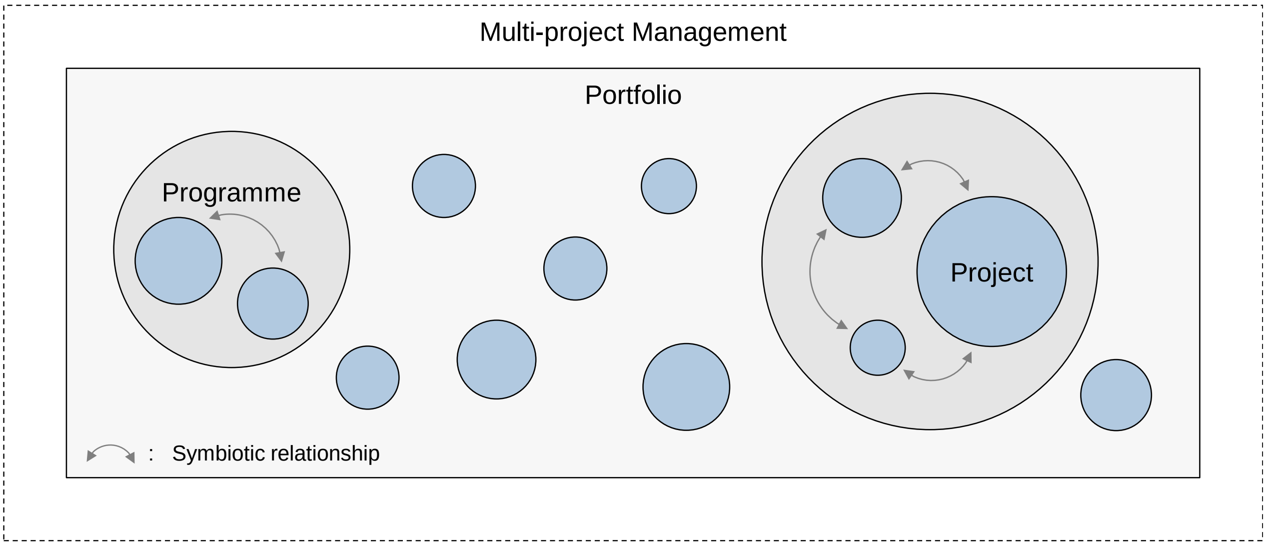

Figure 1: Composition of a multi-project environment [13]

While it is possible for programmes to consist of several projects, other projects of a portfolio may stand alone. In contrast to projects and programmes, neither the project portfolio nor its management are limited in time [13].

2. Need for Research

MPM approaches are provided, for example, by SEIDL or DIN 69909-2 [14,13]. The process of managing projects can typically be divided into the phases like 'Initialisation', 'Definition', 'Planning', 'Control' and 'Closure' [15]. SEIDL chooses a similar approach, dividing his generally valid process model in five comparable phases [13]. The tasks of the process model are clearly assigned to these five phases and are semantically linked to each other via arrows indicating the sequence flow. The horizontal division of such models often show the responsibilities for different tasks. These hierarchical levels furthermore indicate the frequency in which individual tasks are to be processed. The tasks of the model by SEIDL include all tasks taking place at individual project level, such as *project preparation* or *approval of project results*, as well as operational and strategic tasks at programme and portfolio level, such as *managing the project portfolio*. The tasks at individual project level follow the life cycle of the projects, thus varying in duration depending on project type, industry, environment or project-specific factors. These factors accordingly also determine the cycles in which the tasks at programme and portfolio level are to be processed. [13]

While multi-project environments in general can be described and managed through models like the above mentioned, there is no consideration of the special requirements and targets demanded by production environments and their factories. Some of the multi-project management approaches explicitly address the specifics of factory and production environments, but only do so with a focus on individual project types or project management tasks such as production projects or resource management [9,16,17]. Existing approaches fall short of supporting decision making in the event of a conflict of objectives. Overall, there is no consistent process model that can be used by managers in the factory to operate a complete and powerful multi-project planning and control system.

The factory and production environment are subject to the models of production planning and control (PPC). With the Hanoverian supply chain model (HaLiMo) SCHMIDT provides an approach that classifies the tasks of the PPC in an overall context and merges them in a generic framework model [18]. In addition, the interrelationships between the tasks and target values in the PPC are considered. The Hanoverian supply chain model represents a holistic approach to PPC. The model includes detailed descriptions of the main tasks of the company's internal supply chain and their effects and interdependencies with each other as well as with regard to logistical targets. This target orientation is based on the production control according to LÖDDING [19]. The HaLiMo enables the anticipation of decision sequences with regard to the logistical target values [18]. The model offers great value for planning and controlling production environments. However, regarding the content it cannot replace a model for planning and controlling multi-project environments.

