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Designing work procedures for Project Portfolio Management

Ernesto Gutiérrez
Jenny Janhager
Sofia Ritzén
Gunilla Ölundh Sandström
Department of Machine Design
The Royal Institute of Technology
Brinellvägen 83
SE-100 44 Stockholm
Sweden
egut@md.kth.se, jennyj@md.kth.se, sofia@md.kth.se, gunilla@md.kth.se

Abstract
Project Portfolio Management (PPM) is about how companies evaluate, select and prioritize ideas and projects for developing new products. This is aimed to align development investments with company's strategic goals and to reduce the risk caused by uncertainty. Research regarding the procedural aspects of PPM is still considered not enough developed. It is needed a better theoretical ground about which organizational processes should be included in PPM, how they influence each other, and how a work procedure should be designed for suiting a specific company. This paper focuses on understanding the characteristics of processes and activities within PPM. It is grounded on an empirical study in three companies based on qualitative research interviews. It was found that that processes within PPM have five main characteristics: reciprocal influence, parallel running, network of actors, multiple decision levels and decision-realization gap. It is also discussed the implications of these findings for the design of work procedures for PPM.

Keywords: Project portfolio management, process design, project selection, resource allocation, product development.

1 Introduction
Product development activities are characterized in most companies by being run in a dynamic environment, with multiple projects running in parallel and many new ideas demanding financing [1]. Because of limited resources for financing diverse opportunities, companies have to choose and compromise [2]. Decisions regarding which projects are going to be conducted are considered critically important, since they are essential for fulfilling strategies and assuring competitiveness. Thus, a systematic way to manage activities related to evaluation, selection and prioritization of development projects is needed [2], [3].

Project portfolio management (PPM) is a research area focusing on systematically organizing and running the activities that aim to evaluate, select and prioritize ideas and projects for developing new products. This is intended for aligning development investments with company's strategic goals, reducing the risk caused by uncertainty, accepting and making

trade-offs, and monitoring portfolio performance [2], [3], [4], [5]. Also, an efficient PPM would have a positive impact in organizations by improving communication, encouraging people to act as team players, allowing efficient resource allocation and terminating projects [5].

2 Procedural models for PPM in literature

Two models, described in [6] and [3], often cited in PPM literature, present in a comprehensive way, how the different processes encompassed in PPM should be organized and carried out.

The first proposal [6] is a sequential model, based on several propositions grounded in PPM literature, that separates the selection of project portfolios into distinct stages. This model suggests, for each stage, which activities should be carried out and which support tools are appropriate to be used. According to the model the main stages within PPM are pre-screening of ideas, individual evaluation of projects, screening of projects, optimization of the whole portfolio considering interaction among projects and an overall adjustment of the portfolio. This model states that company's strategy for product development is a process that should be made before portfolio decisions are made. Concerning resource allocation, some general advices are given about projects' interdependencies and gradual resource consuming.

The second one [3] proposes a decision model consisted of three major decision processes: business and product development strategy, product development and portfolio review. The major assumptions of the model is that the strategy development process leads the whole portfolio management and that stage gate models for product development process are a central part of the PPM process. Besides, the model suggests a three-step action plan: defining the requirements for PPM, designing central parts of the PPM process and implementing the PPM processes.

In spite of being different opinions about what PPM is and which processes it encompasses [1] [2], there are a set of processes that are commonly named in literature as being a part of PPM [1], [2], [3], [4], [5], [6], [7]:

- *Handling of ideas*: process in which new ideas and opportunities for product development are handled from the moment they arise to when they come to an instance of evaluation and selection.
- *Evaluation and selection of new ideas*: process wherein the proposed new ideas are evaluated and decisions are taken regarding their selection or rejection.
- *Managing of Product development projects*: process in which the selected ideas are in some extent realized, usually in the form of a structured project.
- *Comparison and prioritization of ideas and projects*: process that aims to consider the whole group of selected new ideas and already ongoing projects in order to decide a prioritization rank among them, including decisions about stopping or killing projects.
- *Development of strategies for product development*: process in which general directives and concrete goals for product development are defined, usually in the form of visions, roadmaps and forecasts for products, technologies and markets.
- *Resource allocation among projects*: process wherein the founding of whole projects or partial development activities is realized.

3 Research problem on procedural aspects of PPM

Despite the contribution that the presented procedural models for PPM provides, regarding a better visualization of the activities that should be carried out and the processes that should be encompassed within PPM, the research regarding the procedural aspects of PPM, must be considered not very well developed [2].

