SUPPORTING CYCLE MANAGEMENT BY STRUCTURAL ANALYSIS OF THE ORGANISATIONAL DOMAIN IN MULTI-PROJECT ENVIRONMENT

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ABSTRACT

Today many companies involved in product development usually run several development projects simultaneously. This multi-project environment increases the complexity that the management has to deal with, especially in managing the high amount of iterations (cycles) that are inherent in product development projects. In many cases, the management does not have an overview of how and to what extent different departments are involved in these cycles.

This paper introduces a Multiple-Domain Matrix (MDM) based methodology for obtaining a snap-shot overview of the level of involvement and interaction between different functional departments. The result of this methodology is an organisational map of development departments (organisational portfolio) that provides information to the management on how particular functional departments are involved in the development processes as well as the level of interaction with other departments and suppliers in the multi-project environment. Based on this information, managers can reach decisions on how to improve the information flow between these departments, which consequently supports cycle convergence and reduces cost and time to market.

Keywords: Multi-project, Product Development, Multiple-Domain Matrix, Structural Analysis

1 INTRODUCTION

Product Development (PD) processes differ considerably from manufacturing processes, primarily in the objects that flow between tasks. Namely, in manufacturing processes there is physical material flowing, whereas in product development mainly information in various formats is sent and received between tasks. Information flow is however much more difficult to manage. It is not clear even to date, how to identify tasks of the process where the value is added and where not [1]. Many information quality issues may arise between tasks (interfaces), when the information is sent/received from one task to the other. Moreover, the PD process flow is comprised of a large number of branches, iterations and rework (both referred as cycles in this paper), which further complicates the management and improvement efforts.

Several authors acknowledged the impact of iterations as one of the main causes of extended PD cycle time. Osborne [2] conducted a research to evaluate how iterations affect total lead time in nine semiconductor projects. He found that expected iterations accounted for 30% to 87% of total development time, while unexpected iterations accounted for 13% to 70%. He also stressed that iterations are the main cause of PD cycle time variability.

Ford and Sterman [3] describe an effect called “the 90% syndrome” apparently caused by iterations. They explain that PD projects usually reach about 90% completion rate according to the original project schedule but then they stall, finally finishing after about twice the original project duration has elapsed. According to Ford and Sterman, the inter-phase iterations in the latter half of the project are the main causes of the late discovery of unanticipated rework.

Browning [4] suggests two steps for reducing PD cycle time and variation. The first step is to minimize the unintentional iteration by ensuring that the right information is available at the right place at the right time; appropriate activity sequencing given the relevant constraints; resources are available; requirements are stable and mistakes are minimized.

The second step according to Browning involves managing the intentional iterations in such a way that we achieve:

- Faster iterations, and
- Fewer iterations

Faster iterations are realized by improving communication between teams. This on the other hand is achieved by increasing the frequency and speed of information transfer [5], utilization of appropriate software to speed up or automate specific tasks, usage of simulation and analysis tools to reduce test cycles, standardization of analyzing tools between different engineering departments and removal of extraneous activities from the processes [4].

However, in multi-project environments the issue of cycles is more complicated. These environments are characterised by a multitude of relations and dependencies that exist among projects, comprising tasks, people, knowledge, technologies, products, and components [6]. The functional departments of the company are involved in several projects and hence are exposed to multi-fold iterations. Improving the communication flow between functional departments by considering a single PD project can lead to deterioration of the communication on a portfolio of projects (local optimisation effect). Therefore, the upper management needs to have an overview on how the functional departments are interacting between themselves and what is the extent of these interactions. Only after having this information, should they bring decisions on how to best support the communication flow and thus make iterations converge faster.

The following methodology aims to support these decisions by not only assessing the involvement of each functional department in the PD projects, but also by evaluating the involvement of each department in teams. This information combined helps managers to reach better decisions on how to organize human resources of their companies in multi-project environments with the aim of improving the communication flow in the entire project portfolio.

