Department of Computer Science
Series of Publications C
Report C-2009-19

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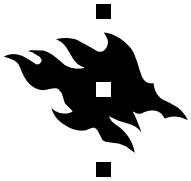

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Working Toward Success Factors in Software Development Projects

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Technical report, Series of Publications C, Report C-2009-19
Helsinki, July 2009, 43 pages

Abstract

Software projects are born and die but their problems remain. While equipment and tools are more powerful than ever before, the success rates of the projects are still poor. This report addresses project failures and their reasons based on the literature. In addition, key subjects for improving one's own projects are presented. Awareness of underlying weaknesses in these projects makes it possible to find targets for improvements. The report mainly focuses on software engineering projects. However, the viewpoint can be applied education (e.g. capstone software project) as well as to improve situational awareness in student projects and to recognize problems in early stages of those projects. As a result, this report eases the work of project managers and supervisors by addressing key points of failures and success. With this knowledge, managers and supervisors can tailor a specific questionnaire to find targets of improvements from their projects.

Computing Reviews (1998) Categories and Subject Descriptors:
D.2.9 Management – programming teams, productivity
K.6.3 Software Management – software process

General Terms:
Human Factors, Management, Leadership, Software Process Improvement (SPI)

Additional Key Words and Phrases:
improvement, software engineering project, success factor, project team, project measurement

Contents

1 Introduction

Less than half of software projects are successful in the sense of keeping the schedule and the budget (Ernest-Jones, 2007; STA3, 2001). A need for successive software engineering tools and processes has existed over decades but developing improvements is still done in a narrow scope. When a project is successful from the customer's viewpoint, the product is of good quality, on time, and within the appointed costs, which fulfills the customer's needs in addition to requirements. The definition given in PMI (2008, 9) for success on the project level consists of (1) product and project quality, (2) timeliness, (3) compliance with the budget, and (4) customer satisfaction.

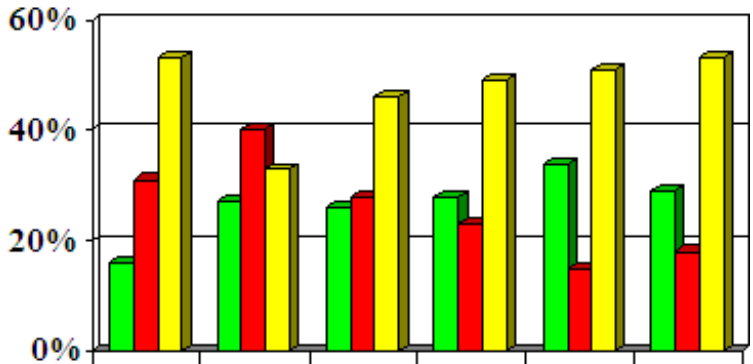
In addition to clear requirements, reaching this goal requires knowledge of the customer's environment and its functionality. Work estimation skills help to make a reasonable schedule. During the manufacturing process, actions should be taken in handling, solving, communicating, deciding, planning, controlling, monitoring, and managing many things and many persons in many ways. Many of these actions are, among others, the responsibilities of the project manager. The manager, in order to complete the job, uses process models such as the waterfall model, and work estimation models, for example COCOMO. These models, however, focus on processes at the cost of people.

Agile process models such as XP, Scrum, or FDD compared to traditional models enable flexibility and are useful particularly if exact goals are unknown at the beginning of a project. After all, software is intangible and complex, and volatility of requirements is problematic (Jurison, 1999). Alongside with this *system-control* focus (Watson, 2006, 30), the existence of human beings in software engineering projects has been noticed decades ago. The meaning of communication, persons and the impact of their capability emerge when a successful system is being produced (Curtis et al., 1988) even though mechanical process models ignore these elements. The focus of process models has emphasized organizations rather than people, no matter whether the viewpoint is in system-control or *process-relational* (Watson, 2006, 30) framing. Research has produced single observations about people, leadership, and humanity, but a larger, multidisciplinary scope integrated into software engineering projects is desirable.

This report presents a set of key subjects to guide project managers and supervisors in finding problems in software engineering projects. Things cannot be managed because people do the things. For this reason, one has also to observe processes as a result of what people do. With this knowledge, appropriate management and more economic projects become possible. The rest of this report has been organized as follows. Section 2 embodies the review of related research. Section 3 presents models focused on human resources, far away from the process viewpoint. Section 4 shows key factors of success and failures. Moreover, it helps project managers and supervisors to taylor appropriate questionnaires to find out problems and targets of improvements in their own projects. Finally, Section 5 summarizes the report.

2 Related work

Despite the half-century history of software projects, serious failures still occur. According to the critized "CHAOS report" from 1995 (STA1, 1995), only 28 % of projects were successful in the sense of time, budget and with the required features in small companies ($100 million to $200 million in revenue per year) in the United States. The success rate in large companies (over $500 million) were an alarming 9 %. In 1999 the Standish Group stated in its "CHAOS: A Recipe for Success" based on statistical facts that the smaller the team and shorter the duration, the greater the chance to succeed. In that report, company sizes did not seem to correlate with their project success rates anymore. Figure 1 presents the success and failure rates in software projects recently.



	1994	1996	1998	2000	2002	2004
Succeeded	16%	27%	26%	28%	34%	29%
Failed	31%	40%	28%	23%	15%	18%
Challenged	53%	33%	46%	49%	51%	53%

Figure 1: Success and failures in software projects (Hartmann, 2004).

In spite of the criticism of the reports, problems do occur in software projects. Many modern projects have no tangible outputs (Maylor, 2001). A world-wide study including the Americas, Europe, the Middle East, and Asia-Pacific (Ernest-Jones, 2007) surveyed IT projects from another viewpoint and found no more than half of the projects successful.

The project manager is the person who establishes conditions for the teams and key user experts to work at their optimum and reach results. Gunson et al. (2003) summarize that

> "The object is to go beyond tasks and milestones, cost and time constraints, and allow the project to transform the enterprise. This requires a synergy in the efforts of project actors and all stakeholders. Otherwise the end result is no more than a shared database and an integrated system for finance / distribution / manufacturing transactions."

Already in 1980, Zmud (1980) recognized that the key factor in commercial software development is the ability to allocate both technical and human resources in relatively

complicated organizational settings. Only some time ago, management has begun to see that human resources also mean something else than salaries or work time allocation. In the 1980s, programming productivity and quality were found to be improved by using hardware or software tools (Boehm, 1981; Thadani, 1984; Jones, 1986). The right kind of automization is good (Ravichandran and Rai, 1994). Nevertheless, understanding the knowledge, tools, and techniques is insufficient for effective project management (PMI, 2008, 13). Automatization in software process support has been overemphasized since the middle of the 1980s (Conradi and Fuggetta, 2002). Since software processes are largely dynamic and cooperative activities, the impact of software process technology with its modeling languages, editors and interpreters has only been small (Conradi and Fuggetta, 2002).

Crucial processes, such as learning, technical communication, requirements negotiation and customer interaction, were poorly described in software process models (Curtis et al., 1988). During the 1990s, the value of the social dimension was about to be adapted into software engineering as seen in Table 1.

	The report 1995 (STA1, 1995)	The report 1999 (STA2, 1999)	The report 2001 (STA3, 2001)	The report 2004 (Hartmann, 2004)
1st	user involvement	user involvement	executive support	user involvement
2nd	executive management support	executive support	user involvement	executive management support
3rd	clear statement of requirements	clear business objectives	experienced project manager	clear business objectives
4th	proper planning	experienced project manager	clear business objectives	optimizing scope
5th	realistic expectations	small milestones	minimized scope	agile process

Table 1: Extraction of the top five success factors listed in the recent CHAOS reports by The Standish Group.

The reasons for most project failures were seen in the managerial, not in the technical sector (Boehm, 1991; Phan et al., 1998). On the other hand, common project failures can often be traced to malfunctional team performance. This is caused by inadequate attention to people and teamwork issues (Jurison, 1999, 35–38). The level of contribution in Open Source projects seems to depend not purely on economics but technological and social motivations (Bonaccorsi and Rossi, 2004; Jensen and Scacchi, 2005). In software engineering generally, the correlation exists between contribution and social motivation without interfering economics (Bonaccorsi and Rossi, 2004).

Falling into the role of project manager by accident happens often and without adequate skills. Four key traits for effective project managers are (1) problem solving (diagnose most relevant technical and organizational issues for a solution or motivation to solving), (2) managerial identity (confidence to assume control and assurance to allow people to follow their instincts), (3) achievement (reward initiative and accomplishment, and show that taking controlled risks will not be punished), and (4) influence and team building (able to "read" people both in verbal and nonverbal ways and react) (Pressman, 1997, 62–63). In addition to team-building, an effective project manager has to be able to (1)

communicate, (2) organizate, (3) negotiate, (4) orientate goals, (5) work under pressure, (6) be competent technically, and (7) have leadership skills (Jurison, 1999, 24).

In contrast, PMI (2008, 13) emphasizes, besides any area-specific skills and appropriate general management expertise, the following characteristics for an efficient project manager: (1) knowledge (about project management), (2) performance (ability to work while applying knowledge of project management), and (3) personal (leadership, attitudes, core personality characteristics in personal behavior when performing the project or connected activity).

Team members should be highly experienced especially in projects involving new technology. Project managers should have, if possible, a strong technical and project management background. However, a certain level of technical competence is secondary. Primary are managerial and interpersonal skills. Moreover, a broad background is more important than expertise in any technical area. The mission of a project manager is to manage commitments and provide visibility to all parties involved. This visibility relates to such issues as project goals, system requirements, and plans, so that they are available and understandable to all participants. Foremost, structuring the team affects its performance (Jurison, 1999, 20–21, 24–28).

The following subsections map issues related to project matters and highlight the multidisciplinary area of software engineering projects.

2.1 Enriching the management scope with soft skills and values

Today's project manager needs the balanced mixture of soft and hard skills for being capable to operate in a customer-driven global business environment (Yasin et al., 2002). Unfortunately, managers of the old school still use the "I order, you jump" style because of their unwillingness or incapability to change. A traditional approach, wherein the context is seen between the project manager and team as leader–follower, teacher–learner, or manager–subordinate, should be replaced by facilitator–team contributor, and knowledge broker–expert (Gunson et al., 2003). Meanwhile, characteristics, such as judgement, persuasiveness, humor, and leadership, become more valuable than ever before during the Information Age (Prusak, 2001).