Particularly, the first model [6] seems to include all activities of importance for PPM, but it assumes that all decisions are made in a linear logical process. Besides, it does not take into account how people are involved in the different stages [2]. The second model [3] is considered too generally described and with strong assumptions not clearly grounded as the role of stage-gate models to support PPM [2].

Regarding processes within PPM, it is not clear which ones should be a part or not of the PPM process or how they should interact with each other. According to [8] the allocation of resources between simultaneous projects is a primary issue in a multi project setting and [4] states that project selection is closely linked to the management of the whole company. Some authors, as [3], asserts that stage-gate models are a central part of PPM, but at the same time empirical evidence shows that product development processes and state-gate models not always support the PPM processes [9]. The sequential and one-way directional interaction between different processes has also been questioned as reference [10] asserts that the strategy processes and the resource allocation process have a relationship that is far to be a sequential one.

It is commonly agreed in PPM literature that no best way to organize for PPM exists. Furthermore, some suggestions on how to manage PPM are only suitable for large companies [2]. More generally, companies are in common still unsatisfied with the performance of practices implemented in PPM and researchers advocate for a better understanding of the whole managerial field [2], [7]. Summarizing, models that have been proposed for PPM processes are made on a rather general level and are based on assumptions that are not sufficiently theoretically grounded [2]. Some aspects that need to be further developed are which factors characterize the processes within PPM, which organizational processes should be included in a PPM model and how they influence each other, and how the whole work procedure should be designed and implemented in a company.

4 Purpose

The purpose of this paper is to understand the characteristics of the processes and activities within PPM. A discussion is going to be made about how this understanding should be used when designing work procedures for PPM.

5 Method

A qualitative research study, following [11], based on semi structured interviews, was carried out in three companies. The studied companies have product development as a core competitive factor, meaning that the business strategy of each company is based on improving existing products and developing new technological platforms.

- Company A develops, produces and sells high technological machinery for the electronic industry. Their product development requires high qualified personnel in several disciplines and technological areas. The company has about 500 employees, including 100 directly involved in development activities.

- Company B develops, produces and sells machinery for diverse industries including aerospace and electronics. The products have a medium grade of technological complexity, encompassing mechanical and electronic components and software. The company has about 350 employees, including 90 directly involved in development activities.

- Company C develops, produces and sells mechanical and electronic solutions for property security. Its products range from a low to medium level of complexity. The company has about 1000 employees, including 30 directly involved in product development.

In total, 30 respondents were interviewed, including general managers, business unit's managers, products managers, development managers and project leaders. Interviewees were asked to talk freely about how various processes in PPM are carried out. Six processes where chosen in the interview guide, because as it was stated before, are the most named in PPM literature: handling of ideas, evaluation and selection of new ideas, managing of product development projects, comparison and prioritization of ideas and projects, development of strategies for product development and resource allocation among projects. At least two of the authors were present at each interview, and at least three of the authors participated in the analysis of the interviews from each company. The general results were accomplished by the four authors and validated with the respondents in respective meetings at the companies.

6 Results

The studied companies have formal forums for making decisions about ideas and projects and a decision process that is also, to some degree, formalized. The number of forums depends on the company size and the organizational structure. Company A has decision forums in each business unit, another forum at general managers' level that covers the whole company and one more forum in the board of directors. Company B has just one decision group for the whole company and Company C has decision groups in each business unit and then a higher forum that covers the whole company. In the three companies the criteria used to evaluate ideas are few dimensions of general character.

Beyond the formalized forums and decision processes, respondents described the dynamic in which the decisions are taken and realized. The empirical data describing this dynamic is presented in the following paragraphs.

The three companies are constantly provided with a plethora of new ideas in spite of not having a formalized process for idea generation. New ideas are able to arise from several sources such as technicians, salesmen, service personnel, strategy groups or customers. These ideas are usually communicated and spread internally in informal conversations or meetings. In this process the idea is changed and recreated between several actors. Respondents stressed that the personality and hierarchical position of the people involved in this informal process influence the idea's possibilities for reaching a formal forum of discussion. As a Development Manager illustrated it: *"The ones that succeed at selling their ideas were able to do what they wanted to do. ...In the first place, one should not get the key persons against oneself... This is an important issue when starting a project, even though ten persons are in favor of it, if one key person is against it, it will never go further"*. Furthermore, subjectivity and intuition is commonly used as an approach for evaluating and deciding about ideas. A Product Manager synthesized the way of deciding prioritization between ideas and projects as: *"It is pure gut feeling and some kind of consensus"*.

