

THE INFLUENCE OF TECHNICAL EXPERTISE ON MANAGERIAL ACTIVITIES THROUGHOUT THE INNOVATION PROCESS

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ABSTRACT

This paper investigates the management activities of the project managers of six new product development projects based on a longitudinal, interview-based study. The study compared how the managerial activities of managers with a technical background differed from those with a non-technical background, and how these activities evolved throughout the different innovation process phases.

The results illustrate clear differences between the two types of managers related to decision-making, participation in the hands-on execution of the project, and role allocation. In addition, project managers with non-technical backgrounds had to tolerate more uncertainty due to limited ability to predict and solve development problems. They also had to redefine their roles as the project proceeded to later development phases, unlike the technical managers who had a strong involvement in technical execution throughout the project. On the other hand, many activities common to all managers, related to for example creating an open and trustful atmosphere and coordinating the whole, differed between the front-end, early development and late development phases.

Keywords: project management, new product development, early design phases, innovation

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1 INTRODUCTION

Innovations are required from new and established companies alike in the modern economy in order to remain competitive (Christensen, 1997; Dougherty and Hardy, 1996; Lawson and Samson, 2001; Shalley and Gilson, 2004). In contrast to routine work, innovative work involves solving complex ill-defined problems that require the generation of novel and useful solutions (Ford, 2000). Multiple functional areas are involved (Waldman and Bass, 1991), and cooperation is required between team members with diverse backgrounds (Mumford et al., 2002). Managing diverse work groups is a challenge and without proper management, the value of diversity may not be realized which may lead to more complicated but not more productive workplace (Jehn and Bezrukova, 2004). Furthermore, the innovation process involves a variety of parallel, competing and conflicting simultaneous processes (Buijs, 2007), and is characterized by uncertainty (Lenfe and Loch, 2010). The responsibility for managing this process, as well as the people in the team striving towards creating an innovation, is typically in the hands of the project manager (Elkins and Keller, 2003).

The task of leading innovative teams is hardly an easy one, with the managers of innovative teams needing to balance between different approaches and behaviors (Amabile et al. 2004; McDonough III and Barckzak, 1991; Valle and Avella, 2003). For example, Hohn (2001) argues that in order to manage the innovation process, leaders must continuously alternate between generative and focusing modes of leadership, supporting both high divergence to encourage creativity and high convergence for efficiency. Further, necessary leader roles for supporting innovative efforts have included idea generating, project leading, sponsoring/coaching, gatekeeping, and entrepreneuring/championing (Roberts and Fusfeld, 1981), acting as a communicator, climate-setter, planner, and interfacier (Barckzak and Wilemon, 1989), as well as strategic planner, team builder, technical expert, champion and gatekeeper (Kim, Min and Cha, 1999). Indeed, a variety of necessary leadership behaviors have been identified in literature, divisions being made between task- and people-oriented (e.g. Fiedler 1967; Slevin 1989), transformational and transactional (Bass and Avolio, 1995) as well as initiating structure and consideration leadership behaviors and theories (Halpin, 1957). Further, previous studies have noted leadership supporting creativity to require both task- and people-oriented activities (e.g. Amabile et al., 2004; Mumford et al. 2002) Task-oriented activities include activities such as defining tasks and roles, coordinating group members' actions and determining standards of task performance, whereas people-oriented activities address the feelings and attitudes of the members, and include activities like supporting, recognizing and reducing interpersonal conflict (Derue, Nahrgang, Wellman and Humphrey, 2011). The study of Mäkiluoto (2004) showed that project managers tend to be more task-oriented with only seven of out of 47 project managers being people-oriented. On the other hand, the study of Keegan and den Hartog (2004) suggest that the style of project manager needs to be more transformational (primarily people-oriented) than transactional (primarily task-oriented).