According to Table 1, "user involvement" is among the most important success factors in each report, as well as "executive management support". The "clear statement of requirements" of 1995 has changed to "clear business objectives". "Experienced project manager" seems to be a temporary trend (the lists from the years 1999 and 2001). Signs of agility exist from 1999: "small milestones" and "minimized/optimized scope" to 2004: "agile process". Numerous publications related to critical success factors concerning information system projects exist, listed, for example, by Esteves and Pastor (2001, 16–18). Team-based learning, group behavior, and ways in which people create purposes and communicate are key elements of the group wherein they form (Hutchings et al., 1993). Information sharing, decision-making and planning are important when working in a group to enable the group to execute its process (Hutchings et al., 1993). However, knowing each other and co-operating energetically and efficiently takes time (Tuckman and Jensen, 1977).

2.2 Lack of direction

One difference between theory and practice is the uncertainty. De Meyer et al. (2002) refer to four types of uncertainty: (1) variation, (2) foreseen uncertainty, (3) unforeseen uncertainty, and (4) chaos. Managers should handle uncertainty by being flexible enough to adopt the right approaches at the right time. Uncertainty is a rule, not an exception. The greatest chance to produce a successful project lies in companies which understand this (De Meyer et al., 2002).

Project managers have tried to avoid failures and to correct problems constantly after becoming aware of them. Unfortunately, such management by looking in the rearview mirror does not utilize a proactive approach. Project managers have focused on the schedule and technical failures. Experience, however, has showed that failure factors that are difficult to correct are usually human-related – far away from the technical aspect. People have a tendency to concentrate on the technical aspects (hardware and software) rather than the peopleware and impermanence. This impermanence caused by the solution covers everything from existing structures and ways of doing business to teams which are born for the purpose of a certain project and then disappear (Gunson et al., 2003).

Time, costs (resources), and the results are the base for any commercial project. However, these dimensions do not suggest a project manager to concentrate on people. Rather, they even create incorrect needs for the project management. For example, one may think that the results are under control if (1) time can be managed presuming that a timetable has been planned well and (2) the costs can be managed presuming that the amount of work and the resources are known, the plans do not fail, and unexpected things will not happen. Basically, such a conclusion ignores people.

A project manager needs to have emotional intelligence and sensitiveness, and reactive capacity whenever a crisis (e.g. a crisis impossible to prepare for) occurs. (Gunson and de Blasis, 2003). Coaching, mentoring, and leadership skills help the project manager make the right decisions even in unknown-unknown situations (Gunson et al., 2003). Experienced project managers have the same kind of risks ahead as novices but experienced ones rate risks in a different way. Experienced managers also use less risk controls than novices because of the awareness of their capability to manage software projects (Addison and Vallabh, 2002). In more detail, project management skills include analysis, design, coding (modifications, conversions, etc.), testing or validation, and end user training. By applying these skills in practice, project managers have a chance to manage tasks, resources, delays, budgets, and needed project management tools (Gunson et al., 2003).

However, managing a software project is not simple because it is not only a formally designated set of tasks. Typical software-related problems concerning management are: (1) Intangibility: software is difficult to manage without visible milestones to measure quality and progress. (2) Complexity: the sheer complexity of software is not so comprehended and this leads not only to technical but management problems, too. (3) The volatility of requirements: the pressure for software changes is high because software can be changed more easily than hardware (Jurison, 1999).

"Managerial activities are always and inevitably implicated in issues of power and relative advantage and disadvantage between human groups and human individuals.", as Watson

(2006, 12) writes. Although most projects are teamwork processes, project managers may not recognize the value of their individual employees and the team power, namely, no one can lead things. Things, instead, have to be led through people who make the things (Blanchard, 2001). Managing things through people creates a need for leading skills, such as motivating, empowering, supporting and truly caring for people. People can work motivated or demotivated but results will be different (Blanchard, 2001; Robbins, 2002). Sackman's second law states: "Individual developer performance varies considerably". Even noticing critique and anomalies against this conclusion made from the experiment, seven-fold differences in performance are possible (Endres and Rombach, 2003, 188–189). One common mistake is that a greatly intelligent information technology nerd is promoted to a project manager as an award (Gunson and de Blasis, 2003). Unfortunately, a "skillful programmer" is not synonymous with a "good leader". Strong technical expertise would enable such a person to participate in technical decission-making and conversation. After the promotion, however, the project may have one capable software specialist less and one incapable manager more. An inability to control and lead the project is an enormous disadvantage or disaster. The assumed seven-fold efficiency in performance is a serious loss for any project.

2.3 Critical success factors in management

Management should be used to provide focus for using the resources to achieve the specific objectives. Things that must go right for a successful project, called critical success factors, are (1) clearly defined objectives (2) top management support (3) adequate budget (4) realistic schedule (5) client/user participation (6) project leadership (7) project reviews (8) change control/management (9) communications, and (10) problem solving (Bullen and Rockart, 1986). These factors should be used for creating a kind of base for project managers to develop their own set of factors. Although the factors are neither action-oriented nor guidable enough for management actions, and are mentioned over 20 years ago, they still show that software engineering projects have not internalized them sufficiently because failures occur even nowadays. Many project managers use involvement as a risk control method for management, users and the steering committee during the project. Management involvement especially decreases the risks of (1) unclear or misunderstood scope or objectives, (2) unrealistic schedules and budgets, and (3) continuous requirement changes (Addison and Vallabh, 2002). The two latter were also identified as the two most frequent risk factors in software projects (Addison and Vallabh, 2002). Even 11 years earlier, Boehm (1991) ranked these two factors among the top six of the software risk factors.

Moreover, other risks occurring in software projects regularly are (1) lack of senior management commitment to the project, (2) failure to gain user involvement (i.e. developers may have to make assumptions about functionality details and objectives when users are not involved), (3) inadequate knowledge or skills (e.g. knowledge of the personnel in technology, business, or project handling), (4) lack of effective project management methodology, (5) misunderstanding the requirements, (6) gold plating (i.e. developers' thoughts of additional capabilities or changes to improve the system), (7) developing the wrong software functions (from the user or technical viewpoint), (8) subcontracting (e.g. shortfalls in externally developed components), (9) resource usage and performance, (10) introduction of

new technology (not successfully in use in other organizations thereby being risky), and (11) failures in managing end user expectations (Addison and Vallabh, 2002).

2.4 Communication

Communication breakdowns are a daily problem in project development. Communication is allowed from the individual level to the business milieu through the team, project, and company levels without the control of a project manager (Figure 2). This *Layered Behavioral Model* helps to analyze software development from the viewpoint of individuals, teams, projects, companies, and business millieu. The model emphasizes factors which affect psychological, social and organizational processes. Hence, it helps to clarify how the processes affect productivity and quality subsequently. Curtis et al. (1988) argue that since software systems are generated by humans rather than machines, their creation must be analyzed as a behavioral process. In the model, the individual level is for an intellectual task subject to the effects of cognitive and motivational processes. However, the development task grows bigger than a single software engineer can handle and a team is convened. Social processes interact with motivational and cognitive processes in performing technical work. In addition to intrateam, interteam group dynamics must also be handled. The project size and structure determine how much each layer influences the development process.

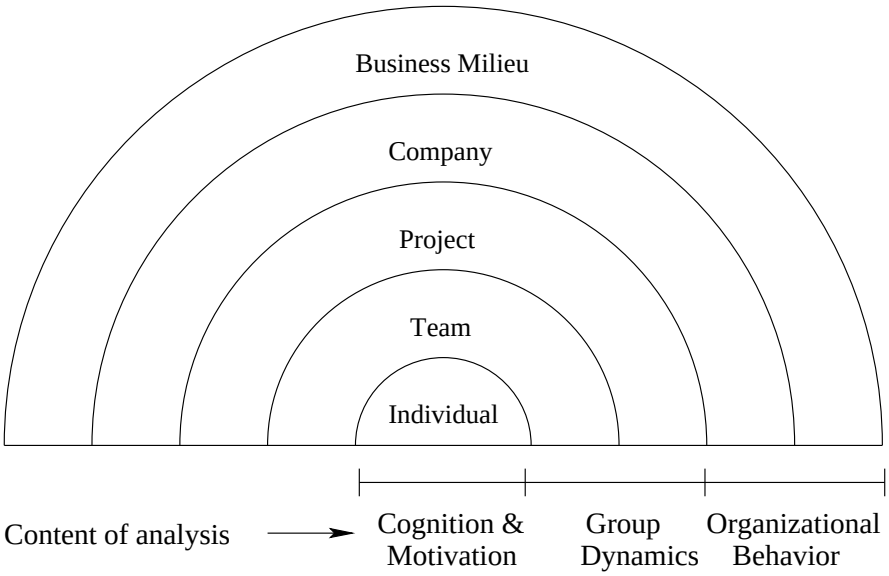


Figure 2: The Layered Behavioral Model of software development (Curtis et al., 1988).

The longer the communication path the more likely messages tend to be corrupted on their way from the source to targets. People at the medium levels may not understand messages of other contexts, i.e. messages that come from lower or higher levels of the organization. Hence, messages going from one level to another get changed before they reach the final destination. Informal personal contacts are frequently the most effective way to transmit messages across organizational boundaries (Curtis et al., 1988).

Nevertheless, communication, accompanying of change, conflict anticipation and resolution, and knowledge management skills were not widely known even in the 1990s (Gunson and de Blasis, 2003). Lack of shared understanding in and between organizations or communities shows as hiding of decision-making process and as decision-making without authority approval (Jensen and Scacchi, 2005). Teasley et al. (2000) even show how the productivity in teams can be doubled by easing their access to each other and by making work artifacts visible to all. In addition to collaboration, leadership, and conflict resolution, communication is considered a success factor in communities of open source software development as well (Jensen and Scacchi, 2005).

2.5 Human Resources

Customer perceptions of quality have a direct influence on information system providers and their products (Licker, 1992). Without understanding human relations, project managers have great difficulties to control their customers or even their own software teams. Project managers can put their teams to work hard with their authorized autocratic power but such management will not motivate the employees.

