Available online at www.sciencedirect.com
ScienceDirect
International Journal of Project Management 25 (2007) 56–65
INTERNATIONAL JOURNAL OF PROJECT MANAGEMENT
www.elsevier.com/locate/ijproman

Role of single-project management in achieving portfolio management efficiency

Miia Martinsuo *, Päivi Lehtonen

Helsinki University of Technology, Department of Industrial Engineering and Management, P.O. Box 5500, FI-02015 TKK, Finland

Received 29 November 2005; received in revised form 17 February 2006; accepted 13 April 2006

Abstract

This paper examines how single-project management contributes to project portfolio management efficiency. Earlier research has suggested that single-project management may be related to project portfolio-level success, but empirical evidence has been scarce. A questionnaire survey with 279 firms verifies the hypothesized role of information availability, goal setting and systematic decision making in achieving portfolio management efficiency. The results reveal a mediating and direct role of project management efficiency but reject the hypothesized link between reaching project goals and portfolio management efficiency. The results imply that understanding of portfolio-level issues needs to be considered as part of project managers' capabilities and not only a top management concern.

Keywords: Project portfolio management; Managing programmes; Managing projects; Implementing strategy; Efficiency

1. Introduction

Not only one but several, even dozens or hundreds of projects are typically going on at the same time within a firm. This multi-project setting has been examined in a fairly independent stream of literature, often titled as "project portfolio management" [1–3]. Project portfolio is a group of projects that share and compete for the same resources and are carried out under the sponsorship or management of an organization [1,4]. Project portfolio management can be considered a dynamic decision process, where a list of active projects is constantly updated and revised [5].

Project portfolio management literature encourages evaluating, prioritizing, and selecting projects based on strategy [6–11,29]. According to portfolio management principles, organizational resources should be allocated to projects in line with strategy [12,13]. Development processes should take into account the existence of different types of projects and their different requirements [14–17]. Furthermore, portfolio (or multi-project) management requires sharing of resources, components or platforms across a multitude of projects during project implementation [18–21]. A majority of portfolio management studies are prospective in nature, i.e. they suggest good practices for project portfolio management. The actual efficiency of project portfolio management has, so far, been a rare topic of study.

Holistic, strategy-based portfolio management methodologies and practices suggest that portfolio-level decisions should be enacted at single-project level or through development process [1,5,22–24]. How do these single-project level actions eventually contribute to portfolio management efficiency? Fricke and Shenhar [25] have identified factors in the single-project–multi-project interface, relevant to efficiency at both levels. Cooper et al. [5,22,23,26,27] have conducted survey-based studies linking the single-project and portfolio management practices to company level performance indicators. Some other studies link project portfolio management with single-project level

* Corresponding author. Tel.: +358 50 4302723; fax: +358 9 4513736.
E-mail addresses: miia.martinsuo@hut.fi (M. Martinsuo), paivi.lehtonen@hut.fi (P. Lehtonen).

0263-7863/$30.00
doi:10.1016/j.ijproman.2006.04.002

outcomes [28]. These different studies provide initial evidence on the potential linkage between single-project management and portfolio management efficiency.

This paper focuses on that linkage. Our research question is: how is single-project management related to project portfolio management efficiency. Our interest is to identify how project managers, at the single-project level, can contribute towards wider business benefits in the entire project portfolio.

2. Portfolio management efficiency

Portfolio management efficiency as such has not been reported in the literature. However, indications of its concept and relevance are evident both in portfolio management and single-project management studies.

Portfolio management studies refer to the objectives of the portfolio, and the necessity to align projects with those objectives [3,29]. An interview study by Cooper et al. [5] with 35 companies identified that the objective of project portfolio management was to maximize the value of the portfolio in terms of company objectives, to achieve a balance of projects in terms of strategically important parameters, or to ensure strategic direction of projects. Efficiency of project portfolio management, therefore, could be determined by estimating the degree to which the portfolio fulfills its objectives: strategic alignment, balance across projects, and value maximization. In this study, portfolio management efficiency concerns organizational members' estimate of the degree to which the projects together, as a portfolio, succeed in fulfilling the portfolio objectives.

Some latter studies [2,23,26,27] have examined the reaching of the above portfolio objectives. They have found some supporting evidence concerning the link between portfolio-level results and business-level performance, and product level performance indicators.

From single-project management viewpoint, many studies indicate that project goals and benefit expectations are expanding from single-project level to the portfolio level. In theoretical analyses, project management research is increasingly linking projects with each other and the wider business context [21,30–32]. Some empirical studies have raised benefits to customer, other stakeholders, performing organization and future as important success criteria in projects, besides reaching of the dominantly used scope–cost–time goals [33–37]. Many of such benefit expectations can be reached only if multiple mutually supportive projects reach their goals.