Respondents stated that most of the actors that participate in the formal decision meetings have already been involved in the informal discussions about the idea. As a consequence, many decisions have been already made in an informal way, before they are considered in the formal meetings. In the words of a Development Manager: *"One talks with colleges in the coffee-room,…and then if the idea is good so spreads the knowledge to several persons … it is corridor talk in this stage …the problem with that is that … everyone has understood that the idea is going to go further."*

Sometimes, people do not wait for a formal decision to develop an idea. Pre studies or other surveys for testing ideas feasibility are carried out eluding the formal procedures for decision making. As a Product Manager explained it, if some middle managers expect that a decision group is going to approve an idea, they do not wait for that, instead they start budgeting and making estimations. That implies to derivate resources to those activities and, as a consequence, it trigs an informal reprioritization of the ongoing projects.

Respondents described the different decisions steps as an interaction of different actors which show different points of view and interests. As a Business Unit Manager explained it, he is the one that is supposed to have the last word when deciding about the start of a project within the unit. Then, he takes into account the financial result to base his decision on. But the unit's Product Manager would consider that another project is more preferable considering the range of products of the unit, the development manager would opine about the technical feasibility and, if the project to be started means a big investment so, the company's CEO would have an opinion, from a company wide perspective.

The execution of product development projects is carried out in the three companies by formal procedures for project management, based on stage-gate models. A common result in the three companies is that stage-gate models are bypassed during the early stages of an idea. Furthermore, respondents in the three companies referred that people attending the gate meetings are not the same than the ones attending meetings for selection or prioritization of projects. Some people attends both meetings but in gate meetings also participate people with technical competence and project managers. During gate meetings projects are followed up from a technical and planning perspective and suggestions are made about the properness of the further development of the project. However, decisions about killing or stopping a project are taken in other forums than gate meetings.

Several respondents referred to events that act as triggers for reprioritizations or reviewing of strategies and plans. For example, a Development Manager explained what happens when products do not work as expected within customers: *" (Product problems within customers) costs very much. Within product development it knocks the whole activity, all projects loose resources and it becomes delays."* New ideas and new projects to be started also forces change of plans, as this Sales Manager expressed it: *"We make a business plan once a year and we decide a budget …but we have more and more projects that arise and more and more opportunities, so we must prioritize somewhere. That is the way it is."* Other triggers to changes are poor resource estimations, projects near to delivery date and unexpected changes in the environment. Some respondents also pointed out that continuous changes and reprioritizations are, in some extent, not possible to avoid, as this Development Manager explained it: *"Whatever we choose we will never choose right … what we had as input data when we made the decision is not valid after a while, because there have arose other things that are more important or because what one has started must be changed and it becomes in another way."*

Activities related to resource allocation were described by respondents as differentiated by the time horizon and the type of resources considered. For example, the resources considered can be as different as money, the availability of people with a special competence or the organizational capability to do something. It could happen that the long-term monetary financing is assured but the constraint resource is the organizational capability because it is not in the company and it is not easy to be achieved outside. It was expressed by a Product Manager in this way: *"We have got 10 millions, but no people."*

Decisions about short-term resource allocation are made in meetings, usually between product managers, project leaders, technical responsible and development managers. For example, Company C uses a chart for visualizing the projects and the availability of the people. Then, once a week meet project leaders, development managers and product managers in front of the chart and decide who is going to work in each project.

According to several respondents some parts of a decision are, sometimes, left to be made in another instance, by another people. For example, a Product Manager told about people that when deciding prioritization just decide the higher position of the ranking, but not which projects would loose resources. As a consequence, somewhere in the process other people are forced to decide the prioritization of the lowest ranked projects. As he told it: *"Until now…we have said what is highest prioritized. So one picks things in and that means that something falls down. Often are the right things that fall down …but it is rarely we pick something out."*

Decisions made in the formal meetings do not always mean that a resource allocation is realized. For example, a formal decision group decides that a project is going to be started, but other decision groups decide later not to prioritize this project, as this Product Manager explained: *"In practice it means that some things are not made, because there are no resources, despite having been decided in the Product Council that they were good things and that they were going to be done."*

7 Analysis

When analyzing the empirical data it was intended to understand the characteristics of the processes involved in PPM. The interviews were analyzed for achieving a description of the processes and activities within PPM, as they were run in reality, beyond each company's formal procedures. From this description there were analyzed the different processes and their interrelations. There were identified five characteristics that described all the studied processes, appeared in most of the interviews and were common for the three companies. Hence, the five identified characteristics of the processes encompassed in PPM are: reciprocal influence, parallel running, network of actors, multiple decision levels and decisions-realization gap.