The five-stage theory of Tuckman and Jensen (1977) about growth and development of the groups suggests that teams need changes to grow. According to the model, the team development starts by *forming* the group and ends in the *adjourning* via the *storming*, *norming* and *performing* stages. The first problems occur right at the beginning. After the group begins to meet, people typically focus on belonging in the group and on orienting themselves. They sit back waiting and collecting more data before really joining the group (Hutchings et al., 1993). Ideally, groups go through the forming stage to the storming stage, from the storming stage to the norming stage, and so on. Maturing requires time and after groups grow, they become more efficient. In practice, fallbacks may occur, for example, from the performing state to the forming or storming stage. Some groups never complete the storming stage (stage 2) probably causing a disband and inability to reach the goals. That is why exceptional results and the highest levels of performance in certain groups are unreachable (Pugh, 1991; Schein, 1988).

To dramatically improve project outcomes with software development technology, understanding is required on how human and organizational factors affect the execution of software development tasks (Weinberg, 1971; Scacchi, 1984; DeMarco and Lister, 1987). Software development should be studied at several behavioral levels (Kling and Scacchi, 1982) including individual, team, project, company and business milieu levels (Curtis et al., 1988). Without focusing the individual, team and the project level, the outer shields of the layered behavioral model of software development (Figure 2) cannot be formulated clearly. A project manager should do the following actions when he or she is concerning a potential or actual conflict situation: (1) cultivating trust among team members, (2) overcoming communication barriers, (3) aligning goals of individual team members, (4) ensuring that the team possesses necessary knowledge and skills, and (5) obtaining clarity regarding team objectives (Govindarajan and Gupta, 2001). On the other hand, many situations and whole projects have been rescued in projects which have had so-called *exceptional designers*. First, they are extremely familiar with the application domain. This crucial contribution enables mapping between the behavior required from the application system

and the computational structures that implemented this behavior (Figure 3). Moreover, they have envisioned how the design would generate the system behavior that customers expect even under exceptional circumstances. Despite this envisioning, they may be weak programmers. Second, they are skilled at communicating their technical vision to other members in the project. They usually possess exceptional communication skills and much of their designing work is accomplished while interacting with others. Third, they are the primary source of coordination among project members. They spontaneously engage in, without formal recognition, many management responsibilities for ensuring technical progress (Curtis et al., 1988). Curtis et al. (1988, 1272) write that

> "although a project may have experts in each functional domain, these experts may be unable to model the effect of component integration on processing or storage constraints. Exceptional designers **can** and also are adept at identifying unstated requirements, constraints, or exception conditions."

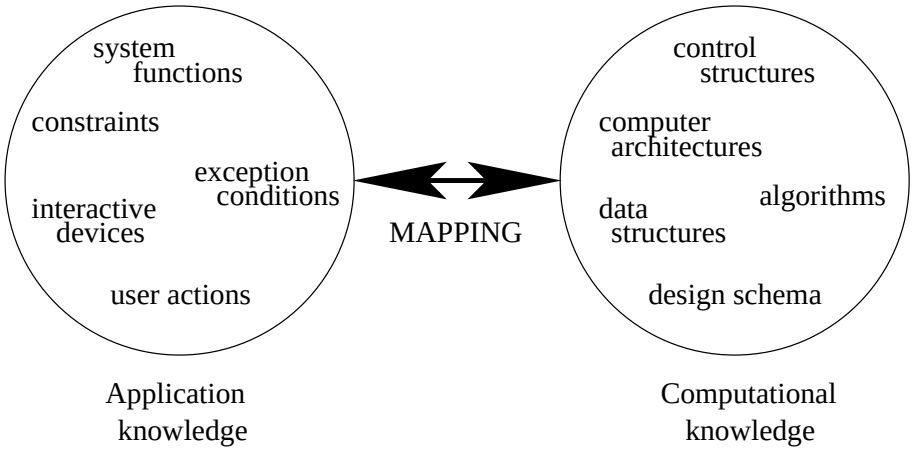


Figure 3: The expertise of exceptional designers (Curtis et al., 1988, 1272).

Relying on the performance of a few individuals in a project is risky. On the other hand, insufficient resources or inappropriateness prevent training the whole personnel to be as skillful as exceptional designers.

2.6 Software Process Improvements

Participative engagement in all process changes and activities is needed to improve software development. Skillful workers do not like top-level dictates to tell them how their work should be done. Continuous improvement of software processes and quality requires participative attention from all employees. This attention cannot be delegated to internal visionaries or quality managers. Long-term dimensions should be preferred and launching projects should be made humbly with small steps (Conradi and Fuggetta, 2002, 98).

In the study of Curtis et al. (1988) the most salient problems reported in projects concerning additional efforts or mistakes included: (1) the thin spread of application domain

knowledge, (2) fluctuating and conflicting requirements, and (3) communication and coordination breakdowns.

Software process improvement is about learning, not control. When a special software process improvement team is created, it should be done separately from the quality assurance department. A reward system should be considered to support problem reporting and improvement suggesting. However, improvement and learning is something that cannot be forced from the outside. These issues have thereby to become an ingrained part of the work process. Otherwise, workers may learn to work around and involve ineffective processes. The software process should be improved by applying results from organizational and behavioral sciences which concern creativity and cooperation in software development. These observations also apply to a large set of creative design processes (Conradi and Fuggetta, 2002).

Process quality associates positively with the extent of planning. Also, assessing the effectiveness of the development process associates positively with the product and process quality. These propositions relate to the development methodology, standardization, project management, and task and control structures of teams (Ravichandran and Rai, 1994, 278).

To improve software quality and productivity, the following issues should be considered: (1) knowledge of application domain should be increased and expanded across the entire software development staff, (2) software development tools and methods should take change into account as an ordinary process; moreover they should support the representation of design decisions in doubtful circumstances (e.g. prototypes or simulations), and (3) making any software development environment into a medium of communication to integrate people as well as tools and information (Curtis et al., 1988).

2.7 Issues outside the project

Stakeholders without appropriate knowledge about projects are a problem, among others, if they have a tendency to get maximal profit in minimal time. Less money is seen as more important in the short run – no matter whether this attitude damages the business – than more productive business with a potential risk to lose everything in the long run. Project managers must tell the upper and top management that reproducible, convincing results may take some time. Those management boards, in turn, should be capable to tell stakeholders the name of the game. The goal should be that the customer, not the stakeholders, feels they have got tangible benefits as the result of the project.

In as early a process as a software assessment, the first step is to obtain commitment from the managers of the organization. When senior managers believe that the process will benefit them, the level of commitment of participants begins to increase (Weiss et al., 2002).

The meaning of cultural differences in multinational projects should not be ignored either. Communication, interaction or behavior between team members may be interpreted generally inpolite, if cultural differences are not understood in the project. For these reasons, cooperation suffers. Raynaud's three different dominant logics are (1) the contract

(Anglo-Saxons including USA), (2) the consensus (Nordic cultures), and (3) the logic of honor (Latin countries including France) (Gunson and de Blasis, 2003).

3 Models outside the software engineering

Agile process methods take into account many actions mentioned above (Abrahamsson et al., 2002; Poppendieck and Poppendieck, 2003). Unfortunately, counting on a certain process model makes managers forget the fact that software projects evolve people. Such a management base does not refer to "soft values" nor leadership but to mechanical routines. This misleading mechanic can still be seen by looking at modern project management: the domination of "hard values" (e.g. dictating instead of directing, being "mother in the backseat" instead of coaching, shrinking instead of supporting, and rejecting instead of delegating) (Blanchard, 2001). Basically, the words "time", "cost" and "result" do not hint that a project manager should prefer soft values. They rather indicate ignoring commitment and focusing on work and implementation without taking people into account. A sense of competence or satisfaction manifesting the team's pride and confidence should not be underestimated (Hutchings et al., 1993, 110–111). The following subsections present three models which are not process models but rather models which highlight human aspects in any team-based software project.

3.1 Project Manager Attributes (PMA)

Management skills are important but inadequate for a project manager. Leadership and critical skills are needed too. *Project Manager Attributes Model* (Gunson et al., 2003) combines managerial and leadership aspects (Figure 4).

The principle of the model is similar to the CMMI model, i.e. moving to a higher level becomes possible when the persons are mature enough at the current level. In the PMA, skills needed in lower levels may be acquired or in-sourced. Instead, in upper levels, one has to be born with the skills required. Although the viewpoint lies in ERP, software engineering in more general fits into the framework as well (Gunson et al., 2003).

A leader should understand how the individuals view themselves. Their socialisation is likely to result in various identities (passive or active). Team members will then discover values of the project manager through actions, which may be critical for project success and for resulting in energy to the team members (Gunson et al., 2003).

The level next to the management skills level (level I) is the level of interpersonal skills (level II). These skills include an ability to communicate and negotiate. At this level, the project manager should participate in the management committee in the organization. The level of coaching and mentoring (level III) includes skills associated with motivating a team: the project manager defends the team and is its champion. He or she should act like an interpreter between the upper management, the user management and the team. In this way, important messages should get across these organizational levels without corrupting or disappearing. When a project manager contrives to accompany with the team during changes, powerful impact on project success is likely to occur. This is associated not only

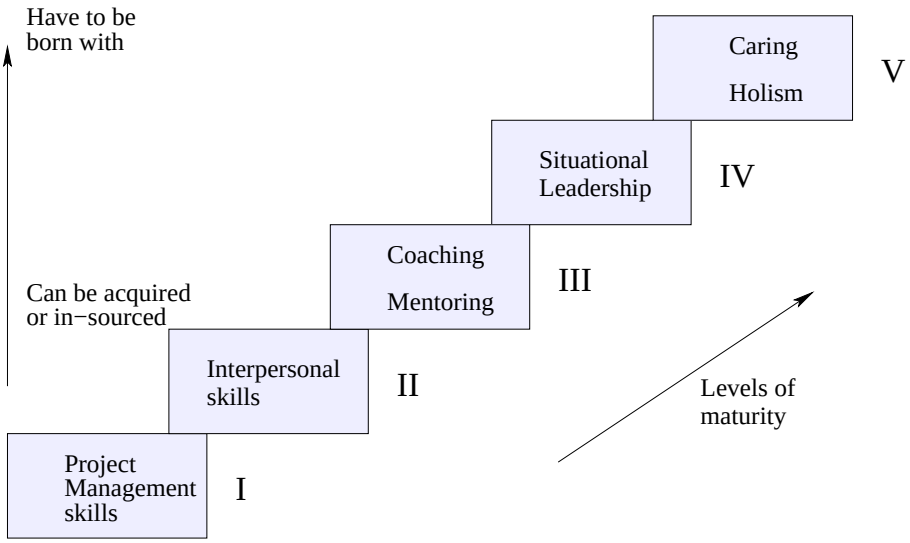


Figure 4: Project Manager Attributes Model (Gunson et al., 2003).

with the team level but with all levels of the hierarchy (Gunson and de Blasis, 2003). The level of situational leadership[1] (level IV) is the ability to respond correctly to even unknown-unknown situations. This is leadership in real time because actions and reactions must often occur within a short timeframe. A series of independent problems may be easy to solve one at a time. The manager with appropriate skills in situational leadership should be able to handle these problems even when they come at such a volume and speed that they constitute a crisis (Gunson et al., 2003).

