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Formalization of project portfolio management: The moderating role of project portfolio complexity

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Abstract

Companies frequently implement formalization to improve success. Previous research has found supporting evidence for the performance-enhancing effects of formalization in both single project management and project portfolio management. However, there is no research on how formalization at the project level interacts with formalization at the portfolio level, or on how this interaction may impact success. This study investigates the interaction of formalization at both levels and examines the moderating effect of project portfolio complexity on formalization. Using a sample of 134 firms, this study shows that single project management formalization and, likewise, portfolio management formalization are directly connected to portfolio success. Simultaneous formalization at these two levels delivers a complementary effect, resulting in an increase in success that is more than additive. A contingency analysis confirms that the proposed positive effects become more prominent if complexity is high. Complexity measured as project interdependency has a stronger moderating effect than complexity measured as portfolio size.

Keywords: Formalization; Project portfolio management; *Project portfolio success*; *Project portfolio complexity*; Empirical study

1. Introduction

Formalization is a central construct in organizational theory and is recognized as a central element of bureaucratic regimes (Weber, 1922). Many studies have shown a positive relationship between formalization and organizational performance (Nahm et al., 2003; Pearce et al., 1987). The drivers and impact of formalization were first studied for *permanent organizations*, which are founded for an unspecified period with the goal of long-term performance for their stakeholders. More recently, researchers have investigated formalization in the context of the *temporary organization* "project" (Lundin and Söderholm, 1995) and found that the formalization of single project management is connected with project performance (Liu et al., 2008; Milosevic and Patanakul, 2005; Na et al., 2004; Nidumolu, 1996; Payne and Turner, 1999). However, there is little research on the interplay between the formalization of permanent and temporary organizations. The present study integrates both views by analyzing the formalization of single project management and project portfolio management, a subsystem of the permanent project-oriented organization.

Single project management (SPM) formalization includes the definition and implementation of standard tools (Milosevic and Patanakul, 2005), established standards (Nidumolu, 1996), defined procedures and processes (Dietrich and Lehtonen, 2005), tight controls (Liu et al., 2008), and consistency across single projects (Payne and Turner, 1999). As the number of projects increases, it is particularly important to guarantee effective and efficient execution of project portfolios. This remains a challenge despite the formalization of single projects, which facilitates faster process implementation and better process quality (Ahlemann et al., 2009; Garcia, 2005). Cooper et al. (2001) emphasize the importance of a well-structured and consistently applied process for project portfolio management in new product development. Consistency of processes facilitates the management of interdependencies between projects and the comparison of divergent projects (Cooper, 2008). While companies are keen to invest heavily in education and (re-) certification of their project management professionals and to

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make use of external guidelines supplied by professional project management organizations to establish standardization, the return on these investments in formalization remains uncertain.

Martinsuo and Lehtonen (2007) suggest that empirical research should link project management practices such as formalization to the portfolio level to increase efficiency in managing project portfolios. De Reyck et al. (2005) support this claim by noting that respondents who implemented the formalization of single project analysis improved their performance within the project portfolio environment. However, literature on the connections between the project and the portfolio level is scarce. So far, the construct formalization has been considered only at the single project level, and no study has analyzed the combined and interacting effects of formalization at both levels. To address this gap, we differentiate and measure project portfolio management (PPM) formalization. In this paper, we argue that the degree of formalization of single projects is an organizational variable that enables the implementation of project portfolio management and increases its positive impact. The definition and implementation of a formalized project portfolio management process also increase and reinforce the formalization of the single project management process.

Despite the merits of formalization, over-bureaucratized systems may paralyze organizations and increase organizational inertia as well as resistance to change. To understand the specific conditions that support the positive effects of formalization, it is essential to adopt a contingency perspective when investigating the effectiveness of formalization (Burns and Stalker, 1961; Dietrich, 2007; Donaldson, 2001). Various characteristics, such as the size, composition, or innovativeness of projects in the portfolio, may influence the effectiveness of formalization. However, most studies do not take contingencies into account. This study considers the individual portfolio's condition by examining the effect of the complexity of a project portfolio on the link between formalization and portfolio success. Project portfolio complexity is of particular importance in the context of project portfolios (Söderlund, 2004; Stummer and Heidenberger, 2003) because a larger portfolio and interdependencies between projects pose challenges for the manageability of project portfolios.

This paper addresses the following research questions: How do the formalization of the single project management process and the formalization of the project portfolio management process influence the success of a project portfolio? How do the two types of formalization interact with each other in their effect on performance? How is the influence of formalization moderated by the complexity of the project portfolio?