3. Approach and current Findings

3.1 Approach

General MPM approaches show difficulties in evaluating and controlling multi-project environments in terms of target fulfilment. PPC models on the other hand offer this possibility, however are not designed to plan and steer environments consisting of projects rather than products. By combining findings from the PPC and MPM topics, a concept of multi-project planning and control (MPPC) with a focus on factories can be developed, offering a broad view of relevant tasks and connecting them via interdependencies. Using the methodology known from PPC models, tasks can thus be linked to targets of the multi-project environment. To ensure that the difficulties of managing multi-project environments in factories can be met, a process map, merging the contents of the subject areas factory and factory planning, (multi-)project management, production planning and control and process modelling, is needed. Figure 2 shows the approach of building the MPPC model broken down in four steps which are further described in the following.

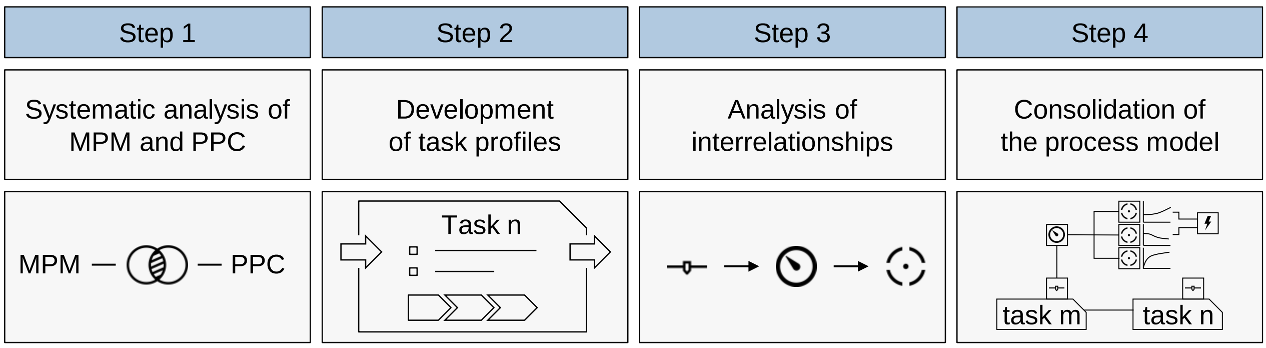

Figure 2: Approach for the development of the MPPC model

In a first step MPM and PPC are brought together in an un-reduced knowledge base for MPPC. The existing preliminary work in the field of multi-project management (MPM) and production planning and control (PPC) are used for comparison in order to systematically record any gaps, different focuses, levels of abstraction and degrees of detail. To justify merging the different concepts, similarities of MPM and PPC are to be pointed out by examining the analogy between the models corresponding objectives. The consolidation of the different approaches into a comprehensive knowledge base of MPPC in the factory is then to be worked out and structured to be described later on.

Using tasks from MPM and PPC as a base, generally valid tasks which are necessary for multi-project planning and control in factories are to be derived and described. The focus lies on working out the contents of the tasks and their processing sequences as well as in- and outgoing information. As an intermediate result, the task profiles, consisting of aim, process and input and output information, are available within the descriptive model of the tasks as part of the multi-project planning and control framework in factories. This step has already been carried out for some of the tasks and is described carefully in the following chapter of this paper. Preliminary work regarding the overall approach has been carried out by NIELSEN, setting a base for further investigation [20]. As of now, the steps described next are yet to be elaborated within the research project.

The task profiles serve as a starting point for the investigation of the interrelationships between the tasks themselves as well as their influence on the factory goals which are affected by the performance of the portfolio, its’ programmes and each project [21,22]. According to the PPC example, actuating variables are determined for the tasks relevant for achieving the desired changes in the project landscape. From there on control variables are identified, which are needed to monitor the effects on the project landscape by the decisions made. Target variables on the other hand are influenced by the control variables and can therefore only be managed indirectly via the actuating variables. Control variables represent the difference between two or more actuating variables. The results shall be documented in a catalogue of actuating and controlled variables. Subsequently, the actuating variables are assigned to those task profiles where an influence is feasible. The qualitative interactions of the variables among themselves and between the different forms of the variables are to be analysed analytically and deductively. For this purpose, binary design structure matrices (DSM) as well as binary domain mapping matrices (DMM) or a causal diagram shall be used. An example for this kind of relationship can be seen in a potential control variable backlog which would result from a difference between the planned end and the actual end of a project. In addition, the causal relationships between control and target variables are to be visualised by means of qualitative curve progressions, as they are already used for many different causes in logistics models [23].