Although many studies touch upon the relationship between single-project and multi-project level performance, none examine it holistically in the context of different kinds of projects and industries. Although Fricke and Shenhar's [25] multiple-case study indicates how single-project level success factors may contribute at the portfolio level, their study is qualitative in nature and limited to engineering projects in manufacturing support environment. Studies by Cooper et al. [2,23,26,27] are limited to product development, and they do not specifically look into single-project management. Of the single-project management studies, none examine whether and how the benefits are actually reached at the portfolio level.

Earlier studies encourage further research in a larger sample of different companies and different types of projects [31,32,38] to verify the link between single-project management and portfolio management efficiency.

3. Single-project management and portfolio management efficiency

Earlier research has suggested that some single-project level factors are related to and possibly contribute to portfolio management efficiency. Table 1 summarizes some of these empirical studies.

In the qualitative, case-based studies [21,25,39,42], the focus has been on portfolio management as understood in this paper, and the approach towards portfolio management efficiency and its contributing project-management factors has been very exploratory. For example the necessity for clear goals in terms of scope, schedule, costs or resources, sharing of information, top management support and a

Table 1
Single-project management factors and empirical research on them, related to portfolio management efficiency

Empirical evidence	Single-project management factors							
	Clear project goals	Information availability	Systematic decision making	Top mgmt ownership or support	Management by project type	Standardization of PM	Metrics and measurement	Other
Artto and Dietrich [39]	x	x	x		x		x	x
Cooke-Davies [40]							x	x
Cooper et al. [2,22,24,26,27]		x	x	x				x
Dietrich and Lehtonen [41]		x	x			x		
Elonen and Artto [42]	x	x		x				x
Engwall and Jerbrant [21]	x							x
Fricke and Shenhar [25]	x	(x)		x	x			x
Milosevic and Patanakul [38]					(x)	x	x	x
Payne and Turner [43]					x	x		

x means that some empirical evidence has been identified in the study. (x) means that a similar type of concept has been used by the authors, or that evidence is weak.

variety of other factors have been identified as relevant contributors to portfolio management efficiency. Wider-scope survey-based studies [2,22,24,26,27] have purposefully focused on the processual nature of product development and tend to assume the necessity of formal process management to portfolio management efficiency. Their results have emphasized the role of decision making, information availability, management support, and a variety of other factors. Studies that combine qualitative and quantitative methods have either explored the relationships or contingency factors between a specific set of success factors and criteria [41,43] or looked more into project management as a capability for achieving repeated success through projects [38,40]. As relevant project management related factors, standardization, metrics and measurement and some others have been emphasized.

The literature review shows that empirical research on the linkage between single-project management and portfolio efficiency is dominantly exploratory and case based [21,25,39,42]. Some portfolio management studies approach the linkage between single-project and portfolio-level factors by examining problems of single-project management that can reduce efficiency at multi-project level [21,42] rather than enhance it. Many of the studies concentrate solely on product development [2,22,24,26,27]. In case of a wider-sample survey study, the relationship between single-project level factors and portfolio management efficiency has not been the key focus but a by-product [38,43].

The above-mentioned studies provide fairly strong evidence that at least setting of goals, availability of project-related information to decision makers, and systematic project-related decision making could be related to portfolio management efficiency. Therefore, our task is to verify these findings in a broader variety of companies and project types. Our first hypotheses are as follows:

Hypothesis 1. The degree to which projects have clearly specified goals is positively related to portfolio management efficiency.
Hypothesis 2. Availability of information on single projects for decision makers is positively related to portfolio management efficiency.
Hypothesis 3. Systematic decision making as part of the development process is positively related to portfolio management efficiency.

For factors such as top management support or ownership, differentiated management style across different project types, measurement, and standardization of project management, there is evidence supporting their relevance at the single-project level and also a link to portfolio management efficiency. However, such factors rather characterize the entire management system of the company than management at single-project level. In addition, researchers have found other factors that can be related to portfolio management, including: communication in a broader sense [25,26,39], learning [39,40], resources and their sharing across projects [21,42,44], and managing projects strategically [39]. Also these items can be considered business-level or portfolio-level success factors.

Instead of examining such items separately, we anticipate that there is a link between the overall efficiency of single-project management, and portfolio management efficiency. Earlier research indeed suggests that project performance translates directly into an improved bottom line [40]. Also, projects need to be managed efficiently in order to get the most out of the project entity [42]. Therefore, our final hypotheses deal with reaching project goals, efficiency of project management, and their link to portfolio management efficiency:

Hypothesis 4. Reaching project goals is positively related to portfolio management efficiency.
Hypothesis 5. Project management efficiency is positively related to portfolio management efficiency.