The highest, the level of caring and holism (level V) is the process of empathizing and using one's "sociological imagination". The level is also the quality of existing (presence). This level can be described but, on the other hand, it is paradoxically intangible: it is a natural-born gift that cannot be learnt. Table 2 shows the attributes of this fifth level.

What it is not, the tone is not right	Characteristics that suggest it is working	Effect it should have on the project team
Agony Aunt	Approachable	Dynamizing
Bleeding-heart liberal	Listener	Motivating
Manipulative	Empathetic	Creation of a prototyping space for problem resolution
Calculating	Instinctive	Good communication
Insincere	Project before self	Synergy
No clear outcome	Character before career	Moving of mountains
Total $\leq$ sum of parts	Bold and loyal	Commitment, trust, fun

Table 2: The fifth level of maturity, Caring, Holism as attributes of the ERP Implementation Project Manager (Gunson et al., 2003).

[1]This level is not the same as the Situational Leadership II model, presented in Section 3.2.

Gunson et al. (2003) suggest caring and holism as a partial solution for attracting and retaining brilliant staff. This requires true presence and attention to actors: both the right kind of support and awareness of their roles in the workplace and on the project. Working 24-hour shifts have causes and effects with accidents.

Coaching is (in football as well as in software development) "constantly pushing the team to attain what they are capable of, encouraging them when discouraged, exhorting them to be lean, mean and to win against all obstacles" (Gunson and de Blasis, 2003). Leadership in Real Time is partly coaching but also conflict resolution and attitude of caring. The ability to anticipate conflicts is needed before crises and risks affect the project. In conflicts between persons or within groups, the project manager should be sensitive and manage to find ways to minimize or even eliminate the stressors (Gunson and de Blasis, 2003). Projects must be placed ahead of everyone's personal needs in their work. The correct point of view is a win-win situation for every single actor rather than a pessimistic attitude. Team members may not be aware of this viewpoint, which is why their project manager needs to see the situations from the viewpoint of each actor. Moreover, the manager should know where the members may not see their own individual interests (Gunson and de Blasis, 2003).

The project manager needs to find a balance between leading and supporting the team (Blanchard, 2001; Blanchard et al., 2004; Gunson and de Blasis, 2003). After all, a project manager with all PMA skills is inadequate for the project. Project sponsors, the steering committee and the upper management should show charisma and sustained leadership throughout the project. The steering committee should consider the PMA model when selecting the project manager (Gunson et al., 2003). The following acid test for the selection is preferred: (1) actions and reactions in a candidate's prior functions, (2) perceiving by his peers, (3) handling simulated project crisis situations, and (4) perception of self and self-concept (Gunson et al., 2003).

3.2 Situational Leadership II (SLII)

Succesful leaders have the ability to adjust their leadership behavior appropriately in different situations. Being aware of different situations at different moments is essential. One insufficiency of many leadership or software process models is they ignore the variable nature of the world. Nevertheless, a subordinate has more than one need during a single task completion. In addition, the expertness of subordinates varies by different tasks: subordinates have different kinds of expertise at the same time, even in the same project and in the same task (Blanchard, 2001; Blanchard et al., 2004).

The *Situational Leadership II (SLII)* theory model (Blanchard, 2001) takes this point into account at the same time on both personal and team levels. The model focuses on the concrete level of practice: what behavior is considered correct when leading subordinates? Two elements, presented above in other models, of the model are (1) relationship behavior on the socio-emotional level and (2) directing of work behavior. In addition to these areas, the new element in the SLII model is the set of development stages of subordinates. The model divides these development stages into four categories according to the needs of subordinates or teams regarding a certain task or a goal.

A certain leadership style is suitable for a certain development stage. A leader should identify this development stage on both the personal and team level regarding appropriate tasks or goals. SLII emphasizes dynamicity and a need for changing leadership styles according to any development stage of subordinates individually. Moreover, the same person may be (and usually is) on different development levels at the same time because of various tasks or goals. Besides, subordinates usually grow throughout the project. This growth goes in a positive direction if the leader is competent. For example, person A is a newcomer in the organization, so he does not know much about corresponding methodologies or policies. Meanwhile, person A may be an excellent C++ coder who is rather an advisor than an apprentice. Now, A is in two different development stages at the same time and the leader should notice this. When A learns the policies, he is not a beginner any longer in that sense. However, if A's project work skills are weak, conflicts or decrease of team spirit may occur. Thus, person A being familiarized with the policies and methods is inadequate.

In other words, the idea of the model is that a leader should use the right leadership style at the right time to correspand to the development stage of a subordinate or a team. This appropriate, dynamic behavior of the leader results in the highest productivity (Blanchard, 2001; Blanchard et al., 2004).

Personal development stages (D1 – D4) from the beginner to the expert are as follows. *Enthusiastic initiator* (D1) has a high commitment but low competence (hopeful, curious and optimistic but inexperienced). *Disappointed learner* (D2) has a low commitment because the current or previous work task has proved more difficult than expected in stage D1. However, this pressurised, confused, unmotivated and frustrated person shows signs of competence. *Careful performer* (D3) is the consequence of overwinning disappointment. Their commitment varies due to self-confidence damaged during stage D2 but their competence is semi-high. Although this kind of person is unsure, bored and self-critical, skills and accomplishments have increased from stages D2 and D3. *Self-reliant attainer* (D4) has both a high commitment and competence. This advance-orientated expert is fairly confident, proficient and enthusiastic which encourages others.

The corresponding leadership styles (S1 – S4) for these personal development stages in the corresponding order are as follows. *Director* (S1) makes most decisions and looks after subordinates' performance. Director defines, specifies, plans, prioritizes, guides, shows and instructs. *Coach* (S2) explains decisions and listens to suggestions from subordinates. Tasks for Coach include clarifying, correcting, giving feedback, encouraging and acknowledging. However, Coach still makes the final decisions. *Supporter* (S3) listens to and encourages subordinates as well but, in addition, offers opportunities for the subordinates to make self-reliant decisions. Supporter asks, persuades, cooperates and shows appreciation. *Delegator* (S4) authorizes subordinates to perform self-reliantly and gives enough resources for performing. Delegator trusts, assures, challenges and keeps in touch while the subordinates make most of the decisions.

Common tasks for a leader in each leadership style are (1) defining expectations and goals, (2) monitoring and controlling performance, and (3) giving feedback (Blanchard, 2001).

3.3 PERFORM

Since most software products are made in groups (or in teams), the team level should be focused carefully. The PERFORM model states characteristics for a high performing team. Awareness of these characteristics enables applying the Situational Leadership II (Section 3.2) principles for successful team leadership. The acronym PERFORM consists of the following.

- (P)urposes and values remind of the team's clear commitment to a common purpose, and common values improve integrity, quality and collaboration.
- (E)mpowerment means availability of relevant organization and business information, as well as initiative, involvement and creativity encouraged by values, norms and policies.
- (R)elationships and communication stress the meaning of respect toward differences in the sense of ideas, opinions, feelings, perspectives, and cultures. Attentiveness includes honest and caring feedback and understanding.
- (F)lexibility consists of shared responsibility, using unique talents and strengths, and openess to explore different ways of working. Calculated risks are also supported.
- (O)ptimal performance constantly builds up production of significant results. The team commmitment is required for high standards and measures for productivity and quality. The team learns from mistakes and improves continuously.
- (R)ecognition and appreciation happens, when team contributions are recognized and valued by the larger organization. A feeling of high regard within the team is common, and accomplishments are acknowledged.
- (M)orale based on confidence and enthusiasm about the team's efforts. The sense of pride and satisfaction is strong and the members help each other (Blanchard et al., 2004).

4 The dimensions and their subjects for finding targets of improvements in the projects

This section is grounded on the notifications that emerged in the previous sections as an aid to design a questionnaire for software engineering projects. The aim is to find targets for improvements in the projects. The following subsections present relevant issues, here called *subjects*, which affect the success of projects. The subjects have been categorized into logical groups, here called *dimensions*, which is helpful when focusing on certain problem areas of projects under monitoring. Particular arguments and explanations of why these subjects are relevant, will be given. Mainly, the subjects have been chosen because literature recognizes them as common reasons for failures or success factors in projects. In this sense, the subjects are expected to reveal signals from threats or opportunities. The subjects have been categorized into logical dimensions, which makes it easier to focus on problematic areas as a whole in one's projects.

Most of the subjects may not be translated directly as questions into a questionnaire. Rather, the subjects express relevant viewpoints of their current dimension, which enables one to taylor the subjects for one's own purposes. Thereby, this tayloring offers a certain viewpoint for the R&D sector to find weaknesses and targets for improvements in the projects. Some subjects may be applied at the beginning of projects while the others are found difficult to answer before the end of projects. Part of the subjects may come through with a self-evaluation, some with a peer-evaluation.

The author has pre-evaluated the subjects empirically by applying them as questionnaires on the real-world-imitating capstone software course, called Software Engineering Project, for Bachelor-level students in the Department of Computer Science at the University of Helsinki. This evaluation consists of data from 61 students in 12 teams, gathered during six semesters during 2007–2009.

4.1 PI: Project information

This dimension asks for general information, and estimations which then can be compared with realisations in the project success (see the SU dimension). Tight deadlines often eliminate quality because time resources have not been allocated for making mistakes nor fixing them.