Reciprocal influence: in the results, it was described how events in some processes (as problems within customers, new ideas that are evaluated, new projects that are started or projects that do not develop as planned) trigs reprioritizations in other processes (as re-planning, resource reallocations and reviewing of strategies). It shows that the different processes, that respondents referred to, are not independent of each other. They influence and, at the same time, are influenced by other processes. This influence happens in a two-way direction, that is, each process produces outputs that mean inputs for the other processes. Other examples of that are reprioritizations triggered when managers informally assigne resources to develop a new idea or when just the higher position of the ranking of projects is

decided. An example that shows the reciprocal nature of the influence between processes is when strategies act as guidelines for idea selection at the same time that a new idea that arises, trigs a review of the strategies. Furthermore, the influence between processes is sometimes much more complex, as for example between idea generation and idea selection. In this case, the previous informal discussions about an idea, produces an informal decision, before the formal meeting for evaluating the idea takes place.

Parallel running: the interactions explained before are presented by the respondents as something that happens continuously. The reciprocal influences between processes are described as formal and informal events that occur simultaneously, not following a sequential path. For example, while top managers design company's strategies, middle managers start developing ideas not waiting for a formal decision and at the same time project leaders and technical managers are deciding in which projects people are going to work. That is, processes run in parallel and the reciprocal influences are continuously happening.

Network of actors: in the continuous reciprocal influences among processes described before people interact with each other in a network of formal and informal relations. Each actor plays different roles in the different processes, acting alternately as a participant in formal decision forums and as an informal actor having discussions or influencing decisions. Respondents described how in the early stage of an idea the interaction of different people, in formal and informal ways, is what shapes the idea itself and the final decision about it. This network makes possible for different actors as experienced technicians or people with deep knowledge of the business to contribute to the decision on the idea by, for example, using their intuition. Another example is the business unit manager that explained how different people interact in the process of making a decision with different perspectives and interests. Here, the network allows enriching the evaluation of the project from different perspectives and balancing the different and sometimes contradictory interests of the different actors.

Multiple decisions levels: Respondents' descriptions about how decisions are taken show the existence of different levels of decision making. That is, decisions are not taken in just one decision moment at one level of the organization. There are different levels of decision making, characterized by groups, people attending in each group, the information considered, grade of holistic view and the strategic importance of the decision. Sometimes is the formal structure that forces different levels of decision, as for example when a project requires a big financing. In those cases the decision goes up in the hierarchical level, and in each level different kind of information is considered, with different grade of detail and considering different perspectives for the decision. Another example is when one forum makes prioritizations in the top of the rank, and then another forum makes their own prioritizations in the rest of the projects and finally some group redistributes the people between projects.

Decision-realization gap: the empirical data shows that not all the decisions have as a consequence that an action is taken and that a resource allocation is made. For example, in the example given before, the prioritization in the top of the rank, could be made following another guidelines that the ones stated in the original strategies, the successive reprioritizations could be based on other ways of understanding what is most important and the final resource allocation is the result of another negotiation that could consider more urgent problems between projects. As a consequence, one original decision trigs a large set of decisions that finally lead to a resource allocation that is not necessary consistent with the first decision. Other times, the inconstancy between decision and realization is about a decision that never is realized. An example of that is the product manager that told about a formal

decision about the start of a project that never had been realized because of later considerations determined that there were not enough resources for financing that decision.

Table 1. Factors that characterize PPM processes

Reciprocal influence	Decisions taken or unexpected events occurring in one process influence the other processes, triggering for example reallocation of resources, reprioritizations of projects or reviews of plans. Influences occur in a two-way direction.
Parallel running	Processes run in parallel and the reciprocal influences are continuously happening, in formal and informal ways and in non sequential order.
Network of actors	People interact in a network of formal and informal relations in which each actor plays different rolls in the different processes. This network makes possible the contribution of different actors, the use of intuition and different perspectives and to balance actors' contradictory interests.
Multiple decisions levels	Decisions are not taken in just one decision moment. There are different levels of decision making for each decision, characterized by decision-groups, grade of detail of the information and the perspective considered.
Decision- realization gap	Not all the decisions have as a consequence that an action is taken or that a resource allocation is made. Sometimes, a decision trigs a large set of decisions that are not consistent to each other or other decisions are never realized.