4. Empirical study

Our empirical study is based on a questionnaire survey targeted at different industry and service companies. The intent was to identify all organizations throughout Finland that had development activities carried out as projects. This population included all organizations that employed more than 100 people and had named a person responsible for development activities in the contact information register. Non-profit associations were left out of the sample. The questionnaire was originally sent to 1102 Finnish companies and public organizations in 2003. The survey was sent to the person in charge of development activities in the organization, with titles such as development manager, development director, quality manager, product development manager, or R&D manager.

Of this population, 288 responded the survey and 279 reported that they conduct at least part of their development in the form of projects. The sample used in this paper consists of the responses from these 279 companies. The focus is on R&D, information systems, organization development and other internal project portfolios within the firms.

Small, medium and large companies are included, and a variety of different businesses. A majority of the responses (53%) were from private industrial firms representing all industry sectors, about one fourth were from private service sector, and the rest of the responses (22.6%) were from public service sector. The respondents are dominantly from a functional line organization (51%), but also matrix (35%) and project organizations (11%) are represented. A majority has a portfolio of only a few projects, but also portfolios of 5–10 projects and larger are represented. In terms of project type, 66% of the respondents chose to focus on organization development and IT systems projects in their responses, while the remaining 34% named product development as the primary project type. Table 2 characterizes the firms participating in the survey.

Table 2
Companies in the survey sample ($N = 279$)

No. of personnel	%	Nature of business	%	Organizational structure	%
1 = 100–199	28.3	Industry	52.7	Line organization	51.3
2 = 200–499	30.5	Services	24.7	Matrix organization	34.8
3 = 500–999	21.5	Public services	22.6	Project organization	10.8
4 = over 1000	19.7			n.a.	3.1
Number of projects in the firm		*Primary nature of projects*			
1 = Below 5	30.8	1 = Product development	34.4		
2 = 5–10	47.7	0 = Internal (organizational or IT systems) development	65.6		
3 = 11 or over	20.4				
n.a.	1.1				

A majority of the individual respondents are middle (46%) and top management (39%) responsible for development activities in their organization, and the remaining sample represents project management and expert tasks. The respondents have on the average 10–15 years of experience with their company.

5. Data collection and analysis

A mailed questionnaire was used to collect data on project management and portfolio management efficiency. In this paper, we focus on the topics introduced in the literature section and use altogether six variables. The items were developed based on earlier research and input from an expert panel of academics. The survey draft was presented to three professional researchers who had extensive experience on questionnaire surveys. Each of these professionals commented on the content as well as the format and the scales of the questions and made suggestions for improvement in an individual discussion. Before the actual delivery of the survey, the questions were tested for usability, relevance and validity with seven industry representatives. As a result, some clarifications were added and minor changes were made to the questionnaire.

All constructs were measured with multi-item scales, three to eight items per variable. A Likert-type scale of 1...5 or 1...3 was used for each item. A principal components analysis was used to verify the variable structure. Each variable score was calculated as average of the included items. The reliability of the scales was estimated by Cronbach's Alpha which ranged from 0.69 to 0.87 and can be considered good. Details of the variable structure, scales, and reliability coefficients are presented in Appendix 1.

5.1. Portfolio management efficiency

In the literature review, we defined portfolio management efficiency as the organizational members' estimate of the degree to which the projects together, as a portfolio, succeed in fulfilling the portfolio objectives, the objectives being strategic alignment, portfolio balance and value maximization. Items for the dependent variable were developed based on questions and scales used in other studies [2]. Portfolio management efficiency variable examined e.g. the portfolio-strategy alignment, knowledge of priorities, financial yield, realization of strategy, and efficiency of managing the project entity. We originally intended to use two separate dependent variables (realization of strategy, and perceived efficiency), but strong intercorrelations between items and a preliminary factor analysis suggested just one dependent variable.

5.2. Project management

We used five independent variables: Goal setting, Availability of information for decision makers, Systematic decision making, Project goal achievement, and Project management efficiency. The items for goal setting and goal achievement were based on general understanding on what the project goals are: scope, costs, and time. We added 'resources and manhours' as a fourth type of goal. As a result, *Goal setting* items focused on the proportion of projects that have defined goals. *Systematic decision making* items dealt with the use of systematic decision making in the different stages of the project: initiating a feasibility study, planning, project execution, proceeding to the next phase, and closing. *Availability of information* questions focused on decision-makers' access to all, truthful, up-to-date and right amount of project-related information. *Project goal achievement* items focused on the proportion of projects that keep up with the original stated goals. Additionally, perceived *Project management efficiency* items examined the way of managing single projects in terms of efficiency, right focus, acceptance, and future prospects.