By addressing these questions, this study contributes to the literature in several ways. First, we provide empirical evidence for the existence of a positive relationship between single project management formalization and project portfolio success. Thus, we corroborate the claim that the standardization of single project management practices is related to project portfolio success. Second, we show that simultaneous formalization at both levels has a complementary positive effect on the quality of the execution of the project portfolio management process. We emphasize that single project management formalization is a necessary but not sufficient condition for project portfolio management quality (PPM quality). Third, we show that formalization becomes even more important for more complex portfolios (i.e., larger project portfolios and portfolios with highly interdependent projects), thus confirming the need to consider contingency factors in project portfolio management research. Fourth, we show that the relationship between formalization and portfolio success is fully mediated by the PPM quality. This finding provides additional insight into the mechanisms by which formalization affects performance and explains why complexity has a positive moderating effect.

2. Theoretical framework and hypotheses

The framework of this study is based on task-oriented contingency theory (Donaldson, 2001), which uses the task variable project portfolio complexity to explain the effects of formalization on project portfolio success (see Fig. 1).

The framework deserves some preliminary comments. Contingency theory goes beyond a mere enumeration of the positive and negative effects that are assumed if a certain strategy pattern or structural decision is preferred over another one. Contingency theory attempts to predict the conditions under which the positive effects of each strategy pattern will be stronger than the negative effects and the conditions under which the opposite is more likely. A contingency theory perspective does not only specify

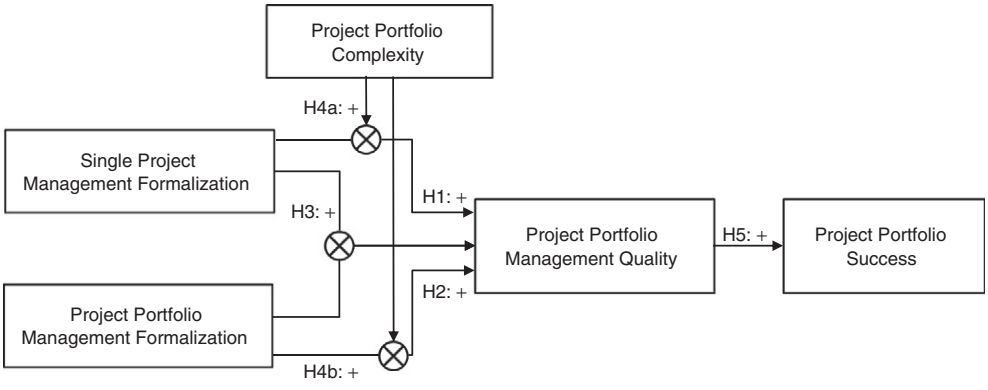

Fig. 1. Framework on the relationship between formalization, PPM quality and project portfolio success.

these conditions, it also describes the mechanism through which different effects occur under certain conditions.

Applied to the present study, the framework includes not only the direct effects of single project management formalization and project portfolio management formalization but also their interaction. The underlying hypothesis is that the use of consistent formalization at both levels will have a complementary effect that leads to a greater benefit than the sum of both individual effects. Furthermore, the interaction effects between project portfolio complexity and each type of formalization are included to analyze the conditions under which formalization is most beneficial. Finally, to explore the underlying mechanism for the performance effect of formalization, the framework includes not only project portfolio success as the ultimate outcome measure but also PPM quality as the mediator between formalization and success. The central idea is that formalization does not improve project portfolio success per se; rather, formalization improves project portfolio success by increasing PPM quality—by improving transparency, enhancing resource allocation, and facilitating cooperation between actors. Improvement of PPM quality is thus understood as the mechanism that explains why and how formalization has positive effects. In the following section, the constructs and their relationships are explained in detail.

2.1. Project portfolio management quality

Project portfolios are defined as collections of single projects that run concurrently (Archer and Ghasemzadeh, 1999). Fundamentally, these multiple projects must be operated efficiently. However, project portfolio management focuses on effectiveness: the execution of the right projects. If a project portfolio were regarded as an organization's investment strategy, the right projects would be those that yielded the most return on investment for this organization (Roussel et al., 1991; Seider, 2006) based on consideration of single project and project portfolio level risks. Thus, project portfolio management is a decision-making process that steers the right projects from idea to successful implementation. These decisions are made on present and potential projects and include selection, prioritization, and termination as well as re-allocation of resources across the collection of projects (Cooper et al., 2001).

PPM quality measures the quality of the process execution in project portfolio management (Dammer, 2008; Dammer et al., 2006; Jonas et al., 2010). It consists of three complementary dimensions. First, information quality is concerned with the availability, comprehensiveness, and transparency of information. Second, resource allocation quality is related to the speed of assignment, reliability of commitment, and avoidance of conflicts during resource endowment. Third, cooperation quality implies the empathy and readiness to help fellow project managers and other project teams (cross-project cooperation).

