

# DO SMALL SOFTWARE COMPANIES NEED PORTFOLIO MANAGEMENT?

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## ABSTRACT

Portfolio management of new product development has been studied in the context of large companies, but its relevance for small software companies has not been discussed. We conducted a multiple case study of four small software companies. The companies did not practice portfolio management, and seemed to suffer from problems that in the literature are considered symptomatic of inadequate portfolio management. Our study suggests that explicit portfolio management seems warranted in small software companies, at least if the development personnel attend to many different types of activities, possess multiple roles and responsibilities, and product development is funded through customer-specific work.

## INTRODUCTION

### Background and motivation

The majority of small software companies – 10-50 people (The European Commission, 2003) – offer both software products and professional services as means of sharing risk, supporting innovation, balancing their cash flow and keeping the business running (Cusumano, 2004; Kuitunen et al., 2005). However, the processes, competences and resources needed for conducting software service and product businesses are intrinsically different (Cusumano, 2004; Hoch et al., 2002; Nambisan, 2001), and an improper balance has been noted “an easy way to ruin an otherwise good small business” (Cusumano, 2004).

In the field of managing new product development, the process for achieving an optimal development resource allocation in terms of value maximization, strategic alignment, risk level and the number of ongoing projects, is known as *portfolio management of new product portfolio management* (Cooper, Edgett, & Kleinschmidt, 2002b), or portfolio management for short. In this context, portfolio management refers to the decision-making process responsible for updating and revising a business’s list of active and planned projects and other activities that require the development resources’ attention. In portfolio management, new projects are evaluated, selected and prioritized, existing projects may be accelerated, de-prioritized or killed, and resources are allocated to and reallocated within active projects. (Cooper, 1998)

Small software companies in Finland see product development and increasing the offering(s) degree of productization as their most important challenges for the near future (Hietala et al., 2003; Jokinen et al., 2004; Kuitunen et al., 2005). As small software companies take on these challenges, they face increasing pressures in managing their product development. This is the case especially if the company is not able to acquire external funding, or simply wishes to rely on revenue to fund their product development.

Literature on portfolio management originates from the context of large companies, where activities are primarily organized as projects, the company strategy is (at least to some degree) explicit, and dedicated portfolio management personnel exist. Although using a portfolio-based approach for managing product development is generally recommended, the actual relevance of portfolio management in the small company context has not been discussed. (Martinsuo, 2001) Also, current software engineering research neglects the portfolio perspective and adheres to the viewpoint of managing individual development projects (Rautiainen, 2004).

Little help seems to be available for the manager of a small company or a workgroup faced with several concurrent projects and a wide range of responsibilities (Tobis & Tobis, 2002). It is thus reasonable to inquire whether portfolio management might be important for small software companies. In this study we look into the topic by comparing problems that in the literature are associated with inadequate portfolio management with the problems experienced by four small software companies.

### **Research problem and methodology**

Specifically, this paper poses the following question: *Do small software companies who offer both products and services suffer from inadequate portfolio management?*

Portfolio management decisions do always get made – not necessarily consciously, but inadvertently, through inaction, or by accident. Thus, a missing or an unclear portfolio management process does not necessarily count as an “inadequate” one: the mix of ongoing activities in a small company may be simple enough to be managed project-wise, or even without formal project management. For example, if the ongoing activities have no resource or deliverable dependencies, explicit portfolio management may not be needed. To diagnose whether a company is actually suffering from inadequate portfolio management, we need a baseline of symptoms that are known to occur in conjunction with from inadequate portfolio management. If a company exhibits many or most of these symptoms, but does not consciously practice portfolio management, it is reasonable to ask if an increased level of explicit portfolio management would be beneficial.

In accordance with the above reasoning, the research problem is further broken down into four research questions:

- 1) What are the characteristics of inadequate portfolio management, and what symptoms occur in conjunction with it?
- 2) Do small software companies practice portfolio management?
- 3) What kinds of problems do small software companies experience in managing their development activities?
- 4) Are the problems experienced by the practitioners similar to those that in the literature are considered symptomatic of inadequate portfolio management?