2 THE APPROACH

Clustered organizational DSM can be used for the purpose of identifying the meta-teams and thus the management can make decisions on how to best support the exchange of information between teams in any single PD project [7]. Even in multi-project environments, companies can derive the organizational DSMs for each project, cluster each of them and obtain the meta-teams. However, the management will not know in those cases how the teams are distributed and what extent each team is involved in these projects. Moreover, they will not have sufficient information on how to best distribute human resources in such an environment. The following methodology aims to support these decisions by assessing the involvement of each functional department in the PD projects and by evaluating the involvement of each department in teams. It comprises 4 steps as seen in figure 1.

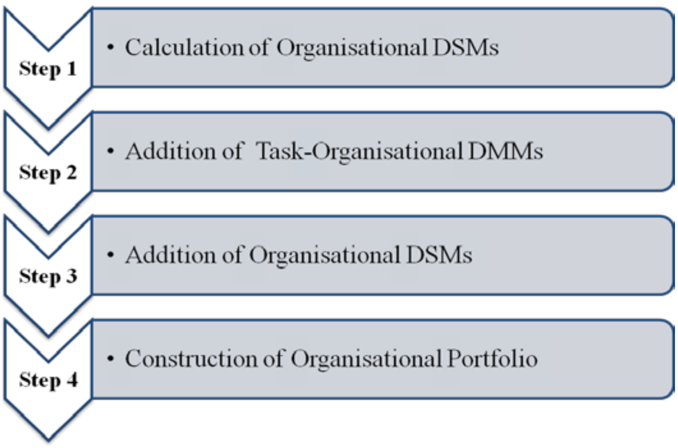

Figure 1. Proposed methodology

2.1 Calculation of the Organizational DSM

The objective of this step is to calculate each Organizational DSM for each ongoing PD project in the company to be analyzed. These DSMs represent the relationship between different functional departments involved in each project.

To conduct this task two matrices from each PD project in the company are required:

- Work packages DSMs – these DSMs are the process models of each PD project. The elements of these matrices are the tasks to be performed, and the relationships show the relations between these tasks.
- Work packages-Organizational DMMs (Domain Mapping Matrices) - these matrices connect the process domain with the functional departments. They depict which functional departments of the company are responsible for which process tasks. Therefore, one Work packages-Organizational DMM of each ongoing project is required.

Once these matrices have been acquired, the calculation of the Organizational DSM for each PD project in the company can be performed.

The calculation of the different Organizational DSMs is performed by deduction of dependencies between the Work packages DSMs and the Work packages-Organizational DMMs of each project [8].

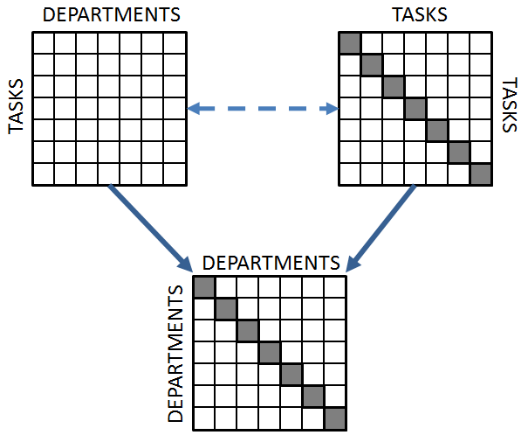

Figure 2. Deduction of dependencies using one DMM and one DSM – adapted from [9]

Nowadays there is a number of research and commercial software tools available to model and analyze DSMs and other matrix-based models, which are useful to calculate the new matrix. The authors of this paper use Loomeo by Teseon GmbH for this purpose.

As final output of this step, *n* number of Organizational DSMs for *n* number of ongoing projects is obtained.

2.2 Summation of Work packages-Organizational DMMs

The objective of this step is to calculate the total number of tasks that each functional department has to perform during the execution of the different PD projects in the company. The inputs for this step are the *n* Work packages-Organizational DMMs.

Two sub-steps are proposed below to conduct this task. Also, an example of the procedure is given to clarify the step.