Many of the listed role and behavior collections require at least some degree of domain expertise from the leader, and, indeed, the importance of the technical expertise of the project leader in development projects has been emphasized (Barckzak and Wilemon, 1989; Clark and Wheelwright, 1992; Howell and Higgins, 1990; Kim, Min and Cha, 1999). Research suggest that leaders should be able to contribute towards generating and recognizing feasible ideas (Roberts and Fusfeld, 1981; Howell and Higgins 1990; Kim, Min and Cha, 1999) and that professionals tend to accept authority based on expertise better than authority based on hierarchy (Kim, Min and Cha, 1999). On the other hand, technical expertise in the domain might entice the project leader to go too deep into the role of a technical expert, at the expense of more fundamental leadership behaviors (Valle and Avella, 2003). Thus possessing technical expertise might be a double-edged sword for project leaders.

Furthermore, the needs of the project might radically change as the innovation process evolves. The various phases entail different tasks and different amounts of task uncertainty from the project team (Kim and Wilemon, 2002; Koen et al., 2001), and thus many of the leadership practices applicable in the early front end phases might not be applicable in later development phases, and vice versa. However, leadership studies have rarely differentiated between the different phases of innovative projects in their prescription of appropriate leader roles and behaviors (Luukkonen and Björklund, 2011). This paper proceeds to study how the mixture of behaviors and roles employed by project managers evolves throughout the different innovation process phases, and whether the process differs between project managers that have technical backgrounds and those who do not.

2 METHODS

To investigate the evolution of project management activities throughout the product development project phases as well as the possible differences between project managers with technical or non-technical background, the present study adopted a qualitative, longitudinal research design based on six new product development projects.

2.1 Data collection

Data was collected from a graduate level product development course at Aalto University during the semester of 2010-2011. In the course, student teams with student managers are formed based on student applications, and each team is given a unique industry provided design brief. In addition to the design brief, the sponsor provides a 10 000 euro budget for the development work of the team for the 8-month-course. The course requires teams to produce an operational prototype as a result of the project. For the purpose of this study, six student project managers – three with a technical background and three with non-technical backgrounds – were selected (see Table 1) and interviewed in the beginning, middle and end of the project.

Table 1. Project information

Project	Project manager background	Project team member amounts				Project brief
		Total	Female	Technical background	Off-site*	
Alfa	Technical	9	4	4	0	Create a new business concept for a small company
Beta	Non-technical	8	0	4	3	Create a consumer product for a large organization
Gamma	Technical	8	1	7	0	Create a new part of a technical, physical product for a large company
Delta	Technical	11	4	4	4	Create a consumer service-focused product for a large company
Epsilon	Non-technical	8	6	6	3	Create a service-focused product for a small company
Zeta	Non-technical	9	1	7	0	Create a new high technology product for a large company

*student members from a foreign university partner, located at their home university

The first, front end phase interviews were conducted when the projects had been running for approximately six weeks, the early development phase interview at four months, and the final, late development phase interviews were held approximately three weeks from the end of the project. The interviews were semi-structured, with the interviewees being prompted to reflect on their activities, their most central roles and challenges in the project. The interviews lasted between 31 and 57 minutes, averaging at 44 minutes. The resulting 18 interviews were recorded and transcribed for analysis.

2.2 Data analysis

The transcripts of the 18 interviews were searched for segments identifying activities and challenges described by the project managers, resulting in 337 segments. The identified segments were categorized based on thematic similarity of content into 16 mutually exclusive categories (see Table 2 and 3). These categories were further grouped together into four classes based on the target of the category activities and challenges; general project management, responsibility and ownership, support within the project team, and providing a suitable context for development work. These classes were divided as either task-oriented (general project management and responsibility and ownership), or people-oriented (support within the project team and providing a suitable context for development

work), based on existing literature on management and leadership activities (Derue, et al., 2011; Fiedler 1967; Slevin 1989). The occurrence and content of each category were compared between the three different phases the front end phase (FEI), early development phase (EDP) and late development phase (LDP) as well as between the managers with technical and non-technical backgrounds.

3 RESULTS

A total of 337 managerial activities and challenges were identified by the interviewees. These were divided approximately equally between task-oriented (see Table 2) and people-oriented (see Table 3, p. 5) concerns.

3.1 General project management activities and challenges

The class of general project management involved activities related to organizing work, consisted of five subcategories: clarifying roles and setting goals, time management, coordinating the whole, monitoring work and acting as an interface (see Table 2). More traditional project management activities such as clarifying the roles of team members and setting goals, and coordinating the project as a whole, were reported as important throughout the project (see Table 2) whereas monitoring the work and acting as an interface were mainly brought up during the front end phase of the project. In the class of general project management, the biggest differences in the approaches of technical and non-technical project managers could be found in the category of clarifying roles and setting goals.