Research question 1 is answered on the basis of a literature review we conducted. The design of the literature review is also described closer there. To answer research questions 2 and 3, we present an overview of how four small software companies practiced – or rather, did not practice – portfolio management and the problems they experienced in managing their development activities. The case study design is also described more closely there. To answer the final research question, we compare the findings of the literature review to the findings from the case studies. The research problem itself is, after discussing the limitations of the study, answered in the conclusion of this paper.

### **A note on terminology: what is portfolio management?**

Plowing through different definitions of portfolio management, we noticed that three concerns seem to lie at its heart, regardless of whether the specific emphasis lies in managing a project, product, or a new product development portfolio. Portfolio management deals with 1) *managing a set of (possibly different types) of activities* that 2) *can be considered to use the same resource pool* in order to 3) *meet company objectives without violating specified constraints*, for example, the availability of resources or the desired risk level (Bonham, 2004; Cooper, Edgett, & Kleinschmidt, 2002b; Dobson, 1999; Dye & Pennypacker, 1999). Indeed, often the definitions are formulated so that the project vs. product vs. product development portfolio distinction ultimately matters little. For example, activities such as maintenance, technology research, and even process improvement efforts are recommended to be included in new product portfolio management if they require the development resources' time (Cooper, Edgett, & Kleinschmidt, 2002b). Or, a *project portfolio* is to be interpreted as widely as needed to represent the "investment strategy" of the company – for example by considering customer service as a part of it (Dye & Pennypacker, 1999).

For the sake of conceptual clarity, as well as to fit the small software company context (as we will see later on in this paper), we speak of *the development portfolio* (or simply portfolio for short) – as opposed to a project or a product portfolio. The development portfolio refers to *the set of ongoing and planned activities that require the development resources' attention, regardless of whether they involve development in the strict sense or not*. Unless otherwise stated, all references to 'portfolio management' from hereon refer to development portfolio management as defined here.

### **LITERATURE REVIEW**

We conducted a literature review in two steps. First, we searched through 17 books on managing new product development and/or software development to 1) provide a preliminary outline of what inadequate portfolio management and its symptoms look like, and 2) to identify keywords for database searches. We selected these books informally, based on their perceived relevance and accessibility. As this had obvious limitations, for example, the exclusion of peer-reviewed material, unknown coverage and lack of reproducibility, we then continued with a systematic review (Kitchenham, 2004) of the ABI/INFORM and INSPEC databases, thus covering journal, conference and magazine publications relevant for the study.

As keywords for the database searches we used the terms that had surfaced during the book review as essentially synonymous or very closely related to the concept of development portfolio management as defined in the introduction. These were *pipeline management* e.g. (Harris & McKay, 1996; McGrath, 1996), *NPD portfolio and pipeline management* e.g. (O'Connor, 2004), *portfolio selection and management* e.g. (Edwards & Francis, 2003), *new product development decision-making* e.g. (Deck, 2002), *R&D project selection* e.g. (Cooper, Edgett, & Kleinschmidt, 2001b), *R&D resource allocation* e.g. (Repenning, 2001; Wheelwright & Clark, 1992), *project prioritisation* e.g. (Engwall & Jerbrant, 2003), *aggregate project planning* e.g. (Wheelwright & Clark, 1995), *multi- (or multiple) project management* e.g. (Anawi-Isakow & Golany, 2003; De Maio, Verganti, & Corso, 1994; Platje & Seidel, 1993) and *program management* e.g. (Patrick, 1999). Overall, the terminology used in the literature is diverse, and using many different keywords seems necessary for finding the majority of the relevant articles. We tested for

keyword validity by conducting further searches using combinations of the most common new keywords from those articles that were found relevant in our database searches. Details regarding the database search protocol (for example, criteria for stopping the search and including and excluding articles) are described in (Vähäniitty, 2006).