5.3. Control variables

We used three control variables at company level (scales indicated in Table 2). We controlled for Number of employees and Number of projects, because we anticipated that increased scope in the organizational setting could increase the relevance of portfolio management as compared to single-project management. Additionally, we used the dummy variable Product development to take into account the possible effect of project type.

6. Results

Means, standard deviations and correlation coefficients among the variables are presented in Table 3. There is a positive correlation between project management variables, project level results, and portfolio management efficiency. There are a few correlations between control variables and other variables, e.g. the larger the company is, the more likely is organization and systems development as chosen type of project, the larger is the proportion of projects that reach their goals, and the weaker is project and portfolio-level efficiency. Product development is positively correlated with the number of projects as well as Project management efficiency, Information availability and Systematic decision making.

To test the hypotheses, we used linear regression to estimate the relationship between independent variables, control variables and portfolio management efficiency. We first inspected the scatterplots between each of the independent and dependent variables to ensure linear relations. We then tested three models, using portfolio management efficiency as the dependent variable. Additionally, we decided to look into project management efficiency as a mediating variable. Table 4 shows the results of the analyses. Inspection of collinearity statistics indicated no problems with the model. We additionally tested some interaction effects but these did not improve the models.

The control variables alone (Number of employees, Number of projects, and Product development as project type) did not produce a model that would explain variance in portfolio management efficiency. However, Number of employees had a negative, almost significant effect as already indicated by correlations.

Models 2 and 3 both were highly appropriate in explaining variance in portfolio management efficiency. In model 2, we added three variables concerning single-project management: Goal setting, Information availability for decision makers, and Systematic decision making. This model explained 33% of variance in portfolio management efficiency. The impact of Number of employees on Portfolio management efficiency seems to be mediated and enhanced by (at least some of) the single-project level items: the more active the single-project management, the stronger the negative relationship between firm size and portfolio management efficiency. This supports our assumption that management at portfolio level becomes more relevant as company size increases. Information availability had the highest significant effect on multi-project management efficiency, whereas Goal setting and Systematic decision making had lower but almost significant effects. This gives support to hypotheses 1, 2 and 3 in demonstrating that higher degrees of Goal setting, Information availability and Systematic decision making are reflected on higher levels of portfolio management efficiency.

In model 3, we added project-level success variables: Reaching of project goals, and Project management efficiency. The model explained as much as 52% of variance

Table 3
Descriptive statistics

	N	Mean	s.d.	Number of employees	Number of projects	Product development	1. Goal setting	2. Information availability	3. Systematic decision making	4. Project goal achievement	5. PM efficiency	6. Portfolio management efficiency
Number of employees	279	2.33	1.09									
Number of projects	279	1.89	0.71	0.11								
Product development	279	0.34	0.48	−0.13*	0.21***							
1. Goal setting	278	4.21	0.76	0.08	0.09	0.08						
2. Information availability	279	3.80	0.62	0.02	0.11	0.14*	0.26***					
3. Systematic decision making	278	2.24	0.38	−0.00	0.09	0.12*	0.32***	0.22***				
4. Project goal achievement	277	3.44	0.92	0.19**	0.14*	−0.04	0.40***	0.41***	0.13*			
5. Project management efficiency	279	3.45	0.74	−0.13*	0.11	0.16**	0.32***	0.48***	0.24***	0.32***		
6. Portfolio management efficiency	279	3.47	0.65	−0.14*	0.04	0.09	0.29***	0.53***	0.27***	0.27***	0.68***	

* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 4
Results of regression analyses

	Portfolio management efficiency as the dependent variable						Project management efficiency as the dependent variable					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	β	t	β	t	β	t	β	t	β	t	β	t
No. of employees	−0.13	−2.04*	−0.15	−2.97**	−0.07	−1.65	−0.12	−1.90	−0.14	−2.74**	−0.16	−3.01**
No. of projects	0.05	0.78	−0.08	−0.15	−0.04	−0.80	0.11	1.74	0.06	1.06	0.05	0.86
Product development	0.05	0.84	−0.03	−0.52	−0.05	−1.04	0.10	1.67	0.03	0.60	0.04	0.83
1. Goal setting			0.14	2.59*	0.05	1.07		1.74	0.18	3.25**	0.14	2.45*
2. Information availability			0.48	9.09***	0.26	5.11***			0.42	7.85***	0.38	6.63***
3. Systematic decision making			0.12	2.19*	0.08	1.73			0.07	1.31	0.08	1.40
4. Project goal achievement					−0.02	−0.46					0.12	1.99*
5. Project management efficiency					0.53	10.31***						
R^2	0.02		0.34		0.52		0.04		0.31		0.32	
Adjusted R^2	0.01		0.33		0.51		0.03		0.29		0.30	
F	2.05		23.03***		37.47***		3.85		19.83***		17.75***	