As a next step a processing sequence is to be derived from the profiles by analysing the priority relationships, according to which the tasks can be practically processed and, if necessary, parallelised. For this purpose, the totality of the already identified incoming and outgoing information per task is to be used. The visualisation of the tasks shall then be combined with the identified interrelationships between actuating, control and target variables. To complete the process model, a categorisation is introduced concerning the tasks of multi-project planning and control. For this purpose a distinction is made between 'permanent' and 'temporary' and the classification into the categories 'planning' or 'control'. The process model will be completed by an allocation of tasks to generally valid project types, with a focus on project size and duration and the project management phases according to DIN 69901-2 are introduced, setting a frame for the model [15]. This process model is finally to be evaluated in practical application in the factory.

3.2 Current Findings

In order to merge the concepts of MPM and PPC and combine their advantages for a holistic MPPC model, legitimacy that approach is needed. This is reached by proving an analogy between the objects of consideration in the respective models, being project and product. The assumption of an overall analogy is confirmed by comparing the contents of the tasks needed for manufacturing a product or carrying out a project. Elaborating analogies in the resources used, occurring costs and time-related characteristics shall further validate this assumption.

The manufacturing of products, as well as the realisation of projects, requires fulfilling essential tasks. Among other activities, a basic definition, the overall planning as well as controlling are addressed by specific tasks in manufacturing and project management respectively. For a project as well as for a production order in a first step, an idea must be specified and an initial basic definition must be made. In both cases the feasibility of the proposal must then be checked. Deviations between the planned and the actual situation must also be constantly monitored respectively in order to control the fulfilment of tasks necessary for reaching an overall aim, implementing measures and controlling their effectiveness. Both projects and production orders are planned on a rolling basis by a supervisory management. In each case this includes selection, scheduling and rough scheduling of the contents. An analogy can thus be seen regarding the comparison of the tasks [18,24,13].

Besides looking at the corresponding tasks as equivalents, there remains another point of view taking into account the proposal's conflicting objects, being scope, cost and time. Products as well as projects make use of the same kind of resources including operating and auxiliary materials, energy used in the process, operating facilities, as well as personnel and materials [25,4]. These equal needs lead to similar costing structures being based on the resources. Some of the more common cost types for both projects and products include personnel, material and capital costs [26–28]. Furthermore, both processes, carrying out projects and manufacturing products usually include setting deadlines and tracking the progress with milestones setting a similar frame for time related attributes [4,18]. The above mentioned characteristics show a similar need to take a stand between the parameters of scope, cost and time, which are conflicting objectives. In project management, this is often referred to as the triple constraint or iron triangle [29]. These findings legitimise comparing tasks from MPM and PPC thus merging them in terms of their contents and additionally allowing for the inclusion of other model components from HaLiMo into an MPPC model.

Based on the proven analogy of project and product a comparison of the corresponding models is to be executed. In the following an example for the systematic analysis of differences regarding the level of detail and possible deficits or inconsistencies is presented. This analysis is based on the summarised descriptions, according to literature. Figure 3 shows the general setup. For each task in the models of SEIDL and SCHMIDT a description was made and the tasks were compared if possible [18,13]. MPPC tasks could either be derived from a comparison of similar tasks or based on specific tasks of the models which did not have a corresponding counterpart task. The table below shows how MPM as well as PPC both provide a task for deciding on outsourcing certain activities partially or completely, generally known as a make-or-buy decision.