Using the database searches we discovered a total of 26 articles that contained material describing inadequate portfolio management and/or the typical problems that occur in conjunction with it. The found articles focused on a specific issue, e.g. resource allocation (Ash & Smith-Daniels, 2004; Cooper & Edgett, 2003; Repenning, 2001), and/or provided generic problem lists of their own e.g. (Cooper, Edgett, & Kleinschmidt, 2000; Elonen & Arto, 2003; Payne, 1995). The overlap of the problem lists was limited, warranting the creation of a synthesis. Thus, we collected the problems listed in the different sources and distilled them first into a total of 42 inter-related but distinct problems related to inadequate portfolio management (Vähäniitty, 2006). We then summarized our findings as the *five characteristics of an inadequate portfolio management* and *seven problems that are symptomatic of (or contribute to) inadequate portfolio management*. These are further described below.

### **Characteristics of inadequate portfolio management**

An inadequate process for portfolio management is typically characterized by 1) *unclear roles and responsibilities*, 2) *unclear project decision points*, 3) *unclear criteria for project selection or prioritization*, 4) *having no overview of the portfolio*, and 5) *no (explicit definition of the) portfolio management process*. These are described more closely below.

First, the roles and the responsibilities of the portfolio level decision makers may not be clear, or the people involved may not have fully digested them (Elonen & Arto, 2003). Second, a common weakness (Cooper, Edgett, & Kleinschmidt, 2002a) is the lack of rigorous criteria (strategic or otherwise) for selecting or prioritizing projects or other tasks the developers are attending to (Cooper, Edgett, & Kleinschmidt, 1997a; Cooper, Edgett, & Kleinschmidt, 2001b). Third, decision points for projects (for example Go/Kill) may be unclear and/or otherwise ineffective (Bonham, 2004; Cooper & Edgett, 2003; Cooper, Edgett, & Kleinschmidt, 2001b). Fourth, even if project decision points are defined and clear criteria for project prioritization exist, a holistic view – looking at the entire portfolio of all projects – may be missing. In such a case, the decision-making process is limited to examining individual projects one-at-a-time, for example at gate reviews. (Cooper & Edgett, 2003) Fifth, the process for portfolio management may be completely missing (Cooper, Edgett, & Kleinschmidt, 2000) – or at least it has not been explicitly defined. While an undefined portfolio management process may serve its purpose, the lack of an explicit definition can also be interpreted as a sign that the company is unaware of the important distinction between project and project portfolio management (Platje, Seidel, & Wadman, 1994).

### **Symptoms of inadequate portfolio management**

We identified the following symptoms of inadequate portfolio management from the literature: 1) *Failures and disappointments*, 2) *Slipping schedules*, 3) *Overcommitment*, 4) *Fire-fighting*, 5) *Bad multitasking*, 6) *Poor portfolio decision-making*, and 7) *Missing strategic alignment*. These are further described below. While we acknowledge that there

are causal relationships between the symptoms, formalizing these is far from simple, (see Appendix B, section B3 in Vähäniitty, 2006) and out of the scope of this paper.

### Failures and disappointments

Projects' scope and deliverables are often compromised, (Cerveny & Galup, 2002) resulting in disappointments with the final results of the projects (De Reyck et al., 2005). Profitability is poor due to too many low or high risk projects, or not penetrating the market due to neglecting of some key activities such as market research (Mader, 2004). Many product launches are issued in an indifferent manner, successful products are rare, and the overall failure rate of products and/or features is high (Cooper, Edgett, & Kleinschmidt, 2001a; Cooper, Edgett, & Kleinschmidt, 2001b).

### Slipping schedules

Often, projects are late (De Reyck et al., 2005; Wheelwright & Clark, 1992), products' time-to-market is increased (Cooper, Edgett, & Kleinschmidt, 2001a; Cooper, Edgett, & Kleinschmidt, 2001b) and development cycle times are poor (Cooper, Edgett, & Kleinschmidt, 2000) because of inadequate portfolio management. Often, target dates do not become commitments, because everyone knows that the priorities will shift and the dates will be revised again. The people may also feel that there are not enough resources "to get the job done on time anyway so why bother". (Wheelwright & Clark 1995) While inadequate portfolio management is a common cause of schedule slippages, it is not necessarily recognized as the source of the troubles. Instead, the personnel believe that e.g. better planning or more careful effort estimates would be the answer. (Cerveny & Galup, 2002)