Standardized beta coefficients are shown.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

in portfolio management efficiency. Only Information availability and Project management efficiency had a strong and significant effect on the dependent variable. This supports our hypothesis 5. As the score of Information availability was lower than in model 2, it appears that project management efficiency mediates part (but not all) of the effect of Information availability on Portfolio management efficiency. Hypothesis 4 is not supported as reaching of project goals does not seem to contribute to portfolio management efficiency. The data suggests that the relationship between single-project level variables and portfolio management efficiency is mediated by project management efficiency. Additionally, it appears that project management efficiency removes the effect of Number of employees that was identified in model 2, i.e. project management efficiency also means "fit to the organizational context", when contributing to portfolio management efficiency.

We additionally did a similar regression analysis using Project management efficiency as the dependent variable, to better understand its mediating role. These results are presented on the right-side columns of Table 4. Control variables alone did not produce a model which would explain variance in Project management efficiency. When single-project management variables were added, they explained almost one third of variance in Project management efficiency and the model was appropriate. Information availability had a strong and significant linear association with project management efficiency, and also Goal setting and Number of personnel implied a similar kind of relationship as with Portfolio management efficiency. Systematic decision making, however, did not have a significant relationship with project management efficiency. Adding the variable Reaching of project goals in model 3 slightly improved the explanatory power of the model but at the same time reduced the impact of Information availability and Goal setting. Number of personnel had a slightly stronger effect than in model 2. Reaching of project goals seems to have a mediating role between information availability, goal setting and Project management efficiency, but does not fully explain this relationship. The low explanatory power of the single-project level models indicates that some additional single-project level factors need to be taken into account when examining the relationship between single-project management and portfolio management efficiency.

7. Discussion

Single-project factors and efficiency together explained over a half of variance in portfolio management efficiency in our data. Information availability for decision makers appeared as the most significant project-level factor contributing to portfolio management efficiency both directly and through project management efficiency. Earlier studies have used fairly differently defined concepts of information or communication, as indicated in the literature study. Our findings focused on information availability, hereby supporting the need for information sharing emphasized in many studies [45–48]. Our results do not take any position towards whether information should be codified or not, which could be a topic for further study especially taking into account that information availability may mediate the relationship between company size and portfolio management efficiency.

To our surprise, goal setting is related to portfolio management efficiency indirectly, through perceived project management efficiency and also through reaching project goals. This can be understood in light of the question setting

in the survey. We focused only on the immediate project goals of scope, time, costs and resources. A more detailed question setting on the customers', firm's and infrastructure goals and the product would likely have produced different results and a direct link. Our results support the idea that more attention should be directed towards the wider business aspects of projects, in terms of broader success criteria than those in the "iron triangle" [34,35] and a more strategic approach to studying projects in their business context [30–32]. For managers, our results mean that project goal setting should clearly be expanded towards wider business goals if portfolio-level results are expected.

Systematic decision making appears to have a more complex relationship with portfolio management efficiency. Even if the relationship appears to be mediated by project management efficiency, systematic decision making does not explain project management efficiency either directly or through reaching project goals. It is possible that systematic decision making is related to development process management [2], project selection and prioritization [6,7], project management standardization [38], or to management support and ownership which were not covered in this study.

Reaching of project goals had a minor mediating role between single project management variables and project management efficiency, but it was not directly linked with portfolio management efficiency. This may be explained through the question setting, i.e. the fact that we had to remove reaching the scope goal from the variable. We are aware that reaching the scope goal often compromises the other goals, and vice versa. The reaching of scope goals could be considered the most important item for portfolio management efficiency since scope as the product is the practical way to implement strategy. Therefore, we are inclined to support differentiation between internal efficiency and external effectiveness and their success factors [35,37,49,50]. However, this differentiation creates a need to prioritize or optimize between business-level benefits and project-level efficiency, which would have an impact on goal-setting, too.

In the survey results, efficiency of project management was the strongest factor contributing to portfolio management efficiency, and our results revealed its mediating role between single-project factors and portfolio management efficiency. Single-project management efficiency may result from many additional variables than those covered in this study. The significant impact from project management efficiency, however, suggests that many issues relevant to portfolio can and should be built into the way of managing single projects. The findings may partially be explained through the sample of non-traditional, fairly immature companies in terms of portfolio management and a possible lack of any portfolio management methodologies. The results might be different in more mature project environments.