PI-01: Is the project schedule easy so that the team will not be busy even at the end of the project?

PI-02: Total estimated number of project hours (all members in total).

PI-03: The maximum number of participants simultaneously in the project regarding the supplier organization?

PI-04: How many interest groups there is or will be in the project (client, subcontractor (each separately), board, etc.)?

PI-05: How challenging the project is in a technical sense when compared with a typical project in your organization?

PI-06: How challenging the project is in a managerial sense when compared with a typical project in your organization?

PI-07: Process model being used?

PI-08: Project-specific goals in this project which are not included in the requirements?

PI-09: "Driving factors" which are conducive to the project.

PI-10: The best characteristics of the customer for the project and their influence on the project.

4.2 TC: Technical competence

The TC dimension not only maps the technical competence of the members but enables the comparison of technical skills of a manager and other members, too. A manager unable to contribute in technical meetings usually has to move decision-making to subordinates because of weaknesses in their own technical skills. In such situations, management of the project becomes more difficult. The lack of a technical leader (and thereby the lack of an executive coordinator in technical issues) may increase conflicts between engineers when they argue about what techniques and tricks they have just learned in courses they should use in the implementation (Curtis et al., 1988). Comparison of RS-05 and RS-06 with the TC dimension and CO-10 implies whether the members are competent in their current assignments.

The subject TC-01 asks about experience on level 1 of the PMA model (Section 3.1). Most managers cannot estimate their staff's capability limits and its impact on producing a successful system (Curtis et al., 1988, 1274). TC-02 finds the existence of this problem when the answer of the project manager is compared with the answers of the members in TC-02 and individual answers of the subject RI-12.

TC-01: Your experience in the following project stages (in general).

(a) Analysis / requirements specification

(b) Designing

(c) Implementation/programming

(d) Testing/validation

(e) Application/training of end user

(f) Maintenance

TC-02: Major limits of the members in technical competence.

4.3 RI: Respondent information

The RI dimension asks for general information (RI-01 – RI-03, RI-11, and RI-12) about individuals and their efforts (RI-05 – RI-07) for the project while RI-04 maps the duration of work experience. The subjects RI-08 – RI-10 ask about issues on level 2 of the PMA model (Section 3.1).

RI-01: Gender.

RI-02: Age.

RI-03: Education.

RI-04: Work experience.

(a) Programming or design work.

(b) Project work in IT.

(c) Project management.

(d) In how many projects have you participated in the work force (a rough estimate)?

RI-05: How many hours per week have you planned on using on this project?

RI-06[2]: How many hours per week (roughly) will you use on other work tasks during this project?

RI-07[3]: How many hours per week (roughly) will you be working during this term?

RI-08: Negotiation skills.

RI-09: Teamworking skills.

RI-10: Communication skills.

RI-11: How experienced are you in the current process model being used?

RI-12: Which languages, tools, project working skills (etc.) do you think you will have to learn (or have you already learned) during this project, in order to perform your assignments or reach the goals?

4.4 PP: Problems in the project

The following subjects map discovered, noted problems directly from the viewpoints of the project personnel including the managers. The comparison between these answers reveals differences in the stands of the groups.

PP-01: The biggest problems during the project and solutions made for them?

PP-02: How could these unsolved problems may have been solved or even prevented?

PP-03: Turning points: Has temporarily or permanent disappointments occurred in the project?

PP-04: Elements that restrains the project.

PP-05: The worst characteristics of the customer for the project and their influence on the project.

[2]For educational version: How many hours per week (roughly) will you use on other courses during this term?

[3]Note! Only for educational version.

4.5 FS: Finding solutions

The goals cannot be attained nor can problems be solved if they are unclear for project participants. The FS dimension asks about the clarity of problem definition and methods used in problem solving. Team members have to develop certain issues as a common approach to getting things solved and done. Successful groups do not accept the obvious causes but think their way around the problem thoroughly (Robson, 1993; Poppendieck and Poppendieck, 2003). The subject FS-02, based on the model of Robson (1993) regarding group problem-solving processes, maps methods the teams use when they are finding a solution. The model combines analytical and creative methods which both are necessary for team members. The FS-03 is based on the question set of Boddy (2002, 140) including our interpretations to apply the questions from the scope of general management to software engineering.

A comparison of the answers within members of teams reveals the difference in visions and a consensus in teams.

FS-01: Clarity of problem definition for the members.

FS-02: Which of the following methods were used to further the project?

(a) brainstorming

(b) thorough clearing of encountered problems

(c) looking for more than one basis and solution

(d) finding necessary information (to solve a problem)

(e) modelling possible solutions (before making a decision)

(f) unanimity about the best solutions

(g) cost efficiency analysis for the selected solution

(h) implementing an experimental solution before making the decision

(i) monitoring and analysis of the effects of implemented solutions.

FS-03: Object clarification in the team.

(a) Does the team know what it can and what it cannot achieve?

Realistic expectations	1 2 3 4 5	Expectations too high or too low

(b) Does everyone know what they have to do alone and what together?

Clear targets	1 2 3 4 5	Unclear targets

(c) Can the members solve conflicts and formulate plans how to do it?

Clear problem definition	1 2 3 4 5	Conflicting priorities

(d) Does the team accept tasks to do to achieve targets: no matter if these are difficult or uncomfortable

High acceptance and commitment	1 2 3 4 5	Hidden agendas

(e) Has the team an ability to reach targets which are set?

Work achieves several objectives	1 2 3 4 5	Multiple goals appearing to be inconsistent

(f) Does everyone like to work with high quality and cares that the software product fullfils customer's needs?

People take initiative to meet objectives	1 2 3 4 5	Confusion and poor commitment

(g) Does the team concentrate its resources to relevant matters and doesn't waste time on irrelevant issues?

Focused effort	1 2 3 4 5	Misdirected effort

4.6 RS: Resource status in the project

Small projects are easier to manage than big ones. Big projects need big resources. The following subjects help to highlight the lack of resources in projects. Comparing the answers of the dimension with the answers of the SU dimension will clarify connections between the resources and the success.

If the project is currently not the only one for the participants (RS-01) or it is inbalanced along other tasks (RI-05 – RI-07, CO-02), focusing on one task creates unwanted pressure. Moreover, continuously switching the focus between projects or tasks takes time at each step, which lowers the ability to concentrate on any project or task (Poppendieck and Poppendieck, 2003).

Project resources can have a different status. Table 3 shows reasons and suggestions to reach an agreement. According to project managers, senior managers often underestimate the resources that a project would need. The personnel of a project should be – besides competitive in a certain operational area – accomplished at project skills too. If the status is poor, project goals are not reachable easily (Boddy, 2002). RS-03 and RS-04 ask about this status.

RS-05 and RS-06, when compared with CO-03, PG-01, PG-04, and RI-04 give signals on how well the abilities of the participants have been utilized by assigning them into the right positions in the project. In addition, comparing RS-05 with RS-06 may indicate a coordination problem if the tasks in practice differ from the formal assignments.

RS-01: Is the project full-time for the members of the team?

RS-02: Acquiring resources. have the resources been mapped (how much of the stake can be used for the project), have they been divided well among the project team, have they been kept in mind throughout the project, and have they been administered efficiently?

RS-03: Resource status of the project at the moment.

Status of project resources	Reasons	Theoretical perspective to reach agreement
Adequate and available	Senior management has understood requirements.	Life cycle. Clarify and operationalise resource allocations.
Inadequate and causing delays	Insufficient appreciation by management of scale or type required.	Participative or political depending on the scale of the gap in requirements.
Available, but allocated to other projects	Disagreement among senior managers over priorities, or between powerful sectional interests.	Political. Project managers may have little ability to resolve problem. Identify most powerful players, possible expose differences and what they imply for the project.
Changing	Changing external demands or changes in other projects creating ripples. Learning as a result of work done during the project to change elements of the context prompts review of options and resource requirements.	Participative and/or emergent. Encourage awareness that change is likely, and engage players in open review and revision. Resource estimates can only be provisional when a project is a voyage of discovery.

Table 3: Status of project resources (Boddy, 2002, 68).

(a) Adequate and available.

(b) Inadequate and causing delays.

(c) Available but allocated to other projects.

(d) Changing invariably.

RS-04: At the moment, what grade would you give to the direction who provide resources for the project? Who or what is this direction?

RS-05: What are your formal tasks and responsibilities?

RS-06: What are your tasks in practice?

4.7 CO: Coordination

A very common reason for a failure or delay in an IT project is lack of co-ordination between IT and line business managers. According to the study of Ernest-Jones (2007,

9–10), this was the case especially in Europe where 47 % of the respondents agreed. In America, the corresponding percentage was 32.

The items in the subject CO-09a as well as in CM-06, CM-07, IP-03 – IP-06, PG-20 – PG-25, PG-31 – PG-35, SO-10, and SO-12 – SO-15 are based on the *People Capability Maturity Model (the People CMM)* (see Curtis et al. (2001)). The subjects CO-04, CO-06, and CM-08 concern the matter of unawareness while the subjects CO-18 and SO-16 ask whether the project expectations are realistic. The subjects CO-17 – CO-21 as well as MF-17 and SO-16 are based on the Project Profile tool by Boddy (2002, 18–27) wherein a high-point answer (i.e. the right end of the axel given in each item) in a single category implies that problems will probably occur in the project. A high-point sum of the answers, suggests random-defined activities, unacceptance of the project goals, and uncertainty in reaching the goals. A low total sum of answers, however, may be a signal of unclear boundaries, a great difference in understanding the goals, and errors in estimating how the milestones are reached (Boddy, 2002, 18–27). Comparing the manager's answers with the answers of the team members reveals whether more attention should be paid to communication and information.

Moreover, outsourcing (CO-20) is one common reason for delays or failures in IT projects: changing things during a project is clumsy when the change has to be coordinated in many organizations (Ernest-Jones, 2007). The process model being used (PI-07) and the experience of participants (RI-11) in that model have to take into account when estimating changes regarding already accepted requirements or decisions made in design or implementation (CO-21). The focus level of efforts can be formulated with the aid of the RS and ME dimensions with the answers related to the subject CO-16.

CO-01: How did you become/how were you elected project manager for this project?

CO-02: Work amount balance between the project participants.