Topic of task: Place project or implement as own	
SEIDL [13]	Commission project, place project if necessary This is where the operational implementation of the decisions takes place. The confirmed order will be included in the planning and the concerned authorities will be informed about the approval and possible conditions. At the same time, a decision will be made whether the contract will be awarded externally, if necessary. In case of rejections, the same procedure is followed [13]. Procedure: Keeping the minutes of the meeting
SCHMIDT [18]	Plan Secondary Requirements - Allocate to Procurementy Types In this step, a decision is made as to whether the calculated requirements are to be covered by in-house or external production. This decision differs according to the type of company, e.g. whether it is a make-to-stock or contract manufacturer [30] and depends on the flexibility of the suppliers, consequential error costs and capital commitment costs. The result is an allocation of finished products, semi-finished products and raw materials to one of the two procurement types. This results in a proposal for an internal and external procurement programme [18]. Procedure: Make-or-Buy Decision Process, Competitive Advantage vs. Strategy Vulnerability
Discussion	The decision regarding the internal or external awarding of contracts takes place in HaLiMo under the item 'Procurement type allocation'. Here a decision is made as to whether in-house or external production is to be carried out. It is clearly shown that the procurement type assignment results in an internal and external procurement programme. Both alternatives with the corresponding tasks are reflected in the model representations. The SEIDL model does not show this differentiation. It is only explained in the text in a generally valid manner. Furthermore, SEIDL's explanations and the model do not show which exact contents are outsourced and which reasons are decisive for outsourcing. The decision on outsourcing should be made according to the example of HaLiMo and the following steps in the outsourcing process should be described. For this purpose the information in the literature according to SEIDL should be adapted and visualised to the needs of project assignments in the factory. [18,13]
Resulting needs	- The task for deciding about subcontracting is carried out in more detail at SCHMIDT than at SEIDL - Compared to the multi project management model by SEIDL [13], a more detailed allocation of procurement types is required - 'Allocate to Procurementy Types' according to SCHMIDT [18] therefore serves as a reference - The base with a PPC focus is further to be adapted for the needs and topics of the MPPC model

Figure 3: Exemple of the systematic analysis illustrated for a task about the make-or-buy decision

In this case the PPC model by SCHMIDT serves as the example for the task of the MPPC model because of a higher level of detail compared to the SEIDL task [18,13]. For the MPPC model this base is to be specified for the requirements of handling projects instead of production according to the resulting needs. Using the above shown way of comparing the tasks, more than 50 tasks are identified as possibly relevant for the process model of MPPC at the current point of research.

From the systematic comparison shown in Figure 3, initial information can be derived for the task profiles which are to be set up. In accordance to the previous example, the profile for the task in which make-or-buy decisions are made is shown in Figure 4 containing the information that has already been gathered at the current state of project research. At this point in time the profiles include information about the tasks themselves, describing their objective, meaning and how to fulfil them, as well as in- and out-going information. Later on in the following steps of the research project there is more information to be added to the profiles as research generates more findings (see Figure 2).

Define make-or-buy shares	*Abbreviation*
Task objective:	
At this point, strategically important decisions regarding outsourcing are made.	
Higher-level process:	Project management phase:
tbd	*tbd*
Upstream task(s):	Downstream task(s):
tbd	*tbd*
Task description:	
It must be decided which projects, programmes or contents are to be implemented in-house or outsourced. This division of a portfolio is similar to the make-or-buy decision in PPC. Data on past projects and programmes from knowledge management support the decision-making process which is influenced by many factors. For example, the availability of human and material resources is as important as the underlying corporate strategy. A lack of expert knowledge or a focus on one's own core competencies can favour outsourcing additionally. The general competitive strategy also has a decisive influence on the choice. Ultimately, external factors also affect the decision for or against in-house project work. Even if the content of a project or programme is completely outsourced, a coordinating role usually remains within the company. [13,31-33]	
Responsibility:	Involvement:
tbd	*tbd*
Input:	Output:
Data from knowledge management	-
Influence on actuating variable(s):	
tbd	

Figure 4: Exemplary task profile for a task about a make-or-buy decision

As the task profile in Figure 4 shows, the description is based on the task provided by SEIDL and extended by information from different sources [13]. This is due to the fact that the prior comparison had shown that in the case of this particular task the description by SEIDL lacked depth compared to the corresponding task by SCHMIDT [18,13]. On top of the description, the profile provides the task's objective, and in- and outgoing information from other areas of the model declared as input and output. Task profiles are to be created for every (possibly) relevant task of the MPPC model. In the further course of the research project all of them are to be specified further by adding newly gathered information regarding a higher-level process, responsibilities, influence on actuating variables and more.

4. Conclusion

In this paper it could be shown that an analogy between MPM and PPC can legitimately be drawn and the corresponding process models therefore be merged. After giving insight into the analysis and comparison of corresponding or similar tasks along the respective models, an exemplary task profile was presented, which provides the base for further findings and gives insight to information which is to be gathered in future steps. After adding profiles for all relevant tasks, the next step in building the process model consists of investigating interrelationships of the model in terms of target fulfilment.

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Biography

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