2.2. Formalization of single project management

Formalization is defined here as the degree to which processes, procedures, work rules, and policies are clearly specified and followed (Jang and Lee, 1998). In project management, this includes the consistent use of defined procedures, methodologies, and tools (Liu et al., 2008). Formalization can take place at the level of single projects or at the portfolio level. Established standards that have been developed explicitly for the project and project portfolio management domain include the guide to the Project Management Body of Knowledge (PMBOK® Guide, Project Management Institute, 2008a), the Project Management Institute's (PMI's) Standard for Portfolio Management (Project Management Institute, 2008c), the PMI's Organizational Project Management Maturity Model (OPM3, Project Management Institute, 2008b), the IPMA Competence Baseline (ICB, Gaupin, 2006), the Association for Project Management's Body of Knowledge (Association for Project Management, 2006), the Office of Government Commerce's (2008) standard on Portfolio, Programme and Project Offices, and the Capability Maturity Model Integration (CMMI®, Software Engineering Institute, 2010). These standards describe processes and tools in detail and provide guidelines and support to organizations in their application of project management practices.

There is sufficient empirical support for a positive effect of single project management formalization on project success (Liu et al., 2008; Milosevic and Patanakul, 2005; Nidumolu, 1996). For example, some studies indicate that standardized project management tools influence project success through increased customer satisfaction, better cost effectiveness, more punctual schedules, and higher-quality accomplishments (Kerzner, 2000; Milosevic and Patanakul, 2005). Formalization of processes helps to exploit economies of scale and of scope. Learning of processes becomes easier, coordination between processes is simpler, processes become more reliable, and processes can be performed in a shorter time. These beneficial effects of process formality have been demonstrated empirically (Jang and Lee, 1998). Formal procedures include a shared and reproducible core process in which all project managers follow the same sequence of project phases, gates, milestones, activities, and major deliverables for each project (Milosevic and Patanakul, 2005). The benefit of consistently applied processes across all projects is the ability to transfer process knowledge from one project to another. Through shared knowledge, project teams achieve a common understanding that is positively associated with information quality (Clarke, 1999), thereby improving the speed and quality of communication within processes (Ahlemann et al., 2009; Garcia, 2005). A well-structured process provides predictability and control, and it prevents malpractice by, for example, inhibiting the unjustified use of resources (Liu et al., 2008). Periodical project status reports and routine project reviews are beneficial for project tracking and initial project planning, which increases the percentage of projects completed on time (Dietrich and Lehtonen, 2005; Leung, 2001; Wohlwend and Rosenbaum, 1993). Predictability of project scopes, schedules, and cost leads to higher transparency and reduces the residual performance risk, which increases performance (Nidumolu, 1996). Furthermore, formalization can improve decision-making clarity (Bonner et al., 2002; Tatikonda and Montoya-Weiss, 2001). However, formalization is not always beneficial. In specific scenarios with radical innovations, formalization may have

negative effects; too much formalization may constrain creativity and interrupt innovation activities (Bonner et al., 2002; Mirow, 2010; Sethi and Iqbal, 2008). While some authors argue that formalization has negative effects, we propose that, in general, the positive effects of formalization prevail. Based upon these arguments and empirical findings, we propose our first hypothesis.

Hypothesis 1. Single project management formalization is positively related to PPM quality.

2.3. Formalization of project portfolio management

In contrast to single project management, project portfolio management is conducted at a higher hierarchical level. With an eye on the entire project portfolio, a more holistic view is required to reflect previous experience, simultaneous projects, the organizational environment, and future organizational intentions (Engwall, 2003). Therefore, the exchange of information, management of resources, and coordination of the collection of projects become even more important for project portfolios. Various studies support the notion that the formalization of portfolio processes significantly influences portfolio performance (Cooper, 1990, 1999, 2008; Kleinschmidt et al., 2007). In stage-and-gate type processes, after each process stage, a go/kill decision is made, and each project is assessed against pre-defined criteria to decide whether to continue investing in the project. If applicable, an action plan for the next stage is developed (Sethi and Iqbal, 2008). At each gate, it is ensured that decisions and resource allocations reflect the needs of the entire portfolio. These formal processes introduce structure, sequence, and clarity to all projects (Tatikonda and Montoya-Weiss, 2001). Establishment of clear rules and guiding principles at the decision points lead to data integrity and facilitate the comparison of divergent projects (Cooper, 2008), ensuring that processes are comprehensive and responsibilities are well defined (Naveh, 2007). Portfolio process formalization therefore improves information and coordination quality by supporting interactions between different functional groups and projects and facilitating inter-project learning (Prencipe and Tell, 2001). Clear criteria for making go/kill decisions and for prioritizing projects allow for a rational, predictable, and deliberate resource allocation and decision process (Benner and Tushman, 2003; Christensen and Bower, 1996). Poor projects can be terminated earlier, and important projects can benefit significantly from the available resources. In light of these arguments, we suggest the following hypothesis.