### Overcommitment

Resource demands are commonly met with having people work overtime because of its effectiveness from the perspective of the company – at least on the short term (DeMarco, 2001; Payne, 1995). However, it is quite common that there are simply too many projects and too few people (Cooper, Edgett, & Kleinschmidt, 2000; De Reyck et al., 2005; Englund & Graham, 1999), with a typical overload being 2-3 times the actual capacity (Wheelwright & Clark, 1992; Wheelwright & Clark, 1995). Sometimes resources are overcommitted to the point that it becomes impossible to get anything done on schedule (McGrath, 1996; Rautiainen, Nissinen, & Lassenius, 2000). Overcommitment may also occur when a significant amount (up to 50%) of development resources' effort is actually spent on tasks outside of the defined portfolio – that is, tasks the developers are not supposed (or not even known) to attend to (Wheelwright & Clark, 1992).

### Fire-fighting

Fire-fighting refers to the reactive and unplanned allocation of resources to fix problems that are discovered (relatively) late in a development project or during maintenance. Rather than being isolated to specific projects, fire-fighting is a self-reinforcing phenomenon, often becoming the de facto process for resource allocation in new product development (Repenning, 2001) – everything must be proclaimed as urgent if it is to be attended to at all. While management should have the flexibility to re-allocate resources regardless of commitments previously made to project teams (Cooper, Edgett,

& Kleinschmidt, 1997b), constant shifting of resources from one project to another leads to decline in productivity (Wheelwright & Clark, 1995). And, when there are no slack resources available, reactive resource redistribution produces negative effects on unanticipated places in the project portfolio (Engwall & Jerbrant, 2003).

### Bad multitasking

Assigning the same individual to multiple projects enables the company to use the expertise of a single individual on more than one project (McDonough & Spital, 2003). Indeed, the best development people often find themselves assigned to more than four or five concurrent projects (Wheelwright & Clark, 1995), or 'crisis' projects in addition to their existing tasks (Wheelwright & Clark, 1992). People assigned to too many concurrent projects find themselves working in a "time-sharing" manner, allocating ever-decreasing slices of time to the different projects in an attempt to satisfy the constant demand of the project managers to see progress in their individual projects (Anawi-Isakow & Golany, 2003). Not only is the completion of each task slowed down (Cerveny & Galup, 2002), but every time the resources switch from one project to another, some "setup" time is lost due to learning, forgetting and re-learning (Ash & Smith-Daniels, 2004; DeMarco, 2001). With people having multiple roles and commitments, more and more meetings are needed to solve occurring problems (Cerveny & Galup, 2002), and time is spent on "update meetings" and other non value-added activities (Wheelwright & Clark, 1995).

### Poor portfolio decision-making

Here, 'poor' is used as an umbrella term for late, toothless, misguided, and/or uninformed portfolio level decision-making. For example, senior management may lack commitment to participate in portfolio decision-making despite of its strategic nature (De Reyck et al., 2005). As a result, strategic decisions are made in frustration by the developers, because senior management has not made them in time, provided the necessary guidelines (McGrath, 1996) or provided feedback to the project level to guide projects to the right direction (Wheelwright & Clark, 1995). Senior management may also be very busy and not properly engaged in the decision-making process. Thus, they are able to deal with problems at the last moment only, if at all (Wheelwright & Clark, 1995). And even senior managers who are committed to and participate in portfolio level decision-making may be overwhelmed with requests concerning the prioritization of projects and the re-distribution of personnel. These requests may not only come from high-priority projects or projects in urgent crises, but from smoothly going projects, or projects of low priority as well. (Engwall & Jerbrant, 2003)

Another side of the coin is that project proposals are sometimes very hard to say no to. Some senior people admit that this is so because they desperately need to get something to the market (Cooper & Edgett, 2003). The incentives of the managers or sales people may also be tied to the initiation of new projects in a dysfunctional way (Cooper & Edgett, 2003; Payne, 1995). On the other hand, all of the ongoing projects may genuinely look good to the managers, and it is hard to "drown puppies" – that is, to kill any of them. Whatever the reason, projects are seldom stopped (Elonen & Artto, 2003) – and when they are, they are often put in a "hold tank" – an endless list of projects that are recognised as inferior, but of which no-one wants to take the responsibility to kill

due to various reasons (Cooper & Edgett, 2003; Cooper, Edgett, & Kleinschmidt, 1997b; Cooper, Edgett, & Kleinschmidt, 2001b; Mader, 2004; Payne, 1995).