The number of employees appeared as the only influential control variable: the larger the firm, the poorer portfolio management efficiency. This negative relationship was even strengthened by the three single-project management practices, but removed when project management efficiency was added. This is largely in line with our presumption that portfolio management practices increase in relevance in larger companies. Impact in model three refers to the existence of some other intervening variable that makes single-project management efficient and, thus, contributes to portfolio management efficiency. With these results, we find support to the important role of organizational complexity [47] in project portfolio management and its efficiency, and encourage further studies in the above mentioned areas of standardization, management style by project type, processes, and project selection.

8. Conclusion

Our study verified the importance of the selected few single-project management factors that are related to the efficiency of project portfolio management. According to our results, single-project management is associated with portfolio management efficiency directly in the form of information availability and project management efficiency, and indirectly in the form of information availability, goal setting and decision making. Project management efficiency was found as a significant mediating factor between single-project factors and portfolio management efficiency, whereas reaching of project goals mediated single-project factors and project management efficiency. The results give support to earlier studies [2,21,22,24–27] and show, in a more diverse sample of multi-project settings, how crucial and, yet, insufficient single-project management is with regards to portfolio management efficiency. Our results show that still almost a half of variance in portfolio management requires other explaining factors which may include standardization and other project-level factors, strategic benefit goals of projects, the practices of portfolio management, portfolio type, and so on.

The results concerning the selected single-project factors and the explanatory power of our model may be optimistic, knowing that the sample represents people responsible for development activities in their organizations. An obvious limitation of the survey was this restricted viewpoint, as well as the use of the same data source both for single project level variables and portfolio-level variables. However, our findings suggests that project managers need to be concerned with business interests beyond the single-project level. We purposefully excluded portfolio management practices in this study in an attempt to keep the topic focused, but they should be part of the future research agenda. An important topic for study is whether portfolio management practices will explain the remaining variance in portfolio management efficiency, whether also individual and firm level factors should be included in further studies, and which other single-project practices contribute at the portfolio level.

As another continuation for our study, we suggest systematic larger-scale studies of the other project manage-

ment factors identified in the literature review, including but not limited to top management support, project management standardization, metrics, resource sharing, and project ownership. Our findings also indicate that the linkage between project management maturity and portfolio management efficiency should be studied to understand whether and how single-project management can be utilized for seeking portfolio-level impacts. In general, more extensive studies are needed on different contingency factors relevant to portfolio management efficiency, with more elaborate measures on e.g. organizational complexity. Furthermore, future studies could focus more strictly and thoroughly in specifying through what kind of actions and routes strategic goal setting, information codification, and context of decision making contribute to expected or unexpected outcomes for the project portfolio.

In all, the results encourage developing project managers' role in business management beyond the single project. The single-project factors tested in this study provide project managers a point of influence towards the entire portfolio and its efficiency. At the same time, we may raise the question of whether project managers are aware of their responsibility towards the entire portfolio, and whether their competences are sufficient. Company management should pay more attention to how they build linkages between single-project management capabilities and portfolio management efficiency in practice. While some companies may plan and organize separate systems for portfolio management, some other companies may benefit from implementing such readiness into single-project management. Another managerial implication of our study is the identification of practical single-project level factors that companies can analyze and perhaps modify to cover

Table 5
Variable structure, items included in variables, principal components analysis, and reliability coefficients

Variables and questionnaire items included in them	Cronbach's Alpha	Component score
Goal setting (4 items, scale 1 = none…5 = all or nearly all)	0.75	
Proportion of projects that have defined schedules		0.87
Proportion of projects that have defined scope objectives		0.85
Proportion of projects that have defined cost goals or budgets		0.69
Proportion of projects that have workload or resource estimates		0.52
Information availability (4 items, scale 1 = strongly disagree…5 = strongly agree)	0.76	
Decision makers have all the required information on projects		0.78
Decision makers have truthful information on projects		0.66
Decision makers have up-to-date information on projects		0.56
Decision makers have the required information on projects, but not exceedingly		0.55
Systematic decision making (5 items, scale 1 = no, 2 = yes, occasionally or in some projects, 3 = yes, always or nearly always)	0.69	
Formal decision making on starting project planning		0.74
Formal decision making on starting project execution		0.65
Formal decision making on proceeding from one phase to another		0.61
Formal decision making on initiating feasibility studies		0.61
Formal decision making on project close-up		0.53
Project goal achievement (3 items, scale 1 = none…5 = all or nearly all)	0.81	
Proportion of projects that keep up with the defined schedule		0.83
Proportion of projects that keep up with the defined cost estimate or budget		0.78
Proportion of projects that keep up with the defined work-load or resource estimates		0.74
Project management efficiency (4 items, scale 1 = strongly disagree…5 = strongly agree)	0.81	
Management of single projects is efficient		−0.68
Management of single projects offers excellent prospects for success		−0.61
Management of single projects focuses on the right issues		−0.46
Way of managing single projects is commonly understood and accepted		−0.35
Portfolio management efficiency (8 items, scale 1= strongly disagree…5 = strongly agree)	0.87	
The objectives of projects are aligned with strategy		0.76
Company strategy is realized well by the project entity		0.76
Resource allocation to projects is aligned with strategy		0.75
Portfolio management supports the strategy process excellently.		0.73
Priorities across projects are known		0.70
The project entity yields an optimal return		0.67
Portfolio management is efficient		0.56
Portfolio management focuses on the right issues		0.44