Hypothesis 2. Project portfolio management formalization is positively related to PPM quality.

Previous research has emphasized the importance of formalizing project management and project portfolio management separately while considering the performance impact on the respective levels. Project portfolio management can only operate if information from projects is available. Formal procedures and rules enhance the availability and determine the format of information, thereby facilitating the comparison of diverse projects. For example, high levels of formalization in single projects result in clear resource requirements and a transparent workload for these single projects. In turn, this increases the efficiency and speed of the formal resource allocation and prioritization process and facilitates coordination between projects. To use standardized project management practices consistently, they need to be mutually compatible and integrated with the formal process (Milosevic and Patanakul, 2005).

Without single project management formalization, the formalization of project portfolio management is elusive. Therefore, an increase in the formalization of project portfolio management without formal processes for single project management will be ineffective in enhancing PPM quality. However, formalization of single project management alone will not be effective either because it lacks a holistic view. Furthermore, the definition and implementation of a formalized project portfolio process will increase and reinforce the formalization of the single project process. While single project management improves efficiency, project portfolio management enables organizations to increase their effectiveness. The above outlined benefits and necessity of formalization suggest that formalization that operates on the two system levels simultaneously results in a complementary effect that leads to increased PPM quality and, consequently, success.

Hypothesis 3. Simultaneous single project management formalization and project portfolio management formalization increases the positive effect on PPM quality.

2.4. Project portfolio complexity as a contingency factor

To increase organizational performance, the structural factors should be appropriate for the contextual factors (Burns and Stalker, 1961; Donaldson, 2001; Lawrence and Lorsch, 1967). One approach does not fit all projects (Shenhar, 2001), and not all portfolios are alike. Therefore, it is necessary to adopt a contingency perspective to specify the conditions under which formalization becomes more or less desirable and effective (Howell et al., 2010; Milosevic et al., 2001). The optimal degree of formalization depends on the characteristics of the task, which are a core theme in task-related contingency theories. Two kinds of task-related contingency theories have been developed in relation to the impact of formalization. The first uses the complexity of a task as a moderating factor, and the second uses the uncertainty, risk or innovativeness of a task. This study follows the complexity research stream. The reason for disentangling complexity and uncertainty is that we assume opposing moderating effects. While we argue in this paper for a positive moderating effect of complexity on formalization, the effect of uncertainty, risk, and innovativeness are more likely to be negative (Salomo et al., 2007; Sethi and Iqbal, 2008).

In project portfolio management, the systemic perspective is often used to describe the complexity of a project portfolio. This perspective includes the following determinants of complexity: the number of elements, the degree of interdependency between the elements, and the magnitude and predictability of

changes in elements and interdependencies (Daft, 1992; Dietrich, 2007; Dooley and van de Ven, 1999; Levinthal and Warglien, 1999; Ribbers and Schoo, 2002). Similar arguments have been used to define the complexity of single projects (Tatikonda and Rosenthal, 2000; Williams, 1999). Because the magnitude and predictability of changes in the elements are also central elements of uncertainty, we will use only the size of a system and the degree of interdependency between its elements as measures of complexity in this study. Following Thompson's (1967) differentiation between sequential, pooled, and reciprocal interdependency, projects in a portfolio may be linked by outcome, resource, or knowledge interdependencies. Outcome interdependency occurs when one project uses the results of another project, resource interdependency occurs when different projects concurrently compete for the same resources, and knowledge interdependency occurs when the knowledge generated in one project is relevant for another project. The more these interdependencies occur, the higher the complexity of a project portfolio is. In the following, project portfolio complexity is defined as the size of the project portfolio (Daft, 1992) and the degree of interdependency between projects (Dickinson et al., 2001; Nobeoka and Cusumano, 1994; Thompson, 1967).

Any collection of interrelated projects requires coordination of project management activities (Dietrich, 2007; Levinthal and Warglien, 1999). The need for coordination results from the inevitable effect of changes in one individual project on the execution of another project in the portfolio. For example, scope creep or delays in one project place the resource commitments and availability of the entire portfolio at risk when projects share the same scarce resources. Therefore, with increasing portfolio size and stronger project interdependency, coordination becomes even more important. Because formalization enables better coordination, it may be especially beneficial in portfolios with high complexity. Project portfolio complexity also increases the opportunity to leverage synergies in knowledge, technological platforms, or customers. Resource conflicts become more likely, and the allocation of resources becomes more challenging. To strengthen core competencies and reduce redundant work, it is important to actively consider complexity. Because we assume that formalization improves information and coordination quality as well as resource allocation, we suggest that the proposed positive effects of formalization are even more prominent if the complexity of a project portfolio is high.