Table 2. Task-oriented project management concerns in each project according to development phase

Class	Category	FEI		EDP		LDP	
		Tech.	Non-tech.	Tech.	Non-tech.	Tech.	Non-tech.
General project management	Clarifying roles and setting goals	All	All	Alfa, Delta	All	All	Epsilon, Zeta
	Coordinating the whole	All	All	Alfa	Beta, Zeta	Alfa, Gamma	All
	Time management	Delta	All	Alfa	Beta, Epsilon	-	Beta, Zeta
	Monitoring work	Alfa, Gamma	Beta	Alfa	Beta	Delta	Beta, Zeta
	Acting as an interface	All	Beta, Zeta	-	-	-	Zeta
Responsibility and ownership	Decision making	Gamma, Delta	Beta, Zeta	All	Beta, Zeta	Alfa, Gamma	All
	Providing autonomy	Alfa, Gamma	Zeta	-	-	-	All
	Hands-on participation	Alfa, Delta	Beta, Zeta	All	-	Alfa, Delta	-

The largest category, *clarifying roles and setting goals*, contained activities that were evenly emphasized by both technical and non-technical project managers: defining team member roles, forming and delegating tasks, and deadlines. Further, these activities were brought up almost by all the managers throughout the project. Project managers reported that finding roles for every team member was challenging throughout the entire projects, especially for less active team members. For two of the three non-technical project managers, defining separate roles for all members when there were many representatives from the same discipline was difficult. While all managers reported difficulties in clarifying roles, it appeared that project managers with technical background (Case Alfa and Delta) mentioned to purposefully aim to get team members to do tasks also outside their core field of know-how, whereas the non-technical project managers aimed to divide the tasks according to the background of the team members. Further, it was mentioned time to time to be challenging to set goals as the field of the project was not always familiar for the project manager either.

All project managers emphasized also the importance of *coordinating the whole*, including activities such as defining the whole, keeping the project (direction) under control, seeing the big picture and

coordinating the work of different parties. These activities were highlighted mainly in the front end and late development phases, where sharing information between subgroups and making sure everyone was heading to the same direction were perceived as important. During the late development phase, emphasis was more on assuring the allocation and schedule of resources than in the earlier phases.

The category of *time management* involved scheduling the project and meetings of the team, and clarifying how much each member had time to use for the project. These activities were reported mainly during the front end and early development phases. Project managers reported several challenges related to the time management such as matching the schedules of the team members in order to get everyone participate in the team meetings or informal gatherings was a challenge in all of the cases. Case Beta also had challenges throughout the whole project in knowing how much the team members were able to work for the project and in the late development phase, also how long the completion of their tasks would take. During the early and late development phases few project managers reported also to be busy with other than project-related things and it was challenging to try to balance between the project and other things. This affected also in how the project managers were able to e.g. monitor the project.

The fourth category, *monitoring work*, included segments reflecting following up on delegated tasks, for example by checking the situation in weekly team meetings or enquiring on progress by phone or email. By the early development phase the project managers, the managers had gotten to know their team members better, and reported that the working of some team members needed to be followed more closely than others. The identified activities were distributed quite evenly between managers, but none were particularly emphasized in any phase.

The last subcategory of the general project management activities, *acting as an interface*, consisted of a few segments describing acting as a link between the team and the sponsor, and being in charge of answering the enquiries from the sponsor side. These activities were mainly highlighted during the front end phase.

3.2 Responsibility and ownership

The class of responsibility and ownership contained interview segments reflecting the extent to which project managers distributed decision making power (in the categories of decision making and providing autonomy) and participated personally in the development work (in the category of hands-on participation) (see Table 2, p. 3). In this class, differences in the managerial approaches between the technical and non-technical project managers could be found in all categories. The largest category, *decision making*, reflected the project manager having a strong role in decision making and making the final decisions in situations where no clear decisions could be made with the team. These activities reported rather evenly in all the different phases of the project. However, it could be noted, that although all the project managers had a central role in making decisions, the project managers with technical background were making bigger decisions, e.g. related to the product concept, more independently. Further, they had the courage to make changes still in the later phases of the project, whereas non-technical project managers highlighted proceeding as previously planned in the late development phase.