Finally, the data and/or information models used for portfolio level decision-making may imply a degree of precision far beyond people's ability to provide reliable data. Various financial models, rank-ordered lists and bubble diagrams may appear so elegant that management sometimes forgets how imprecise the data upon which these diagrams or charts are constructed actually is. Management may also be overwhelmed with all the possible ways to plot and visualize relevant information. (Cooper, Edgett, & Kleinschmidt, 1997b) Finally, it may simply be that no relevant data on which portfolio decisions could be based has been collected (Cooper, Edgett, & Kleinschmidt, 2001b).

### Missing strategic alignment

Projects may not be strategically aligned, or at least they have no apparent link to strategy or organizational goals (Cooper, Edgett, & Kleinschmidt, 2001a; De Reyck et al., 2005; Englund & Graham, 1999). This is because product development decisions are not made with consideration of company objectives for growth, product mix, or short- and long-range emphasis (McGrath, 1996). Lack of strategic alignment amplifies many of the problems already mentioned. For example, there's no possibility to make fire-fighting decisions in the context of strategy (McGrath, 1996) and divergence between the maximization of the objectives of the organization and an individual project (Dooley & O'Sullivan, 2005) develops more easily. "Wrong" projects are selected (Cooper, Edgett, & Kleinschmidt, 2001a), as engineers' technical interests and/or requests from marketing dominate over selecting projects most critical to the business (Wheelwright & Clark, 1992). At least in large companies, a portfolio consisting of many small projects of low value, for example tweaks and modifications to existing systems, is a sign of missing strategic alignment (Cooper, Edgett, & Kleinschmidt, 2000; Cooper, Edgett, & Kleinschmidt, 2001b).

## **CASE STUDIES**

To answer research questions 2 (*Do small software companies practice portfolio management?*) and 3 (*What kinds of problems do small software companies experience in managing their development activities?*) we conducted four qualitative case studies (Yin, 1994). This section describes the case study design, provides an overview of the case companies and presents our findings regarding the case companies' problems and their match with the symptoms of inadequate portfolio management from the literature.

### **Case study design**

The selection of the case companies was purposeful (Patton, 2002), as they were participating in our research projects on software process improvement at the Helsinki University of Technology. Possible implications of the selection on the results are discussed in the conclusion.

The state of practice in the case companies as described in this study is mainly based on interviews at each of the case companies at the start of the research co-operation (see Table 1 below). We conducted a semi-structured in-depth interview with the product development manager at each of the companies. Also, we conducted informal, conversation-like interviews with other product development personnel (3-4 people, depending on the case) for triangulation. The interviews were not aimed at examining the

state of portfolio management in the companies, but to give an overview of their software development processes and perceived problems and challenges.

### Overview of the case companies

The case companies, here referred to as *Achilles*, *Ajax*, *Hector* and *Odysseus*, are all small, with 12, 10, 14 and 7 developers, respectively. All of them offer software products as well as different kinds of services, some of which are not related to the products. All of the case companies had experienced fairly rapid growth in revenue and in personnel during the last few years. Table 1 provides an overview of the case companies.