Hypothesis 4a. The relationship between single project management formalization and PPM quality becomes stronger with increasing project portfolio complexity (positive moderating effect).

Hypothesis 4b. The relationship between project portfolio management formalization and PPM quality becomes stronger with increasing project portfolio complexity (positive moderating effect).

2.5. Project portfolio management quality and project portfolio success

Project portfolio success is understood as a multidimensional construct. Traditionally, to be regarded as successful, a project must achieve its budget, time, and quality objectives (Pinto and Slevin, 1988) as well as customer satisfaction (Atkinson, 1999; Shenhar et al., 2001). We combine these four aspects into the construct *average single project success*, which reflects the success of all projects within the project portfolio (Martinsuo and Lehtonen, 2007). Three additional success dimensions are considered when judging a collection of projects on the project portfolio level: (1) the project's alignment with strategic goals, (2) the balance of the portfolio, and (3) the maximization of the portfolio value by the use of synergies (Cooper et al., 2001; Dammer et al., 2006; Jonas, 2010; Meskendahl, 2010). The project portfolio's *strategic fit* assesses the alignment of individual projects' objectives with corporate strategy (Dietrich and Lehtonen, 2005). *Portfolio balance* is concerned with the steady utilization of resources during project execution and the equilibrium of risk in the technology base (Killen et al., 2008). The *use of synergies* involves capitalizing on the interdependence between individual projects, which includes multiple usages of technology platforms or existing marketing channels as well as the avoidance of redundant work.

Project portfolio success has been shown to be highly positively associated with information quality, cooperation quality, and allocation quality, which together compose PPM quality (Jonas et al., 2010). High information quality and transparency over the project landscape form the basis for good decision making and facilitate the prioritization of the right projects. A lack of information quality has been highlighted as a central barrier for project portfolio success (Cooper et al., 2001) because, for example, it impedes the efficient application of optimization algorithms. A lack of transparency limits resource allocation and opportunities for cooperation because information necessary for precise directives and alternatives is missing. Generally, increased PPM quality promotes and generates better management decisions, thereby improving success. Jonas et al. (2010) suggested PPM quality as a predictor of project portfolio success. This leads to the formulation of our next hypothesis:

Hypothesis 5a. PPM quality has a positive effect on project portfolio success.

Finally, we propose that PPM quality completely mediates the positive effects of single project management formalization and project portfolio management formalization on project portfolio success. This means that both types of formalization only increase project portfolio success because they increase PPM quality. Formalization increases transparency, ensures clear responsibilities, and facilitates resource prioritization and allocation, but it is not connected to the effectiveness of the project portfolio, per se.

Hypothesis 5b. The effect of single project management formalization and project portfolio management formalization on project portfolio success is completely mediated by PPM quality.

3. Method

3.1. Data collection and sample

The testing of our hypotheses is based on a cross-industry sample of firms in Germany. To generate a high response

rate, we cooperated with project management institutions.[1] A letter providing a general explanation of the study was sent to members of these institutions, and a call for registration was solicited. The object of analysis was the project portfolio of a firm or business unit. To test the effect of formalization and the contingency factors of project portfolio complexity in a meaningful way, we exclusively admitted to our study firms with portfolios of 20 or more projects managed in parallel. The key informant was the project portfolio coordinator, who was identified for every participating project portfolio. Typically, this person was responsible for the immediate management of the project portfolio as well as conceptual and advisory activities to shape the project portfolio processes. Thus, the project portfolio coordinator was in a unique position to judge the applied procedures, methods, and processes for managing the portfolio. Typical job titles for coordinators included portfolio manager, head of project management office, division manager, or department manager. Although portfolio coordinators can be considered the best source for the variables used in this study, the chosen key informant approach carries the risk of bias due to common-method variance (Podsakoff et al., 2003). To reduce systematic bias, we guaranteed anonymity to the informants and assured them, in the introductory remarks to the questionnaire, that there were no right or wrong answers. Furthermore, we ensured the appropriateness of the informants by telephone calls. We received 134 returned and fully completed questionnaires. The sample consisted of firms from various industries: manufacturing (35%), financial services (22%), information and communication technologies (15%), pharmaceuticals (5%), the energy sector (5%) and other industries (18%). Of these firms (or business units), 40% had fewer than 500 employees, 28% had between 500 and 2000 employees, and 32% had more than 2000 employees.