On the other hand, non-technical managers highlighted *providing team member autonomy* in the late development phase letting team members to pursue solutions to possible challenges more freely than technical managers. However, all the managers provided decision authority to the sub-groups on their tasks. In the front end phase, the category contained mainly segments describing providing autonomy through offering larger task units rather than specific instructions.

Finally, in the category of *hands-on participation*, the managers described taking part in the actual development work of the project, typically in building the prototype. More precisely, this involved project managers rebuilding parts of the product or concept by themselves or with the help of a team member, and taking charge of tasks that others did not have the skills for. In the front end phase activities related to concept creation and ideating were highlighted and at this stage also some of the non-technical project managers had a central role, as they had experience in ideation, market studies, and user studies. However, in the early and late development phases naturally the project managers with technical backgrounds had a stronger role in activities related to hands-on participation, taking a strong role in building the physical products. Especially in the late development phase, two technical project managers (Case Alfa and Delta) were very busy with the execution work, which took their concentration away from project management activities.

3.3 Providing a suitable context for development work

People-oriented managerial concerns were divided roughly equally into providing a suitable context for development work, and providing support within the team. Context concerns were more development-work specific, including five categories: creating an open and trustful atmosphere, establishing ways of working, accommodating diversity, encouraging exploration and minimizing fear of failure (see Table 3). Most of the activities in this class were focused on the front end phase and no remarkable differences could be found between the approaches of managers with technical and non-technical background.

The largest category, *creating an open and trustful atmosphere*, was highlighted by all managers during the first half of the project. In the front end phase, managers emphasized the importance of getting to know their team and making team meetings more relaxed. They encouraged giving feedback, acted openly and relaxed themselves, and aimed not to dominate meetings. More challenges were reported in the category in the early development phase, with team members being reluctant to spend time and participate actively in team meetings or informal gatherings.

Establishing suitable ways of working for the project was brought up by all non-technical managers and project manager Alfa in the front end phase, including practices such as “selling” ideas, hands-on working, and protecting ideas from premature criticism. Project manager Alfa had a very strong vision of the ways of working, providing a team member guide in the beginning of the project to underline appreciated behavior and discussing the topic with the sponsor. Providing a good example was highlighted as a means of communicating the desired high level of quality.

Table 3. People-oriented project management concerns in each project according to development phase

Class	Category	FEI		EDP		LDP	
		Tech.	Non-tech.	Tech.	Non-tech.	Tech.	Non-tech.
Providing a suitable context for development work	Creating an open and trustful atmosphere	All	All	All	All	Delta	Epsilon
	Establishing ways of working	Alfa	All	Alfa	-	Alfa	-
	Accommodating diversity	Delta	Beta	Alfa	Beta, Epsilon	Gamma, Delta	All
	Encouraging exploration	Alfa, Delta	All	-	-	-	-
	Minimizing fear of failure	Alfa	Epsilon, Zeta	-	-	Alfa	-
Providing support within the team	Encouraging team member participation	Alfa, Gamma	All	Alfa	All	All	Beta, Epsilon
	Providing positive feedback and recognition	Alfa	Beta	-	Epsilon	Alfa, Gamma	Beta, Epsilon
	Being available	Alfa, Delta	-	Delta	-	-	-

The category of *accommodating diversity*, on the other hand, included interview segments reflecting how diversity affected the ways of working and behavior of the project manager. Creating a common vision and understanding was more challenging due to the educational and cultural diversity of the team, and in the front end, ideation challenges resulted from the different perspectives and approaches of designers and engineers. In the late development phase, most diversity challenges, in turn, were related to the integration of off-site team members. For example, there was unawareness of the progress of tasks and commitment of remote team members, and keeping them along in and up with the fast pace of late phase decisions was challenging.