CO-03: How are the tasks assigned for the participants: are these assignments based to skills, interest, or enthusiasm, for example?

CO-04: Is each appropriate participant clearly aware of how the requirements for the project will going to be reached? Why?

CO-05: Pre-emptive operations for avoiding coordination-related problems in the project.

CO-06: Ensuring shared visions. Has the group set overall goals, interpreted them unanimously, reacted to changes, cleared problems, and outlined overall goals to form a suitable whole?

CO-07: Monitoring and learning. Do the members see the whole picture, do they manage time and other resources, or do they predict how the client will react to the solutions made by the team?

CO-08: Ensuring effective communication. Have interest groups outside the project team (the client etc.) been committed to promote and support the project (fully)?

CO-09: What of the following actions have been taken into account in the project?

(a) Delegating assignments and responsibilities.

(b) Expedient, knowledgeable participants have been appointed for the project.

(c) A preparation plan has been made for the project to ensure that every member of the team can carry out their assignments without unforeseen delays.

(d) Descriptions of the project duties or responsibilities have been written down so that appointees to the project can be discovered a suitable duty or responsibility.

(e) The acquisition of competent workers for the project has been ensured for the later stages of the project.

(f) The job descriptions (or assignment roles) employed in the project are expedient.

(g) The project assignments have been divided into suitable and manageable pieces.

CO-10: How successfully have the responsibilities been divided?

CO-11: How efficiently the team has used time?

CO-12: Is the project on schedule? Why?

CO-13: In what ways has the project manager advanced to attain the goals?

CO-14: The organizational structure of the project and its changes made during the project, and the reasons for the changes.

CO-15: What does the team think about the reality of the requirements?

CO-16: Amount and quality of overlapping or unnecessary work.

CO-17: Significance of the project. How close is the project to the core operating activities of the organization in the sense of

(a) techology (margin – core)

(b) techniques or methods planned to use in the project (margin – core)?

CO-18: Pace. How fast the results (not milestones) are achieved relative to reasonable speed: do senior managers expect too rapid change and quick results or is there more gradual rate and enough time to execute tasks (gradual – rapid)?

CO-19: Changes in already assigned decisions, contracts, and project goals (minor – major; seldom – often)?

CO-20: Links of the project to other units or organizations (cooperation, technical expertise or resources from outside) (few – many)?

CO-21: Have requirements already done had to change and how? How about plans or executions already done?

4.8 ME: Meeting efficiency

The number of meetings (ME-01) combined with their typical durations (ME-03) can explain frustration of the members if the meetings have lasted a long time. These long-lasting meetings may also decrease members' satisfaction towards the project and increase absences from the meetings (ME-02). Thereby, the meetings should be kept short so that everyone has a chance to contribute and stay focused. The quality of preparation and control of the meetings (ME-04 – ME-09, based on Boddy (2002)) affect participants' interests as well. The more negative the answers in the subjects ME-04 – ME-09, the more likely that the meetings will fail. Participating in meetings becomes unpleasant if they fail time after time, which damages communication and the coordination of the whole project (Boddy, 2002).

The process model being used (PI-07) may affect the duration of the meetings. Comparing the total project time (SU-09) with the time spent on the meetings shows how big a part the meetings can have in projects. Such time-consuming events should be taken into account in the estimation of total workloads.

ME-01: How many meetings were approximately held during the project (a general estimate)?

(a) Normal team meetings.

(b) Meetings with the client.

(c) Other meetings.

ME-02: How often were all relevant participants present at

(a) normal team meetings?

(b) client meetings?

(c) other meetings?

ME-03: The average duration of meetings in minutes (a general estimate).

(a) Normal team meetings.

(b) Meetings with the client.

(c) Other meetings.

ME-04: Were the meetings scheduled in good time in advance?

ME-05: Were the contents of the meetings well planned with relevant papers handed out in advance?

ME-06: Did the participants take up relevant issues only?

ME-07: Did the meetings follow a pre-made schedule?

ME-08: Was there time to discuss all the issues?

ME-09: Were the decisions noted in the minutes, which were distributed within 24 hours of the meeting?

4.9 CM: Communication

The CM dimension highlights fluency of communication in projects. Ignoring communication disagreements within any group is dangerous (Boddy, 2002, 151–152). Comparing the answers of this dimension with the subjects CO-08, FS-02, ME-01 – ME-09, and RI-10, gives the scope of fundamentals for communication

Centralised networks (chain, wheel and Y) usually work best when tasks are simple and routine. Decentralised networks (star and circle) are more effective in complex or uncertain tasks (Boddy, 2002, 150–151). These network patterns are queried in CM-02 and presented in Figure 5.

CM-01: Communication within the group. What of the following categories do the members use in the project and how often?

(a) Proposing: Behaviour which puts forwards a new suggestion, idea or course of action.

(b) Supporting: Behaviour which declares agreement of support for an individual or their idea.

(c) Building: Behaviour which develops or extends an idea or suggestion from someone else.

(d) Disagreeing: Behaviour which states a criticism of another person's statement.

(e) Giving information: Behaviour that gives or clarifies facts, ideas or opinions.

(f) Seeking information: Behaviour which asks for facts, ideas or opinions from others.

CM-02: Communication patterns. In what kind of situations has the following communication patterns been used (see Figure 5)? How effectively have these patterns worked?

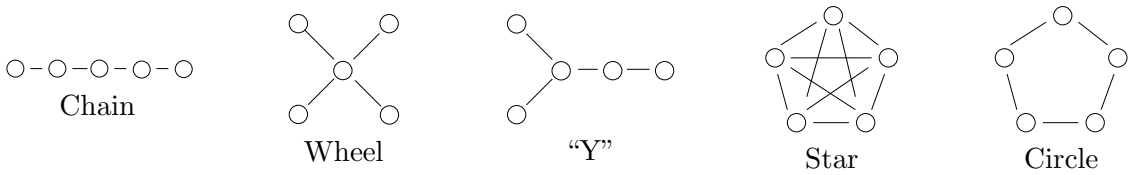


Figure 5: Communication patterns.

CM-03: Communication breakdowns. What kind of communication breakdowns have been occurred in the project?

CM-04: Communication with the customer. In what ways and how have the supplier communicated with the customer? What kind of problems have been noticed in this communication?

CM-05: Has everyone been sufficiently aware of and current on what everyone else was doing in the project?

CM-06: How well are the lines of communication working, both inside the project team and between the project and the supplier organisation?

CM-07: Are the project participants able to communicate sufficiently and meaningfully inside the project?

CM-08: How well has the team clarified its goals and agreed on them?

CM-09: Communication skills of the members: what is working and what is not?

4.10 IP: Influencing possibilities

Yukl and Falbe (1990) refined the work of Kipnis et al. (1980) with a wider empirical study from which emerged the nine most typical influence tactics used by managers in dealing with their subordinates, superiors, and co-workers. Regarding these tactics, (1) rational persuasion, inspirational appeal as well as consultation by the agent affect task commitment positively, (2) pressure, coalition and legitimating are often ineffective, and (3) ingratiation and exchange affect the task commitment of peers and subordinates positively, however, they are ineffective in influencing superios (Yukl and Tracey, 1992). The nine tactics are queried in IP-07.

Table 4 shows three responses to influence attemps. These responses are queried in IP-08. Explanations for the responses are seen in the third column of Table 4.

Repondents' understandings about their own influencing (IP-01) can be compared with the evaluations of their teammates (IP-07, IP-08). In addition, this comparison shows whether the nine tactics are effective in current use.

IP-01: Your influencing possibilities regarding the project issues. In what ways do you influence

(a) decision-making

(b) the participants?

IP-02: Skills in influencing others (conciliation, negotiation, reaching a consensus, etc.)

IP-03: How much have the teams the power to decide how best to complete the tasks assigned to them that have already been approved by the client?

Responses to influence	Description	Commentary
Compliance	Target accepts proposal because manager has power – but does so grudgingly.	Produces the desired outcome, but not voluntarily. Can deny responsibility for results.
Identification	Target accepts proposal as they identify emotionally with source of influence.	Difficult to maintain, and uncritical acceptance leads to dependence, not initiative.
Internalisation	Target accepts proposal as their own.	Most likely to develop and improve the idea, after voluntary acceptance, influence attempt may be invisible to the target.

Table 4: Three responses to influence attempts (Handy, 1993).

IP-04: How much can the teams decide for themselves when they need further training to complete their assignments?

IP-05: Are the teams responsible for their own development?

IP-06: Have the teams or the project the power to decide on recreation etc. covered by the project or the organization?

IP-07: In which ways other members have influenced you[4]?

(a) Rationalised persuasion or coaxing: using logical arguments and factual evidence to convince you of the usefulness of the suggestion.

(b) Inspirational appeal: making an interesting suggestion that promotes your trust in completing the task.

(c) Consultation: seeking your participation in developing a strategy, function or change for which your support is important. This person may be willing to change his or her presentation to barter with your suggestions and worries.

(d) The flatterer: trying to get you in a good mood or to think positive thoughts before asking you to do something.

(e) Exchange: promising you benefits in exchange for your help.

(f) Personal appeal: appealing to your feelings in the name of loyalty and friendship before asking you to do something.

(g) Alliance: seeking support from others to persuade you to do something. This person may also use the support of others to make you agree.

[4]The descriptions below should not be taken too literally; the purpose of the exaggerated descriptions is to give an idea of different ways of influencing others, which occur to some extent every time people work together.

(h) Legalisation: seeking justification for their demands or arguing that their demands are in harmony with established practices, rules, or tradition.

(i) Pressure: demanding, threatening or constantly reminding you to make you do what they want.

IP-08: How do the members react to the uses of influence? Evaluate the members according to the image of them that you have reached during the project.

(a) The member accepts a proposal — reluctantly — because the project manager has power.

(b) The member accepts the proposal because he or she identifies emotionally with the influencing agent.

(c) The member accepts the proposal as if it was his or her own.

4.11 RT: Roles in the team

According to Belbin (1993), the team composition has a crucial impact on success. An essential point in Belbin's team role theory is that the composition should correspond to the task in hand. According to the theory, particularly successful teams have (1) a capable coordinator, a strong plant (i.e. a creative and clever source of ideas), (2) at least one other clever person to act as a stimulus to the plant, and (3) a monitor-evaluator (i.e. someone to find flaws in proposals before it was too late). In contrast, ineffective groups often have a severe imbalance, such as (1) a coordinator with two dominant shapers, because the coordinator will almost certainly not be allowed to take that role, (2) two resource investigators and two plants, because no one listens or turns ideas into action, or (3) a completer with monitor-evaluators and implementers which are probably slow to progress, and stuck in detail (Belbin, 1993).