3.2. Measures

We used multi-item measurement scales with items drawn from the literature on project portfolio management and related fields. Informants were asked to rate each item on a Likert-type scale from 1 ("strongly disagree") to 7 ("strongly agree"). Item scales were validated using principal components factor analysis (PCFA), followed by confirmatory factor analysis (CFA) (Ahire and Devaraj, 2001). PCFA tests for the unidimensionality of each scale by checking whether all items load on a single factor (i.e., there is only one eigenvalue larger than one). Cronbach's alpha is used to assess scale reliability (acceptable values are larger than 0.7). Finally, a CFA was conducted to confirm the measurement model. Following Hu and Bentler (1998), the measurement model is deemed acceptable if the comparative fit index (CFI) exceeds 0.90 and the standardized root mean square residual (SRMR) is below 0.08. Item wordings and validation statistics are listed in the appendix. All scales fulfill the above criteria and can therefore be considered satisfactory.

[1] Special thanks go to the GPM — Deutsche Gesellschaft für Projektmanagement, the German member association of IPMA.

Project portfolio success was measured as a second-order construct based on the dimensions of average project success (four items), portfolio synergies (two items), strategic fit (three items), and portfolio balance (two items). Dimensions and items were based on Cooper et al. (2001), Dammer et al. (2006) and Dammer (2008). *PPM quality* was also assessed as a second-order construct consisting of three dimensions: information quality (six items), resource allocation quality (four items), and cooperation quality (three items). These items were based on Dammer et al. (2006) and Dammer (2008). *Single project management formalization* was captured using six items that measure the degree to which a formal project management standard is implemented in the firm and to what extent formal rules of project management planning and monitoring are used. These items were conceptually based on Leung (2001) and Dammer et al. (2006). *Project portfolio management formalization* was measured similarly, using six items that assess the degree to which formal rules and procedures, such as the existence of formal review meetings, exist for the project portfolio management process. These items were conceptually based on Cooper et al. (2003) and Griffin (1997). *Project portfolio complexity* was assessed as a characteristic of the project portfolio using two variables: project interdependency and portfolio size. *Project interdependency* was measured with five items that capture the extent to which the projects in the portfolio depend on and are influenced by each other (Dammer et al., 2006). *Portfolio size* was captured by the portfolio budget, using a single seven-point item on the overall budget of the projects in the portfolio (discrete steps from 1 = "smaller than 5 million Euros" to 7 = "greater than 200 million Euros").

Additionally, we controlled for other firm and portfolio characteristics that might influence the relationship between formalization and PPM quality or project portfolio success. *Firm size* was the natural logarithm of the number of employees of the focal firm or business unit. Larger organizations might have more formalized processes, in general. *Internal project ratio* was the percentage of projects (from 0 to 1 = 100%) in the portfolio that have internal clients (as opposed to external clients); it acted as a proxy for portfolio composition. Thus, potential differences in the management of external vs. internal portfolios were controlled for. Table 1 displays the descriptive statistics and correlations of all variables.

4. Results

Hierarchical multiple regression was used to determine the effects of single project management formalization and project portfolio management formalization on PPM quality and project portfolio success as well as the moderating impact of project portfolio complexity on these relationships. Interaction effects between the two types of formalization and between each type and project portfolio complexity were tested using the procedures proposed by Aiken et al. (1991). After mean-centering the variables, the product term was included in the regression model. If the interaction term is significant and the inclusion of the term significantly increases the explained variance of the model, an interaction effect can be assumed. To visualize

Table 1
Descriptive statistics and correlations.

		Mean	Std. dev.	Min	Max	Skewness	Kurtosis	1	2	3	4	5	6	7
1	Project portfolio success	4.53	0.85	2	6.6	−0.31	0.15							
2	PPM quality	4.48	0.85	2	6.3	−0.21	−0.12	0.66**						
3	Firm size (ln)	6.45	2.35	2.3	11.0	−0.49	0.02	0.10	−0.07					
4	Internal project ratio	0.72	0.38	0	1	−0.71	−0.83	−0.06	−0.09	0.19*				
5	Project interdependency	4.21	1.09	1.8	6.6	0.04	−0.53	0.06	−0.10	0.19*	0.16			
6	Portfolio size	4.04	1.81	1	7	0.05	−0.85	0.12	−0.05	0.24**	−0.11	0.14		
7	SPM formalization	5.30	1.14	2	7	−0.56	0.08	0.35**	0.37**	0.12	0.29**	0.07	0.21*	
8	PPM formalization	4.10	1.47	1	6.8	−0.16	−0.63	0.37**	0.40**	0.11	0.19*	0.22*	0.08	0.49**

n=134.
* $p<0.05$.
** $p<0.01$.

the nature of interaction effects, we plot regression curves for high and low values of the moderator. According to Aiken et al. (1991), a high (low) value is the mean plus (minus) one standard deviation. The results are illustrated in Table 2.