Case Company	Type(s) of business	# of developers (total # of people)	Types of work attended to by the developers
Achilles	Mobile enterprise solutions and professional services	12 (20)	Product development, consulting, customer-specific projects (OEM), developer rental
Ajax	Solutions for automating safety-critical logistics	10 (15)	Development of control systems and remote control software (customer-triggered, partly customised), deliveries, customer support and repair jobs
Hector	Solutions for relationship and customer information management	14 (20)	Platform development, application development (on top of the platform; release-based as well as customer triggered), technology development, customer deliveries and installations, consulting
Odysseus	Solutions for securing electronic transactions	7 (15)	Product development (release-based and customer-triggered), technology development, delivery and installation projects, sales support

Table 1: The case companies, their personnel and the activities the developers attended to

### Portfolio management in the case companies

As an answer to research question 2 on whether small software companies practice portfolio management, none of our case companies managed their development activities as an explicit portfolio. They lacked clear priorities for their development efforts, and the different types of work attended to by the developers actually became distinct for the companies only afterwards, as a by-product of the interviews. Setting up new projects was considered both frequent and impulsive in nature, often without getting old assignments finished or put deliberately on hold. Sometimes, decisions were not made deliberately, but rather inadvertently, or even through inaction. Because different activities were not necessarily explicitly managed as projects, or even recognized as part of the product development portfolio, resource planning was seen as difficult, and was often omitted entirely because of its perceived futility. None of the case companies had long-term plans of where their products or product development were going. Also, there were no explicit lists on features-to-be-implemented, but the ideas for future improvements resided in various text files, emails and so on. The topmost improvement need in all of the case companies as perceived by the interviewed product development managers was the need to understand the big picture, that is, to get a common understanding of what projects and other development activities were underway, how these were resourced, what their relative priorities were, and why so.

### **Problems experienced by the case companies**

To answer research question 3, the following problems were common to all of the case companies in managing their development activities. Additional case-specific detail can be found from (Vähäniitty, 2006).

In all of the case companies, the original schedules planned for the projects rarely held. However, the interviewees considered that their performance was no worse than that of their peers, as slipping schedules were seen business as usual in the industry. All of the companies considered, however, that their project planning and management were in need of improvement. It also seems that the interviewees were not at the time conceptually aware of the distinction between portfolio and project management.

Overbooking of the development resources was common, and with the big picture missing, the developers' efforts could not be systematically re-scoped or re-prioritized. Instead, the developers had to decide what tasks to do and what to drop. As a result, some important activities, for example, testing, did not receive enough attention, causing surprises later in the projects. Most developers were attending to several concurrent projects or had other time-consuming tasks besides their main duties. Seeing what implications decisions in a project had on the other projects in the portfolio was challenging due to the missing "big picture" and consequently, unknown resource interdependencies.

Prioritization "happened" through fire-fighting or personal judgment. Decisions were being made on the level of individual projects, with their effects rippling across the entire portfolio and causing a cascade of new decisions. Most of the interviewees felt that priorities were unclear, and many felt that they were shifting constantly.

A shared understanding of how and by whom portfolio level decisions were, or even should be made, was mostly missing. The personnel were generally not aware of the gamut of important decisions they faced in managing their product development activities. Important product development decisions were often made based on the opinions of the key personnel without explicit discussion or justification. While we can not directly comment on the quality of these decisions, we found out that at least some of the interviewees in each company considered that the dialogue between the business (in other words, top management and sales) and the development people (later, just Business and Development) was in need of improvement: At Achilles, dialogue between Business and Development was scarce, and combined with a lack of long-term plans for the products, product development efforts had little explicit consideration for business case. Almost all of ideas for new features or products had originated from Development and were technical in nature. At Ajax, Business (according to Development) sold new projects without properly considering the projects' impact on the already overcommitted development staff. At Hector and Odysseus there was an active dialogue between Business and Development, but the downside of this was the impulsiveness in setting up new projects and shifting priorities – which often resulted in not getting old assignments finished as they were overridden by new ones. Also, no long-term plans or explicit visions for the products existed, except possibly in the minds of the CEOs, and the 'idea generator' sales manager at Hector.

### Do the problems resemble symptoms of inadequate portfolio management?

Table 2 presents a comparison of the symptoms of inadequate portfolio management as identified from the literature, and their match with the problems experienced in the case companies.