portfolio-level interests, in their attempt to improve portfolio management efficiency.

Appendix 1. Variable structure and reliability

To confirm the variable structure and verify the distinctiveness of the independent and dependent variables from each other, we conducted a principal components analysis of the items. We used oblique rotation due to expected correlations across factors. The pattern matrix largely confirmed the six-variable structure, and the model explains 60% of the total variance. Only a few principal component loadings were low, as indicated in Table 5, which causes limitations for the study. Even in these cases the items did not have a higher loading in the other principal components. The observed component loading in one survey item, "proportion of projects that keeps up with the original stated scope goals", was in conflict with the intended variable structure and we decided to remove the item from the final model. Only the remaining items in each variable are presented here and are used in the analysis.

References

[1] Archer N, Ghasemzadeh F. Project portfolio selection techniques a review and a suggested integrated approach. In: Dye LD, Pennypacker JS, editors. Project portfolio management. Selecting and prioritizing projects for competitive advantage. USA: Center for Business Practices; 1999. p. 207–38.
[2] Cooper R, Edgett S, Kleinschmidt E. New product portfolio management: practices and performance. J Prod Innovation Manage 1999;16:333–51.
[3] Dye L, Pennypacker J, editors. Project portfolio management. Selecting and prioritizing projects for competitive advantage. USA: Center for Business Practices; 1999.
[4] Archer N, Ghasemzadeh F. An integrated framework for project portfolio selection. Int J Project Manage 1999;17(4):207–16.
[5] Cooper R, Edgett S, Kleinschmidt E. Portfolio management in new product development: lessons from the leaders I. Res Technol Manage 1997;40(5):16–28.
[6] Hall D, Nauda A. An interactive approach for selecting IR&D projects. IEEE Trans Eng Manage 1990;37(2):126–33.
[7] Henriksen A, Traynor A. A practical R&D project-selection scoring tool. IEEE Trans Eng Manage 1999;46(2):158–70.
[8] Comstock G, Sjolseth D. Aligning and prioritizing corporate R&D. Res Technol Manage 1999;42(3):19–25.
[9] Graves S, Ringuest J, Case R. Formulating optimal R&D portfolios. Res Technol Manage 2000;43(3):47–51.
[10] Ringuest J, Graves S. Formulating R&D portfolios that account for risk. Res Technol Manage 1999;42(6):40–3.
[11] Spradlin C, Kutoloski D. Action-oriented portfolio management. Res Technol Manage 1999;42(2):26–32.
[12] Hansen KF, Weiss MA, Kwak S. Allocating R&D resources: a quantitative aid to management insight. Res Technol Manage 1999;42(4):44–50.
[13] Cooper R, Edgett S. Overcoming the crunch in resources for new product development. Res Technol Manage 2003;46(3):48–58.
[14] Adler PS, Mandelbaum A, Nguyen V, Schwerer E. From project to process management: an empirically-based framework for analyzing product development time. Manage Sci 1995;41(3):458–84.
[15] Adler PS, Mandelbaum A, Nguyen V, Schwerer E. Getting the most out of your product development process. Harvard Business Rev 1996(March-April):134–52.
[16] Cooper R. Winning at new products—accelerating the process from idea to launch. Massachusetts, USA: Perseus Publishing; 2001.
[17] Loch C. Tailoring product development to strategy: case of a European technology manufacturer. Eur Manage J 2000;18(3):246–58.
[18] Nobeoka K, Cusumano MA. Multiproject strategy, design transfer, and project performance: a survey of automobile development projects in the US and Japan. IEEE Trans Eng Manage 1995;42(4):397–409.
[19] Nobeoka K, Cusumano MA. Multiproject strategy and sales growth: the benefits of rapid design transfer in new product development. Strategic Manage J 1997;18(3):169–86.
[20] Cusumano M, Nobeoka K. Thinking beyond lean. How multi-project management is transforming product development at Toyota and other companies. USA: Free Press; 1998.
[21] Engwall M, Jerbrant A. The resource allocation syndrome: the prime challenge of multi-project management? Int J Project Manage 2003;21(6):403–9.
[22] Cooper R, Edgett S, Kleinschmidt E. Portfolio management in new product development: Lessons from the leaders II. Res Technol Manage 1997;40(6):43–52.
[23] Cooper R, Edgett S, Kleinschmidt E. New problems, new solutions: making portfolio management more effective. Res Technol Manage 2000;43(2):18–33.
[24] Cooper R, Edgett S, Kleinschmidt E. Optimizing the stage-gate process: What best-practise companies do—II. Res Technol Manage 2002;45(6):43–9.
[25] Fricke SE, Shenhar AJ. Managing multiple engineering projects in a manufacturing support environment. IEEE Trans Eng Manage 2000;47(2):258–68.
[26] Cooper R, Edgett S, Kleinschmidt E. Benchmarking best NPD practices—I. Res Technol Manage 2004;47(1):31–43.
[27] Cooper R, Edgett S, Kleinschmidt E. Benchmarking best NPD practices—II. Res Technol Manage 2004;47(3):50–9.
[28] De Reyck B, Grushka-Cockayne Y, Lockett M, Calderini SR, Moura M, Sloper A. The impact of project portfolio management on information technology projects. Int J Project Manage 2005;23(7):524–37.
[29] Englund R, Graham R. From experience: linking projects to strategy. J Prod Innovation Manage 1999;16(1):52–64.
[30] Artto K, Wikström K. What is project business? Int J Project Manage 2005;23(5):343–53.
[31] Engwall M. No project is an island: linking projects to history and context. Res Policy 2003;32(5):789–808.
[32] Söderlund J. On the broadening scope of the research on projects: a review and a model for analysis. Int J Project Manage 2004;22(8):655–67.
[33] Dvir D, Lipovetsky S, Shenhar A, Tishler A. In search of project classification: a non-universal approach to project success factors. Res Policy 1998;27(9):915–35.
[34] Shenhar AJ, Dvir D, Levy O, Maltz AC. Project success: a multidimensional strategic concept. Long Range Plann 2001;31:699–725.
[35] Atkinson R. Project management: cost, time and quality, two best guesses and a phenomenon, it is time to accept other success criteria. Int J Project Manage 1999;17(6):337–42.
[36] Lim CS, Mohamed MZ. Criteria of project success: an exploratory re-examination. Int J Project Manage 1999;17(4):243–8.
[37] Munns AK, Bjeirmi BF. The role of project management in achieving project success. Int J Project Manage 1996;14(2):81–7.
[38] Milosevic D, Patanakul P. Standardized project management may increase development project success. Int J Project Manage 2005;23(3):181–92.
[39] Artto KA, Dietrich PH. Strategic business management through multiple projects. In: Morris P, editor. The Wiley guide to managing projects. USA: Wiley; 2004. p. 144–76.
[40] Cooke-Davies T. The "real" success factors on projects. Int J Project Manage 2002;20(3):185–90.