7 Discussion

Analysis of the empirical data shown that PPM, from a procedural perspective, has five main characteristics: reciprocal influence, parallel running, network of actors, multiple decision levels and decision-realization gap. However, procedural models for PPM found in the literature [3], [6], contradict these findings assuming that processes influence each other in a sequential way, there are clear and defined decision points and the whole decision process is able to be formalized. Besides, it is also assumed the use of rational evaluation tools and that decisions lead to consistent actions. In addition, it is stated that these models contribute with an understanding of the development activities, giving a chronological structure, controlling by successive decision making and organizing by a standard procedure [8]. They also contribute to allowing managing innovation by strategies and plans, achieving optimal solutions, and communicating how decisions were made [12] and to contribute to the acceptance of decisions in the organization [13]. Thus, the procedural models proposed in the literature, seemed to be built on assumptions that contradict the procedural characteristics found in this study. Besides, some authors assert that these models contribute to support some organizational requirements on PPM

In the other hand, as the innovation processes is a complex task that requires different approaches for making decisions, there are another set of organizational requirements there

are not able to be fulfilled through processes based on sequential and formal procedures and rational tools [12]. Thus, the reason because the processes within PPM display the five characteristics found in this study is that there some aspects of decision making on innovation that makes them needed. Although our analysis does not allowed to state which specific contribution each one of the found procedural characteristics make for decision making on innovation, is it possible to assert that if they are not taken into account in the design of the decision making process, it is going to be affected in a negative way the capability to fulfill some organizational requirements on PPM process.
For example, some authors have stated the risk of using models for decision making processes based only on sequential and formal procedures and rational tools. The risk consists in limiting the organization capability to face some situations that are a part of product development as ambiguity and political conflicts [13]. One consequence of that could be that god ideas are not selected if they are affected by ambiguity in their early stages [8]. Moreover, to ignore the existence of different decision levels and that decisions are taken formally and informally in a complex network [14] is also a risk because those ignored and not supported decisions are able to be the ones that in fact shape strategy [10].

Another aspect of importance to be considered when designing processes for PPM, is the overlap between the process of generating ideas and the process of making decision about those ideas. Some authors assert the importance of conversations and ambiguous actions for the developing of the idea [8], [15]. At the same time other authors have questioned the assumption that an idea is able to be reduced to information that is written down and argued for the importance of the processes of making sense of information [16], [17]. Thus, how researchers understand what an idea is and how it would be managed is going to influence not only the PPM process but the whole organizational capability of generating new ideas. Thus, designing processes for PPM requires an understanding about the reciprocal influence of the different processes encompassed in PPM and how they impact in the output of the innovation process.

8 Conclusions

Processes within PPM have five main characteristics: reciprocal influence, parallel running, network of actors, multiple decision levels and decision-realization gap. Those characteristics contribute with dealing with some aspects of decision making on innovation.
Procedural models for supporting decision making based on sequential and formal procedures and rational and analytical evaluation tools are grounded on assumptions that contradict those five factors. Because of those models are useful for fulfilling a limited part of the organizational requirements on PPM processes they mean a risk of limiting the organization's innovative capabilities.
Thus, researchers aiming to design processes for PPM should be aware of the complexity of the innovation processes, and that the way in which the work procedures are designed, implemented and run is going to influence the output of the innovation process itself. Thus, the understanding of PPM as a process becomes crucial, and the five factors that this paper show becomes necessary for the designing of work procedures for supporting PPM.

Furthermore, when designing work procedures for PPM it should be taken into account that supporting different aspects of decision making, implies different types of solutions. To fulfill organizations` need of control is not the same than to promote creativity, or to enhance informal contacts or to manage an information system. Thus, the design of the work procedure should be guided by the goal that it is intended to fulfill and the organizational requirements that it implies. One of the greatest challenges for researchers is designing work

procedures that support the use of non rational means, informal meetings and discussions, networks of actors beyond the formal organizational structures and the power of make decisions outside the formal hierarchical procedures.

Empirical studies in different settings that the one presented in this study can help to validate the procedural characteristics found in this study, or to find new ones or to establish which of them are context-specific. Furthermore, more research is needed to state how the different characteristics of the processes within PPM contribute to face different situations in decision making on innovation. Moreover, it is still not enough explained how the way in which ideas are evaluated and selected would affect the process of generation of ideas itself. Thus, more research is needed about the reciprocal influence of the different processes encompassed in PPM and how they impact in the output of the innovation process.

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