The two last categories were less frequent and reported mainly in the front end phase. Also, no clear differences could be found between the technical and non-technical managers. The managers were *encouraging exploration* in the front end phase by explicitly requesting several solution alternatives, stimulating team members to take on multiple perspectives, and avoiding providing any ready solutions. Three of the managers (two non-technical, one technical) attempted to *minimize fear of failure* by highlighting the importance of learning rather than succeeding right away. In the late development phase, only project manager Alfa was reporting such activities.

3.4 Providing support within the team

Providing support within the team consisted of three categories; encouraging team member participation, providing positive feedback and recognition, and being available (see Table 3, p. 5). Activities in this class were distributed rather evenly throughout the different phases of the project. However, providing positive feedback and recognition and was emphasized only at the development phase.

Encouraging team member participation was the largest category of all 16 categories by far, accounting for nearly a fifth of all identified managerial activities and concerns. Most managers emphasized its importance in all three phases. The methods of encouraging participation were similar through the project phases, including actively asking for opinions, explicitly encouraging participation in tasks, dividing the team into smaller subgroups and calling quieter team members to prompt for their view separately. However, the amount of challenges in the category increased as the projects proceeded. In the front end phase, difficulties were reported mainly in getting all team members to voice their opinion as team meetings were held in English, the mother tongue of none of the members, and in getting engineers to participate actively in tasks outside their field of know-how. The engineers' participation challenges disappeared, however, once the projects proceeded to the building phase. Achieving active participation in team meeting was still a challenge in the early development phase, for example due to the constraints of Skype as off-site members participated. In the late development phase, the focus was mainly on getting all team members to participate in the best possible way for the rest of the project. The managers reported giving only tasks that the team members were enthusiastic about, dealing with the rest themselves.

The second category, *giving positive feedback and recognition*, was mentioned by many managers, although emphasized by none. The category consisted mainly of interview segments showing appreciation and giving positive feedback from work well done. No manager reported giving any negative feedback, and one explicitly avoided it in fear of damaging motivation in "a non-vital school project". While in the front end feedback was given mainly after accomplishments, in the two development phases positive feedback on the importance of the contribution of all team members and small gestures of appreciation such as bringing tea and biscuits to work sessions were utilized to counterbalance long work hours and outside setbacks.

Finally, two project managers highlighted the importance of *being available* for team members by allocating time for one-on-one meetings, keeping contact by phone and being present while subgroups were working on their own tasks.

4 DISCUSSION

Previous research has emphasized the role of technical domain expertise of project managers, arguing that project leaders must maintain and develop their own technical capacity in the work field (Valle and Avella, 2003). The project manager acts also as a technical expert, and should be able to generate and recognize good ideas, find and define significant problems, and suggest new ideas and alternative technological solutions to provide technical stimulation for the team (Howell and Higgins, 1990; Kim, Min and Cha, 1999; Roberts and Fusfeld, 1981). However, not all project managers do possess expertise in the project field. The present study compared the managerial approaches of project managers with technical and non-technical backgrounds in the different phases of development projects.

4.1 Managerial approaches of technical and non-technical project managers

The most pronounced differences between technical and non-technical project managers could be found in their level of ownership and participation in decision-making and hands-on working. Project managers with technical backgrounds made decisions more independently than project managers with

non-technical background. Even though both types of managers had an important role in decision-making, project managers with technical backgrounds were more courageous in making bigger decisions independently for example changes in the product concept, even in the later phases of the project. Project managers with non-technical backgrounds, on the other hand, preferred to stick to what had been agreed upon with the team and emphasized team member autonomy more in the late phases. The difference is an interesting one, as previous literature has emphasized the importance of providing autonomy in development work (Amabile, 1998; Hohn, 2000; McDonough, 2000). The non-technical project managers reported feeling more uncertain in making decisions, setting goals and showing direction to the team, as they were dealing with a project outside their field of know-how. Tolerance for uncertainty has been highlighted as a necessary feature for development managers (Buijs, 2007), and the present study suggest that project managers with non-technical backgrounds need to be able to tolerate even more uncertainty than technical managers. The non-technical project managers reported feeling powerless in the face of technical setbacks, as they were unable to help solve them or even estimate how long it would take to fix the situation. In addition, predicting such problems was more difficult for them. However, a technical background did not guarantee familiarity with the domain of the project, and it was previous experience in the particular field rather than technical expertise *per se* that seemed to account for the difference in certainty. For example, one of the technical managers frequently reported feeling uncertain making decisions regarding issues she had no previous experience with. Hence, the results remind that having technical expertise is a matter of degree rather than a clear-cut attribute of the project manager.