[41] Dietrich P, Lehtonen P. Successful management of strategic intentions through multiple projects—reflections from empirical study. Int J Project Manage 2005;23(5):386–91.
[42] Elonen S, Artto K. Problems in managing internal development projects in multi-project environments. Int J Project Manage 2003;21(6):395–402.
[43] Payne JH, Turner JR. Company-wide project management: the planning and control of programmes of projects of different type. Int J Project Manage 1999;17(1):55–9.
[44] McDonough III EF, Spital FC. Managing project portfolios. Res Technol Manage 2003;46(3):40–6.
[45] Bresnen M, Edelman L, Newell S, Scarbrough H, Swan J. Social practices and the management of knowledge in project environments. Int J Project Manage 2003;21(3):157–66.
[46] Kasvi JJJ, Vartiainen M, Hailikari M. Managing knowledge and knowledge competences in projects and project organisations. Int J Project Manage 2003;21(8):571–82.
[47] Pich MT, Loch CH, De Meyer A. On uncertainty, ambiguity, and complexity in project management. Manage Sci 2002;48(8):1008–23.
[48] Prencipe A, Tell F. Inter-project learning: processes and outcomes of knowledge codification in project-based firms. Res Policy 2001;30(9):1373–94.
[49] Pinto JK, Mantel SJ. The causes of project failure. IEEE Trans Eng Manage 1990;37(4):269–76.
[50] Connell J, Edgar G, Olex B, Scholl R, Shulman T, Tietjen R. Troubling successes and good failures: successful new product development requires five critical success factors. Eng Manage J 2001;13(4):35–9.