1. In the first sub-step, the number of tasks executed by each functional department in each of the ongoing projects is calculated. For this purpose, the dependency marks contained in each DMM are going to be added up column by column. By doing so, the number of tasks assigned to each department in individual projects is revealed.

This step is represented in the example below, where 3 different DMMs from fictive PD projects are shown. For each project there is one Work packages-Organizational DMM. In this first sub-step, the dependency marks contained in each column in Work packages-Organizational DMM have been added up, in such a way that the result shown under the matrices reveals the number of tasks executed by each department for single projects.

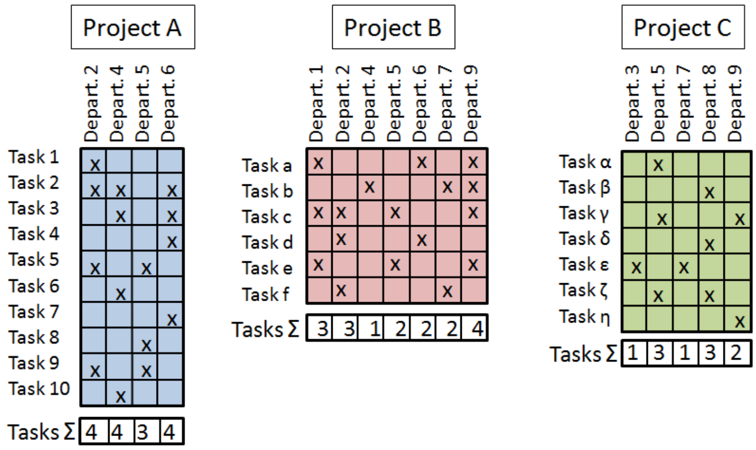

Figure 4. Sample DMMs and the summation of the number of tasks per project

2. In the second sub-step, different results obtained in the first sub-step corresponding to the various ongoing projects are added up in order to calculate the total number of tasks that each functional department executes in all PD projects portfolio. In a similar manner as it has been done in the previous sub-step, the summation is performed column by column as shown in figure 5.

	Depart. 1	Depart. 2	Depart. 3	Depart. 4	Depart. 5	Depart. 6	Depart. 7	Depart. 8	Depart. 9
Project A	-	4	-	4	3	4	-	-	-
Project B	3	3	-	1	2	2	2	-	4
Project C	-	-	1	-	3	-	1	3	2
Σ tasks	3	7	1	5	8	6	3	3	6

Figure 5. Number of tasks for each department for the entire project portfolio

This step can be mathematically represented with the following formula:

$$N_i = \sum_{j=1}^{j=m} n_{i,j} \qquad (1)$$

N_i = number of total tasks per department i
m = number of all the ongoing projects
i = index for departments
$n_{i,j}$ = number of tasks for department i in project j

The final output of this step will be the number of tasks performed by each functional department during the execution of the various PD projects. This result will be used in step 4 for further calculations.

2.3 Summation of the Organizational DSMs

The objective of this step is to determine the total number of interactions that take place among the functional departments during the execution of the PD projects. The inputs for conducting this step are all the Organizational DSMs of the different ongoing PD projects that were calculated in step 1.
In a similar way as it has been done in the previous step, the summation procedure will be divided into two sub-steps, which will be accompanied by a related example.

1. In the first sub-step, the number of functional departments involved with other departments during the execution of each project is calculated. For this purpose, the dependency marks contained in each DSM are added up column by column, so that the number of interactions for each department is revealed (figure 6).

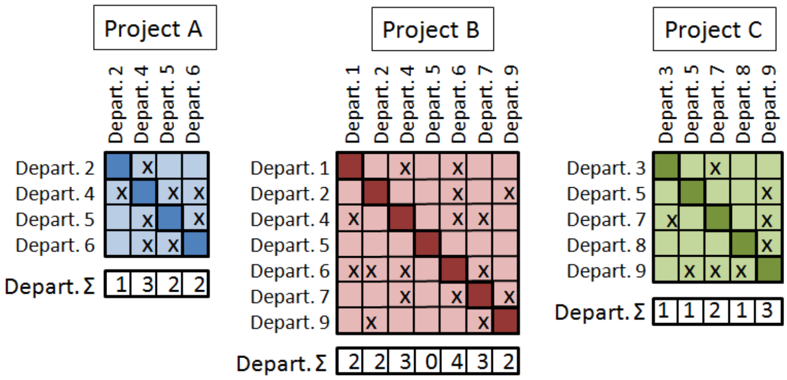

Figure 6. Sample Organisational DSMs and the summation of number of interaction per project