Unfortunately, these recommendations of the team composition has been critized. However, the team role theory is useful when, for example, someone has to be chosen for a new assignment or a certain position. RT-01 maps Belbin's team roles in the team. Additionally, this subject measures whether the rest of the team recognize the roles of each member. For example, if a respondent believes in being an implementor but any other member disagrees, the implementor role of the respondent obviously does not show in the interaction of the team members. Depending on the answers for the subject RT-02, it may be that members are incapable to estimate each other as individuals.

RT-01: Roles that emerged in the team[5].

(a) Implementor: well-disciplined, trustworthy, conservative and efficient. Turns ideas into practice.

(b) Co-ordinator: experienced, self-assured, the right choice for chairperson. Clears up the goals, promotes decision-making, delegates well.

[5]These roles are not related to the formal responsibilities given to project participants.

(c) Shaper: Challenging, dynamic, excels under pressure. The bulldozer is strong and has the courage to overcome hurdles – likes to win.

(d) Plant: creative, imaginative, thinks outside the box – the perfect person to solve hard problems.

(e) Resource investigator: extroverted, enthusiastic, communicative – maps possibilities, develops contacts, naturally forms networks.

(f) Monitor-evaluator: stable, strategic and observant. Sees all the alternatives, weighs them carefully – the controller.

(g) Teamworker: cooperative, gentle, sharp and diplomatic. Listens, constructs, prevents friction, keeps silent – sensitive towards people and things.

(h) Completer: careful, conscientious, enthusiastic. Looks for mistakes and omissions. Finishes his or her work on time.

(i) Specialist: focused, takes the initiative, committed to his or her work. Has exceptional knowledge and skills.

RT-02: According to your assessment, the participants are aware of their roles as you have described them above.

4.12 PG: Performance and growth of the team

Groups are usually organized as project teams but sometimes the team form is not the right solution. If successful, a team's productivity is greater than its members' combined productivities. Nevertheless, the team form can also damage a project (Boddy, 2002, 111–115). The subjects in the PG dimension map the team's performance and its changes during a project. Shared leadership is typical for any high-performing team (Blanchard et al., 2004). The productivity is queried in PG-07, PG-10, PG-12, and PG-13. PG-19 asks, which levels of CMMI did the team or the project attain or complete (CMMI Product Team, 2007)?

The CMMI model focuses on the following issues: (1) characterizing the maturity of workforce practices, (2) establishing a continuous program to develop the workforce, (3) setting priorities to form improvement actions, (4) combining workforce development and process improvement, and (5) establishing a culture of excellence (CMMI Product Team, 2007)).

However, CMM does not contain many practices needed to motivate, develop, attract, or retain top software talent (Curtis, 1994, 24). Executives in every domain of business know that their ability to compete directly depends on how they can organize people and motivate, develop, attract, and retain talented people (Curtis et al., 2001). The People CMM (Curtis et al., 2001), instead, is based on human-related issues in software projects. The model uses the process maturity framework of *Capability Maturity Model for Software (SW-CMM)* and is supposed to guide management and development of the workforce, and to help address critical people issues. The People CMM, like CMMI, consists of five maturity levels. Issues at level 1 are not specified since an organization incapable to reach

level-2 issues lies at level 1.

The subjects related to the People CMM are queried in PG-21 – PG-25 (related to the performance and growth of the team), CM-06 and CM-07 (related to communication), CO-09 (related to coordination), and IP-03 – IP-06 (influencing possibilities). The options in PG-20, instead, are a simplification of the People CMM for capstone software projects since part of the model for those projects is inappropriate.

In more detail, the People CMM issues have been applied the following subjects.

- Level 1 ("Initial"): –
- Level 2 ("Managed"): PG-21, PG-22, PG-31, PG-32, PG-34, CM-06, CM-07, CO-09b, and CO-09c.
- Level 3 ("Defined"): PG-23, PG-24, PG-33, PG-35, SO-10, SO-13, CO-09d, CO-09e, and CO-09f.
- Level 4 ("Predictable"): PG-25, SO-12, SO-14, CO-09g, and IP-03 – IP-06.
- Level 5 ("Optimizing"): SO-15.

These five levels establish successive foundations for (1) continuously improving individual competences, (2) developing effective teams, (3) motivating improved performance, and (4) shaping the workforce that an organization needs to accomplish future business plans (Curtis et al., 2001).

The subject PG-26 maps the growth of the teams according to the five-stage model of Tuckman and Jensen (1977). The answers can reveal the fluency of the transitions from stage to stage and whether the teams have reached the performing stage so that they have fundamentals to focus on performing. The fallback to a lower stage is common, especially in circumstances where new members join the group or old members leave (Tuckman and Jensen, 1977). Moreover, newcomers may have difficulties in orienting themselves to the "project memory" (i.e. what is going on and what has been going on in the project) (Čubranić et al., 2004). The subject PG-36 particularly asks about such situations in the teams while PP-03 asks about turning points that have occurred in general. The set of subjects PG-05 – PG-12 gives a view about the cohesion level in the teams. The subject PG-29 specifically figures out project managers' ability to "sell" themselves to their current project.

Group performance review (Boddy, 2002, 152–153), queried in PG-27, PG-28, CM-08, CO-10, CO-11, and MF-16 shows the performance of the group assessed both by the manager and by the teams.

PG-01:

(a) Give a short description of your personal goals that you want to attain during this project.

(b) How are you going to try to attain these goals?

PG-02: Are you committing deeply to this project?

PG-03: In what ways will your initiative benefit the progress of this project?

PG-04: Which skills unrelated to computer science or IT do you have that you think will benefit this project?

PG-05: Do you feel you belong to your group? Why?

PG-06: Do you feel the project manager belongs to the groups? Why?

PG-07: How efficient do you feel yourself?

PG-08: Do you feel your group feels you belong to the group? Why?

PG-09: In what ways has the project manager taken care of the project or your group?

PG-10: How efficient do you feel your group feels you are?

PG-11: Dare the members ask advice or help (thus revealing their incapability in that issue)?

PG-12: Co-operation competence in the group?

PG-13: For the project, is the group more than its members separately? Why?

PG-14: Appropriateness and amount of critism the group members give?

PG-15: Making individual initiatives: what kind of promoting things through actions and risk-taking has the project manager done to keep the project moving?

PG-16: Skills in project working.

PG-17: Social skills.

PG-18: Collaboration skills.

PG-19: The capability stages achieved by the team according to the CMMI model. Select only the levels that were achieved or walked through in the project.

(a) Level 1 – Initial: The software process is unpredictable. A few processes have been specified and their success depends on individual input.

(b) Level 2 – Repeatable: The basic processes of project management are employed for monitoring costs, shcedule and functionality. Good routines have been imported into the project from previous experiences. The team is able to complete the project according to plan.

(c) Level 3 – Defined: The software process as well as project management and software engineering have been documented and standardised. The team attempts to make the software process more efficient.

(d) Level 4 – Managed: Detailed gauges for the quality of the software process and the product are employed. Their aim is to improve both the software process and the

product.

(e) Level 5 – Optimizing: Constant process development is employed. Information is gathered automatically and used to optimise the process.

PG-20: Issues considered during the project.

(a) Work processes are applied expediently.

(b) Rewards.

(c) Coaching and development.

(d) Performance management.

(e) Adaptation of working environment.

PG-21: Is the project team constantly looking for ways to improve the performance level of the project, on the individual level as well as for the processes and resources?

PG-22: Does the project employ gauges with which the performance level can be measured?

PG-23: Will the project work promote your own career development?

PG-24: Are the performance of the teams developed and the state of the project monitored?

PG-25: Have the participants proved being worth of expectations: have they required logical knowledge and skills for the performance of the duties?

PG-26: Which of the following team stages have come up during the project and what was the atmosphere in the team during these stages?

(a) Forming: The teams are formed and their members are trying to impress each other. Members look for their group identity.

(b) Storming: The members discover that others want different things from the team. Priorities vary from member to member. There may be conflicts.

(c) Norming: The members start to adjust to their differences in a constructive way. The group discovers common ways of action and agrees on rules. The areas of responsibility are defined as people accept or create roles.

(d) Performing: The team works well and achieves its goal.

(e) Adjourning: Either the assignment has been completed or the team has been found unable to handle it. Thereby the team closes its work.

PG-27: Has the team developed its working methods so that they are efficient?

PG-28: Has the team observed and frequently checked its own working methods and procedures?

PG-29: How did you move from your previous project or tasks into this project?

PG-30: The most important growth issues on each individual in the project?

PG-31: Has functional work space been allocated to the project to enable efficient teamwork and, when necessary, individual work without disturbances?

PG-32: Does the reward system employed in the project (or organisation) spur the participants to constantly improve their performance?

PG-33: Does either the project team or the supplier organisation keep account of the knowledge and skills of the participants and their improvement with time?

PG-34: Has each team member the skills required to carry out their given assignments?

PG-35: Are project participants trained (or they train themselves) for project duties when necessary?

PG-36: How the activity or behavior of the team has changed when a new member has joined or an old member has leaved the team?

PG-37: The most important, positive characteristics of each member for the project.

4.13 SH: Skills in human relations (HR)

> "Today's leader must be an enabler of people and a facilitator of teams – not only as an effective team leader but as an effective team member as well." (Blanchard et al., 2004, vii)

Politics is inextricably linked into project management. Successful project managers usually understand intuitively that their job is not only to be technically and managerially competent. Since project managers typically have an unstable base of power, they must learn to cultivate in other ways (Pinto, 2000).

Despite that the SH dimension focuses particularly on project managers, the answers from team members expand the picture about the project team. The subject SH-02 asks about level 3 of the PMA model while the SH-03 focuses on level 4 and SH-04 finds out level 5 of the PMA model (see Section 3.1).

SH-01: Motivation methods being used for the team.

SH-02: In what ways have you express coaching or mentoring the project teams?