Models 1 to 6 test the effects of single project and portfolio management formalization on PPM quality. Model 1 includes only the direct effects of the control and independent variables on PPM quality. Models 2 to 6 each test a specific interaction effect by adding the multiplication term into the model and comparing the model to the simple model 1. Finally, models 7 and 8 show the direct impact of all independent variables and PPM quality on project portfolio success.

Model 1 shows that single project management formalization has a significant positive impact (b=0.23, $p<0.01$) on PPM quality, as does project portfolio management formalization (b=0.20, $p<0.01$). Consequently, both hypotheses 1 and 2 can be supported. In addition, the control variable percentage of internal projects shows a significant and strong negative influence on PPM quality, which remains rather stable in the subsequent models. Model 2 includes the interaction term between the two types of formalization to account for their simultaneous effect. The interaction term is significantly positive (b=0.08, $p<0.05$), and the increase in the explained variance of PPM quality compared to model 1 is significant. Therefore, hypothesis 3 can be supported, in that the two types of formalization complement each other in their effect on PPM quality. Fig. 2 visualizes the nature of the interaction effect between single project management formalization and project portfolio management formalization.

Models 3 and 4 test the interaction effects of single project management formalization with both types of project portfolio complexity. Hypothesis 4a) stated that with increasing project

Table 2
Results.

	Project portfolio management quality						Project portfolio success	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm size (ln)	−0.01	−0.02	−0.01	−0.01	−0.01	−0.01	0.03	0.04
Internal project ratio	−0.41*	−0.36*	−0.46**	−0.46**	−0.41*	−0.41*	−0.35	−0.09
Project interdependency	−0.10	−0.09	−0.12*	−0.12*	−0.11	−0.11	0.01	0.07
Portfolio size	−0.09*	−0.08*	−0.09*	−0.09*	−0.08*	−0.08*	−0.02	0.04
SPM formalization	0.23**	0.27**	0.28**	0.28**	0.25**	0.25**	0.16*	0.01
PPM formalization	0.20**	0.17**	0.21**	0.21**	0.19**	0.19**	0.17**	0.04
SPM × PPM formalization		0.08*						
SPM formalization × Project interdependency			0.15**					
SPM formalization × Portfolio size				0.06†				
PPM formalization × Project interdependency					0.10*			
PPM formalization × Portfolio size						0.06*		
PPM quality								0.64**
Constant	4.48**	4.41**	4.44**	4.44**	4.47**	4.45**	4.53**	4.53**
R^2	0.29	0.32	0.34	0.31	0.33	0.32	0.19	0.48
Delta R^2		0.03*	0.05**	0.02†	0.04*	0.03*	0.00	0.29**
Adjusted R^2	0.26	0.28	0.30	0.28	0.29	0.29	0.16	0.46
F	8.74	8.36	9.17	8.21	8.72	8.59	5.09	16.90

Hierarchical regression models with project portfolio management quality (Models 1–6) and project portfolio success (Models 7 and 8) as dependent variables; unstandardized regression coefficients are reported; all variables are mean-centered; n=134.
† $p<0.10$.
* $p<0.05$.
** $p<0.01$.

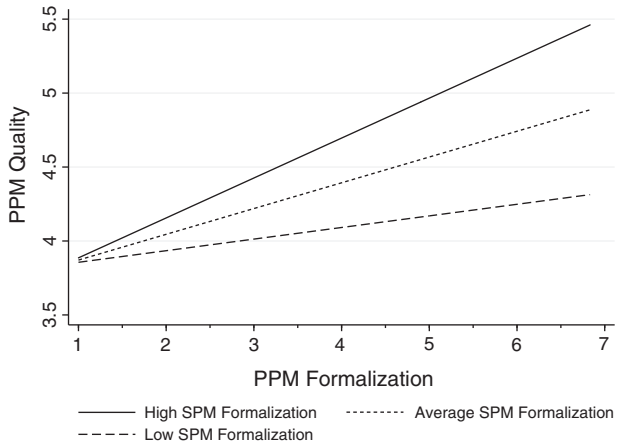

Fig. 2. Interaction between SPM formalization and PPM formalization.

portfolio complexity, the benefits of single project management formalization for PPM quality will further increase. The interaction effects of single project management formalization with both project interdependency (model 3: b=0.15, $p<0.01$) and portfolio size (model 4: b=0.06, $p<0.10$) are positive and significant. Models 3 and 4 also explain significantly more variance in PPM quality than model 1. Therefore, hypothesis 4a) can be supported. Fig. 3 shows the visualized interaction effects between single project management formalization and project interdependency.