2. In this sub-step, the summation of the results obtained in the first sub-step corresponding to the various ongoing projects is conducted. The result obtained will reveal the total number of interactions for each functional department in all PD projects. In a similar manner as in the previous sub-step, the summation is performed column by column (figure 7).

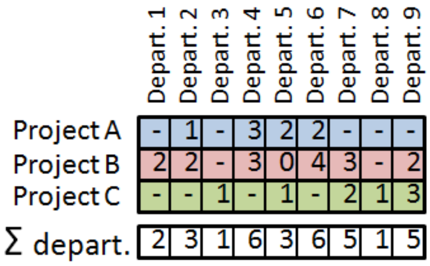

Figure 7. Number of interactions for each department for the entire project portfolio

The final output of this step is the number of teams each department collaborates/interacts with during the performance of all the assigned PD projects of the company.

2.4 Construction of Organisational Portfolio

In this step it is proposed to define a new metric called "Level of interaction" for each department of the organization. The level of interaction is the percentage assigned to each functional department that shows amount of tasks that need interactions with other departments in the entire PD project portfolio. In other words, the level of interaction reveals how independent different departments are in executing their PD tasks. This metrics is defined by the following formula:

$$I_i = \frac{\sum_{j=1}^{j=m} d_{i,j}}{\sum_{j=1}^{j=m} t_{i,j}} \qquad (2)$$

I_i = Level of interaction of department i
$d_{i,j}$= number of interactions of department i in project j
$t_{i,j}$ = total number of tasks of department i in project j
m = total number of projects

The level of interaction can provide managers with the following useful information:

- The value of the level of interaction is in the range 0 to 1. If the value is closer to 0, this means that the department works in a more autonomous way, since it is not involved with other departments in executing its tasks. On the contrary, if this value is closer to 1, this means that the department requires a greater collaboration with other departments to execute its tasks.
- In combination with the number of tasks, the level of interaction can provide information about how important certain departments are for the overall PD efforts of the company.

The departmental classification according to their importance for the PD process is based on three parameters: the level of interaction, the number of tasks each department executes and the number of workers each department has. These three values will be represented in an “Organisational portfolio” a tool that is proposed for a better overview of the departments (see figure 8). Each value has to be represented as explained below.

- The level of interaction is displayed on the ordinate axis, which takes values from 0 to 1.
- The number of tasks of each department performs is displayed on the abscissa.
- The workforce size of departments is represented by the size of the circles.

Once these values are known, the organisational portfolio can be constructed. Through this portfolio, departments are divided into 4 categories, corresponding to 4 quadrants of the portfolio:

- *Critical*: this group refers to departments which are responsible for a high number of tasks and have a high level of interaction with other departments.
- *Highly involved*: this category includes those departments which have a high level of interaction but perform a low number of tasks.
- *Tasks intensive*: in this category are included those departments that execute a high number of tasks but the number of interactions with other departments is low.
- *Non-critical*: the departments classified in this category have a low level of interactions as well as perform a low number of tasks.