SH-03: How well have you reacted to changing human-related situations in the project?

SH-04: How does your caring toward the team show among the team members. Do you think the members agree?

4.14 MF: Motivation and feelings

Team members may have to take care of unfamiliar, unpleasant assignments without relevant skills or training. Sometimes members may not have any formal tasks or goals in projects. They may not have time to do tasks because of poor management or coordination (see the PG and CO dimensions). They possibly have to spend their time on external problem solving or on politics by wondering how to get things their way. Without any power or ability to influence others (see the IP dimension) even the best solution may be declined among the team members. Such a continuous declining or ignorance can frustrate these persons and damage the project.

Commitment consists of motivation and self-confidence about one's own competence (Blanchard, 2001). Commitment is queried directly in the subjects MF-06 and PG-02, and initiaviness in MF-07, PG-03, and PG-15. The rest of the subjects of the dimension relate to motivation and self-confidence.

MF-01a: Your current feelings about this project?

MF-01b: How about at the start of the project (after the initial project meeting)?

MF-02a: Your expectations of how this project will succeed?

MF-02b: How about at the start of the project (after the initial project meeting)?

MF-03a: Your expectations of how pleasant the duties assigned to you during this project will be?

MF-03b: How about at the start of the project (after the initial project meeting)?

MF-04a: Your current level of motivation for this project?

MF-04b: How about at the start of the project (after the initial project meeting)?

MF-05a: How invested are you in this project at the moment?

MF-05b: How about at the start of the project (after the initial project meeting)?

MF-06: Commitment of the members in the project?

MF-07: Initiative of the members in the project?

MF-08: Enthusiasm of the members in the project?

MF-09: Your most positive experience in the project: In what ways did they affect to your working motivation or project quality?

MF-10: Your most negative experience in the project: In what ways did them affect to your working motivation or project quality?

MF-11: The feelings of the participants towards the project at the moment?

MF-12: The expectations of the participants towards team work at the start of the project?

MF-13: The expectations of the participants towards future assignments (in the project) at the start?

MF-14: The motivation level of the participants regarding the project at the moment?

MF-15: The contribution of participants into the project at the moment?

MF-16: How pleasant is it to work in the team.

MF-17: How significant the team feels the product will be?

4.15 SO: Supportive culture in the organization

Taking care of adequate resources has a statistically significant effect on the project's outcomes (Boddy and Macbeth, 2000). Boddy (2002) shows by combining models from Leavitt (1965), Buchanan and Badham (1999), Markus (1983), and Pfeffer (1992), that a project context is made up from the seven empirically grounded elements, queried in SO-01 – SO-07, and that the context affects the project. These elements affect the project positively if they have been designed to fit the project context well.

The risk for failure is huge, if the project has no senior management support. SO-08 asks for the items of the "danger signal" list of Boddy (2002, 197). These items give early warning of possible trouble with senior management.

The values that guide the actions of project members, represent the perspective that the members typically take towards two inherent tensions which occur in any organization. The values of these tensions are between flexibility and control, and between maintaining the internal system and adapting to the external environment as shown in Figure 6: open systems, rational goal, internal process, and human relations (Quinn et al., 1996). These four culture types are queried in SO-11.

Senior managers[6] may have an inappropriate, negative impact on project success. The subject SO-17 asks for danger signals that imply troubles with senior managers (Boddy, 2002, 197).

SO-01: Business processes: how well the procedures and mechanisms used for information, communications and client cooperation function?

SO-02: Technology: how well does the information systems, hardware, and physical facilities serve the project goals?

SO-03: Resources: how economical are the assets available to the project?

SO-04: Structure: how well are the mechanism or method in which the assignments necessary for implementing the product coordinated and distributed?

SO-05: People: how well do their know-how, skills, attitudes, and goals serve the project goals?

[6]For educational version: an instructor, a supervisor, or both together in the scope of capstone software projects.

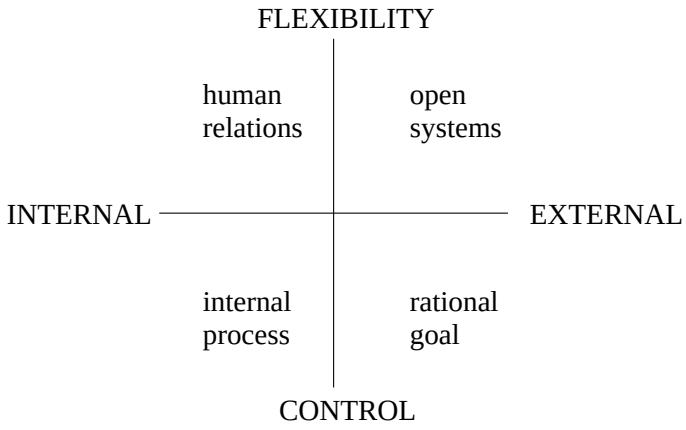


Figure 6: Culture types in organizations (Quinn et al., 1996)

SO-06: Culture: how well do prevailing norms, beliefs and basic values, on which the organisation is built, support the project?

SO-07: Power: how appropriately decision-making and opportunities to influence it has been distributed or centralised?

SO-08: Support for the project from "up" (i.e. from the senior manager or board levels[7]).

SO-09: Physical workplace.

SO-10: After the project has ended, will its participants be tried to ensure appropriate future job duties?

SO-11: Supportive project culture.

(a) Open systems.

(b) Rational goal.

(c) Internal process.

(d) Human relations.

SO-12: Teams' awareness of which appropriate tools or work methods are employed by other teams as well as other projects.

SO-13: Do parties outside the project (inside the supplier organisation) let the project team work in peace?

SO-14: Have the teams the opportunity to use methods or tools of the supplier organisation to make their work easier or more efficient?

SO-15: Is information about the innovations or methods developed in the project gathered by the organisation so that they can be utilised in other projects or departments of the organisation?

[7]For educational version: the instructor or the supervisor of the course.

SO-16: Senior stance: the attitude of the top management or the steering group towards the project. Are they visibly behind the idea of change, willing to give it the resources that it needs, and with reasonable expectations of what the project can achieve?

SO-17: Which of the following is true of the *management group above the project* (the group responsible for the project)?

(a) Interference without consulting the project manager.

(b) Support or help not available when the project would have needed it.

(c) In general, no help available to the project.

(d) The project manager has been left outside the decision-making process in important matters.

(e) Has failed on given promises or commitments.

(f) Has ignored or not reacted to unpleasant but important information.

(g) Has paid unnecessary attention to unfounded criticism.

(h) Has delayed decisions or seals of approval unnecessarily.

(i) Has recquisitioned project resources for other projects.

SO-18: What other negative things has this top management or the steering group done about this project?

4.16 SC: Supportive culture in the customer organization

Corresponding with SO-01 – SO-07 (see the SO dimension), the subjects SC-01 – SC-07 ask about the estimation of fitting the seven elements in the customer organization. CM-04, PI-10, and PP-05 support forming a helicopter-view about the customer.

SC-01: Business processes: how well the procedures and mechanisms used for information, communications and client cooperation function?

SC-02: Technology: how well does the information systems, hardware, and physical facilities serve the project goals?

SC-03: Resources: how economical are the assets available to the project?

SC-04: Structure: how well are the mechanism or method in which the assignments necessary for implementing the product coordinated and distributed?

SC-05: People: how well do their know-how, skills, attitudes, and goals serve the project goals?

SC-06: Culture: how well do prevailing norms, beliefs and basic values, on which the organisation is built, support the project?

SC-07: Power: how appropriately decision-making and opportunities to influence it has been distributed or centralised?

4.17 SU: Success of the project

Speed and flexibility is believed to be the characteristics of the successful future organization. On the other hand, when a delay occurs in a project, project teams usually try to implement all the requirements, thus putting the entire project at risk (Ernest-Jones, 2007).

Each project has unique features: different expectations, goals, criteria, and methods, which makes estimating the success of the project complex. The SU dimension maps a project's own definitions and feelings with some information about realisation whether the project was successful. The answers can then be compared with the four dimensions of success of Shenhar et al. (1997): (1) project efficiency, (2) impact on the customer, (3) realization of expectations in success, and (4) contribution of the project in preparing the organization for the future This comparison of the answers determines how much the project team is aware of the meaning of the existence of their project (in general) and whether they know the goals they are reaching. Naturally, these success criteria highlight the success of the project. The project efficiency dimension dominates in this report since the future is hard to measure. The definition of success between Shenhar et al. (1997) and PMI (2008) (see Section 1) differs, which emphasizes the variety of viewpoints.

Among many recommended statements regarding success, only five are statistically significant in successful projects (Boddy and Macbeth, 2000). These statements create the need for managers to focus on the following five areas: (1) ensuring agreement with goals, (2) obtaining resources, (3) monitoring and learning, (4) exercising influence (using individual initiative and creating appropriate structures), and (5) ensuring effective communication (Boddy, 2002, 63–64). The subjects PG-15, RS-02, CO-06, CO-07, and CO-08 ask about the use of these five activities to find out whether they correlate with the success of the current project when compared with the SU dimension.

SU-01: What criteria have to be completed in order for the project would be successful?

SU-02: How far the project kept on schedule?

SU-03: How far the initial requirements were attained?

SU-04: How far the readjustments made (which the client accepted) to the initial requirements were attained?

SU-05: How satisfied the client was with the project?

SU-06: Do you think this client might order deliveries from your organization in future as well?

SU-07: How successful the project was?

SU-08: In future, would you like to work in projects in which have

(a) the same client?

(b) the same or similar project team?

SU-09: Realization of total work amount in the project in hours (a general estimate)?

SU-10: Plainly, how satisfied you felt the project?

5 Summary

This report has addressed both restraining and driving issues and their reasons for success or failure in software engineering projects. As a solution for the poor rate of project success, the report suggests that supervisors and project managers focus on certain key subjects. These subjects, presented in Section 4, concern project issues from varying viewpoints. Because the selected subjects are based on the literature, they should be relevant when applied to any software engineering project. Thereby, the author strongly encourages to take the viewpoints of this report into use.

Acknowledgements

The author would like to express his gratitude to Graduade School on Software Systems and Engineering (SoSE) for its full-time funding regarding this work. Professor Jukka Paakki and Professor Pekka Abrahamsson deserve thanks for their great investment of time in this work.

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