Second, project managers with technical backgrounds tended to take a different kind of role during the projects compared to the project managers with non-technical backgrounds. All the technical project managers had a central role in the hands-on execution of the development project, participating in the building of prototypes and making changes independently in the physical products. Furthermore, they did not have a time in the project when they did not know what their role was. Project managers with non-technical backgrounds, in contrast, had a more hands-on role in the front end phase for example by possessing expertise of ideation and user studies. However, they reported having to find and fine-tune new roles for themselves in the early development phase when they were no longer able to participate in the execution of the development work. Nevertheless, the ability to participate in the hands-on execution of the product development had a clear negative side effect as well, with technical project managers clearly having limited time for any other managerial duties during the late development phase. Indeed, the risk of becoming too deeply involved in the technical execution has been previously discussed by Valle and Avella (2003).

Finally, technical and non-technical managers seemed to differ in their approach to role and task divisions. As interesting tasks are amongst the most important motivators in development work (e.g. Amabile, 1996; James, 2002), task allocation is amongst the key managerial concerns, and all managers reported some challenges in finding suitable roles for all team members, especially for the less active team members. However, whereas non-technical managers aimed to divide the tasks according to the backgrounds of the team members, and had challenges in defining separate roles when there were many representatives from the same discipline, the technical managers appeared to assign tasks also outside the core skills of team members by purpose. It might be that feeling more certain and in control of the project otherwise, the technical managers dared to “play” more with the roles.

Many activities, such as coordinating the project and encouraging team member participation, however, were quite evenly emphasized and employed by both technical and non-technical managers. From the task-oriented activities, all of the project managers seemed to have internalized the key role of coordinating the whole project. In terms of people-oriented concerns, creating an open and trustful atmosphere and encouraging team member participation were central issues for all managers. Interestingly, no matter whether the project manager was an engineer him or her self, engaging and inspiring the engineer team members in ideation and concept development was reported to be a struggle.

4.2 Managerial activities at different phases of innovation process

Previous research has suggested that technical expertise of the manager might be more relevant in new product development than in the front end phases (Luukkonen and Björklund, 2011), and in the present study, differences between the technical and non-technical managers seemed to become more

pronounced after the front end phase. Several other differences between managerial activities in the different phases of the development projects surfaced, as well, highlighting the complex and changing nature of the innovation process (Buijs, 2007; Koen et al., 2001; Waldman and Bass, 1991). Encouraging exploration, minimizing fear of failure, establishing ways of working and acting as an interface between the team and the sponsor were mainly limited to the front end phase. In other activities, the main concerns and challenges varied between different phases. For example, creating an open and trustful atmosphere was emphasized more in the first half of the project, but most challenges in the atmosphere were reported in the early development phase. Managers emphasized the importance getting to know the team members and creating a common vision and understanding in the front end, whereas the allocation and scheduling of resources was emphasized in the late development phases. In fact, keeping the project under control, seeing the bigger picture and coordinating the work of different parties were emphasized by all the managers during the front end phase, and again all the non-technical managers in the late development phase, but seemed to be less of a concern in the middle of the project. The most pressing challenges varied between phases, as well, with for example ideation challenges resulting from the diverse approaches of the heterogeneous team members being a key diversity challenge in the front end, and the integration of the off-site team members the most pressing diversity challenge in the late development phase.

The present study thus helps to shed further light on the appropriate managerial behaviors during the diverse needs of the innovation process. As the study shows, clear differences emerged between the roles and behaviors adopted by project managers with technical and non-technical backgrounds. Neither background type seemed to be better suited for the task than the other, but rather both had a set of unique benefits and limitations. However, given the small number of individuals it is impossible to say whether the technical managers differ because they represent typical managers with engineering background or because they happen to be different kind of people (e.g. better self esteem or self competence). Natural future work would be to design a survey study based on the discovered themes and study both student and professional managers from different background and career lengths in detail.

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