Symptom	Related problems experienced by the case companies	Match?
Failures and disappointments	Not evident based on the interviews.	No
Slipping schedules	Schedules rarely held; Interviewees generally felt that better planning and project management would be needed	Yes
Overcommitment	Overbooking of the resources common; Neglecting activities due to schedule pressures caused surprises later in the projects; Management sold new projects without consideration of resource implications;	Yes
Fire-fighting	Decisions made on the level of individual projects, effects ripple across the portfolio; Priorities unclear and/or shifting; Setting up new projects frequent and impulsive, often without getting old assignments finished or on hold	Yes
Bad multitasking	Developers assigned to several concurrent projects and/or had other major duties; No explicit resource scheduling in place; All of the different activities the developers were attending to were not recognized as part of the product development portfolio.	Yes
Poor portfolio decision-making	Developers' efforts could not be systematically re-scoped or re-prioritized; developers have to decide which tasks to skip; Important product development decisions often made based on the opinions of key personnel without explicit discussion or justification; (At least) short-term financial considerations are acted upon in a prompt manner; Dialogue between business and development in need of improvement; Personnel not aware of the distinction between project and portfolio management	Yes
Missing strategic alignment	No long-term plans for product development; Product development efforts had little explicit consideration for business case; The relative priorities of the ongoing projects unclear for most developers;	?

Table 2: Symptoms of inadequate portfolio management found at the case companies

As can be seen from Table 2 above, the problems experienced by the case companies seem very similar to those that are in the literature considered to be symptomatic of inadequate portfolio management. However, the interviewees did not feel that they had experienced significant failures or disappointments in terms of the projects' final results or business success. If we assume that the interviewees did not withhold these, a possible explanation could be that as all of the companies had recently grown significantly, the negative effects from inadequate portfolio management had not yet been around long enough to affect business performance adversely. In the light of the other experienced problems – as well as the fact that inadequate project management and planning often pass as scapegoats for portfolio management (Cerveny & Galup, 2002), it seems that the problems match quite well. Thus, our answer to the final research question (*Are the problems experienced by the practitioners similar to those that in the literature are considered symptomatic of inadequate portfolio management?*) is positive.

### CONCLUSION

We conclude the article by answering the research problem in the light of the limitations of the study. We then outline managerial implications and present directions for future research.

## **Limitations**

The discussion below is organized according to the methodologies used and the respective research questions.

### The literature study

The literature study on problems associated with inadequate portfolio was conducted after the data for the case studies had been collected. This is because we realised that many of the companies' problems could stem from the lack of (explicit) portfolio management only after the initial interviews had been completed.

The bias of looking for evidence in support of the hypothesis – also known as “fishing” (Patton, 2002) – is difficult to avoid. In this case, the fieldwork may have affected the literature study. To limit potential bias, we tried to conduct our literature review in a systematic and reproducible manner, using a defined protocol to e.g. include and exclude material (Vähäniitty, 2006). The main weakness of our approach was that we did not systematically go through the reference lists of the relevant articles produced by the database search, but covered them only in an informal manner. However, the end results seem adequate for the intended comparison. Also, using a defined protocol in the literature study can be considered an improvement compared to the majority of contemporary software engineering research (Kitchenham, 2004). The methodology of the literature study seems adequate for answering the first research question regarding the nature of inadequate portfolio management and the associated problems.

### The case studies

The main concern here lies in understanding the representativeness of the case companies with respect to the population of small software companies who offer both products and services. For example, our co-operative relationship with the case companies creates a potential for sampling bias. Second, it can be questioned whether companies who – like our case companies – experience pressures in managing their product development portfolio are an actual majority in the population of small software companies.

While the question concerning representativeness is a difficult question to answer conclusively, it seems plausible that in the majority of small software companies, the situation may not be much unlike that observed in our case companies (Vähäniitty, 2006). In conclusion, we consider the methodology of the case studies adequate for answering research questions 2 (*Do small software companies practice portfolio management?*) and 3 (*What kinds of problems do small software companies experience in managing their development activities?*), provided that the scope of the answer is limited to companies similar to the case companies.

### The comparison

Because the data of the case studies was originally gathered to study the case companies' software development processes and not portfolio management, our analysis had to rely on less detailed data for some of the companies. To alleviate bias, the comparison was made for those problems that were experienced by all of the case companies.