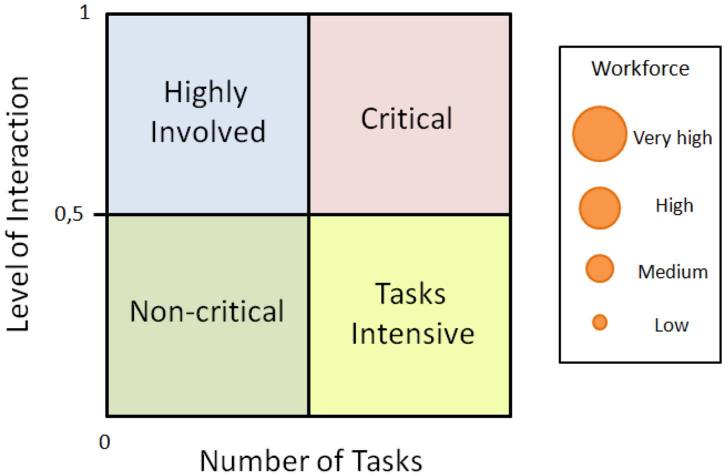

Figure 8. Organisational portfolio

After placing each functional department in the appropriate position in the organisational portfolio, they will be classified based on the quadrant they belong. Following are some conclusions that can be deduced from this departmental classification. It has to be kept in mind however, that the management should acquire additional information in order to reach strategic organisational decisions and not rely solely on the information contained in the organisational portfolio. The organisational portfolio is hence only a framework for discussion to reach such decisions.

- Departments classified as *Critical* are involved with many other departments of the company and they also perform a high amount of tasks. These departments have a central role in the company’s PD overall efforts. Therefore the management has to make sure that the information flow is facilitated for these departments. This can be achieved by co-locating these departments with the departments that interact mostly. Another option is to assign special software tools or common databases to support the information flow. These departments are usually of strategic importance for the companies, therefore an appropriate number of staffing should be maintained.
- Departments classified as *Highly Involved* perform a relatively low number of tasks but require a very close collaboration with other departments. These departments should be also co-located or in another way attached to the collaborating departments. In cases where these departments cooperate only one other department, a decision on incorporating them might be a plausible solution. The high interaction also tells the management that in most cases it is not reasonable to outsource the services of these departments.
- *Tasks Intensive* departments do not have much interaction with other departments in the organization so their location is not critical as with the previous departments. Therefore they can

be located where costs are lower for the company. Even outsourcing their services could be a reasonable decision. However, as in the case of the critical departments, it is important to provide them with the appropriate amount of resources to ensure the execution of their large number of assigned tasks.

- Maintaining the *Non-critical* departments working independently in most of cases is unnecessary, unless their tasks are of strategical importance for the company. Due to their small size and low workload, the possibility of incorporating them into some other departments or even outsourcing their services should be considered. The large size of these departments can point out on possible excess of staff in these departments.

Although it is not always the case (especially in PD projects), the departments with more tasks are expected to have more staff. The management can easily track in the organisational portfolio whether the size of the department corresponds to the workload. Hence, the organisational portfolio can serve also as a pre-analysis tool for staffing purposes.

All these decisions that the management can take, should be supported with other analyses. The organisational portfolio should never be used solely for reaching such decisions, but rather serve as an informational complement to management.

3. CONCLUDING REMARKS

One of the main tasks of the management in multi-project PD companies is to support the flow of information between different company departments. By doing so, the iterations as an inherent feature of the PD projects converge faster thus the time-to market and costs are reduced. This paper presented an MDM methodology that can support the management in taking organizational decisions based on the level of interaction of different departments. For this purpose, the organizational portfolio is proposed in order to provide a visual aid for the management to reach these decisions.

However, additional analyses have to be performed in order to support such organizational decisions at this level. For example, in case of outsourcing services of non-critical departments, the management has also to analyze the effect on cost, quality and timing of such a move. Another important perspective is the strategic orientation of the company. Certain departments of the company provide the competitive advantage in the market the company operates in, therefore it is essential that these departments are well integrated in the company. It is worth mentioning, that also the suppliers can be integrated in this methodology. The information from the organizational portfolio could then be used to decide on closer integration of suppliers or even decide on insourcing the services of certain suppliers.

A very important issue in multi-project PD environment that was not considered in this paper is the time distribution of tasks for each department. Due to the complexity of the products and processes, the resources needed at certain points of time might not be available. Therefore, a planning tool that considers the time domain is necessary for effective daily management of resources. Hence, the organizational portfolio is a more abstract tool, more useful for portfolio managers in PD companies and supports higher level (strategical) organizational decisions.

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