The categorization of the symptoms of inadequate portfolio management can also affect the results of the comparison. To assess whether we had unconsciously formulated

our problem list so that it matches with the case companies' problems, we matched the case companies problems against the problem lists presented in (Elonen & Artto, 2003) and (Payne, 1995). These lists were chosen, not only because they summarize existing literature well, but also because they are quite different both in terms of content and structure. Using the problem list by Payne (1995), it is less easy to judge whether our case companies are suffering from inadequate development portfolio management or not. This may be due to the large company focus implicit in the article: many of the problems described seem related to managing a large matrix organization. However, comparing with the problem list by Elonen & Artto (2003), our case companies do seem to suffer from inadequate portfolio management, despite of the large company focus of the article. Thus, we consider the comparison reliable from the perspective of answering the final research question on the similarity of the experienced problems.

### **Answering the research problem**

Taking the discussed limitations into account, we answer the research problem as follows: *At least those small software companies, who offer both products and professional services and fund their product development efforts with revenue, are likely to experience problems that stem from inadequate portfolio management.*

### **Contribution and managerial implications**

This study identifies and summarizes problems associated with inadequate portfolio management as presented in existing literature and presents the problems experienced by four small software companies in managing their development activities. The main managerial implication of our study is that explicit management of the development portfolio should be considered in the context of small software companies as well. Abstracting from our case studies, we identified three factors that seem to complicate portfolio management in some software companies. These are 1) dealing with *a portfolio of different kinds activities* instead of a clear-cut product, project or product development portfolio; 2) the developers' *multiple and sometimes conflicting roles and responsibilities*; and 3) the *need to leverage customer-specific projects for product development*. These are further discussed in the three paragraphs below.

The developers in our case companies attended to many activities besides product development (for example, sales, maintenance, deliveries, customer service and consulting). These activities were not necessarily conducted as explicit projects or even dealt with the actual products the company offered. For example, Hector and Achilles had their developers doing management consulting, and the latter even had a significant percentage of its entire development staff contracted to other companies for longer-term software development projects. It seems that in the small software company context, finding out what the development resources are actually spending their time on, distinguishing between different types of activities, and extending the boundary of the development portfolio to these, could be the starting point for improvement efforts.

When product development has to be funded by cash flow, having sources of revenue besides license sales may be necessary. Besides offering services such as consultancy, all of the case companies developed new features in customer-specific projects in order to include the results as part of a later product release. It seems plausible that without explicit strategic balancing, for example through managing the development efforts as a

portfolio, a company is more likely to adopt a reactive rather than proactive stance, and thus be more easily diverted from its goals and vision.

Even though the total number of products and services offered by the company may not be high, the fact that the product development personnel have to take on multiple roles and responsibilities can make the complexity of portfolio management comparable with large companies. It also seems reasonable to ask, whether portfolio management could in the small software company context be even more complex, as a single developer may have to deal with not only multiple and important, but inherently conflicting roles as well. For example, the product manager at Odysseus acted simultaneously as the manager of a certain customer-triggered product development project as well, recognized himself as biased towards letting through requests from his own customer with a less thorough consideration for the direction the product should be going to. If portfolio management in the small software company context is revealed to be more complex than in large companies, it could mean that the traditional notion of project management setting the basis for portfolio management (O'Connor, 2004) would not necessarily hold. If project management in the small software company context becomes feasible only after the rudiments of a portfolio management process have been established, a change of priorities in how to improve the software development process – as well as the contemporary software engineering research agenda – may prove useful.

### **Future research**

Implementing portfolio management has been referred to as a “notable challenge even for the most progressive company” (O'Connor, 2004). Indeed, many techniques, tools and methods for portfolio management have been presented in the literature, but they so far enjoy limited industrial adoption (Cooper, Edgett, & Kleinschmidt 2001). Furthermore, as they typically originate from and are designed for the large, company context, their applicability in small companies can be questioned (Martinsuo, 2001). We propose that further research on portfolio management in the small software company context should focus on how to assess the state of portfolio management in a company. Also, solutions, principles and guidelines that support establishing *adequate* portfolio management in the small software company context are called for.

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