Similarly, models 5 and 6 test the interaction effects of project portfolio management formalization with both types of project portfolio complexity. Hypothesis 4b) can also be supported because the interaction effects of project portfolio management formalization with project interdependency (model 5: b=0.10, $p<0.05$) and with portfolio size (model 6: b=0.06, $p<0.05$) are both significant and the models each explain significantly more variance than the base model 1. Therefore, with increasing project portfolio complexity, project portfolio management formalization will be more strongly associated with PPM quality. Fig. 4 shows the visualized interaction effects between project portfolio management formalization and project interdependency.

Hypotheses 5a) and b) stated that *PPM quality* positively affects project portfolio success and further mediates the effects of formalization on project portfolio success. Model 7 shows the direct impact of both types of formalization on success, and model 8 includes PPM quality. Model 8 further shows that the impact of PPM quality on project portfolio success is very strong and significant (b=0.64, $p<0.01$), which supports hypothesis 5a). Furthermore, a joint consideration of models 1, 7, and 8 shows that the positive effects of both types of formalization on project portfolio success are completely mediated by PPM quality. The conditions for a mediating relationship, as proposed by Baron and Kenny (1986), are fulfilled: (1) both types of formalization are significantly related to project portfolio success (model 7); (2) both types are also significantly related to the mediator PPM quality (model 1); (3) PPM quality is significantly related to project portfolio success (model 8); and (4) the effect of both types of formalization on project portfolio success disappears when the effect of PPM quality is controlled for (model 8). Therefore, hypothesis 5b) can also be supported.

5. Discussion and conclusion

This study examined formalization in a project portfolio environment. We differentiate between single project management formalization and project portfolio management formalization. Both types of formalization configure standardized routines and processes. However, the former does this to manage projects and the latter to manage whole portfolios. Thus, two distinct levels of formalization are analyzed, and their joint impact on PPM quality and project portfolio success is considered. The results show that both types of formalization are independently associated with increased PPM quality and, consequently, project portfolio success. Thus, formalization of both single project management and project portfolio management improve transparency in a project portfolio environment as a result of the increased availability and comprehensiveness of information. Furthermore, formalization is connected with the speed of resource allocation and the reliability of commitment, and it reduces conflicts in resource endowment. Empathy and willingness to help fellow project managers and project

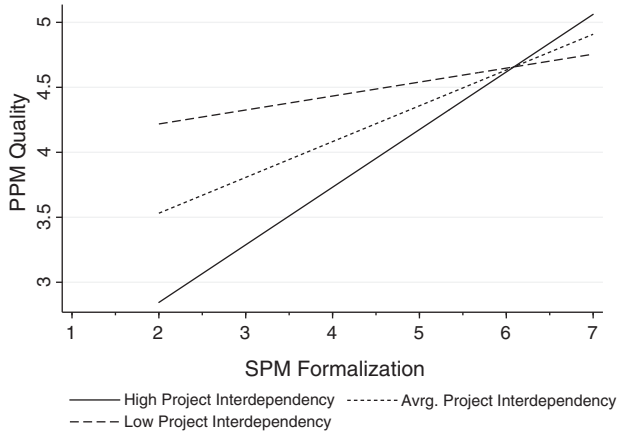

Fig. 3. Interaction between project portfolio complexity and SPM formalization.

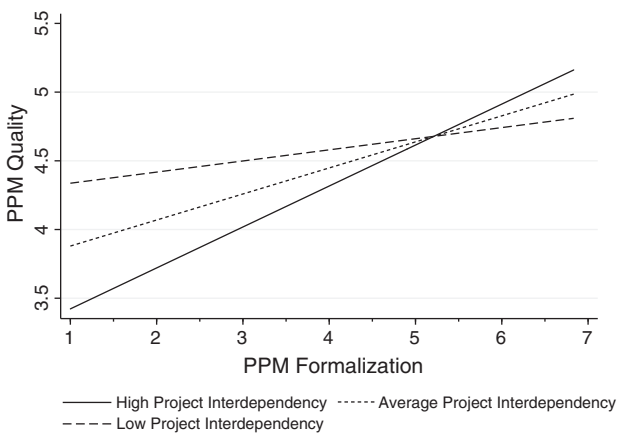

Fig. 4. Interaction between project portfolio complexity and PPM formalization.

teams is also increased. More importantly, we find that joint formalization at both management levels impacts PPM quality even more strongly. Therefore, the positive effect of one type of formalization is strengthened when the other type increases. This integration of the micro and macro levels in formalization answers the call to examine the interface between single project management and project portfolio management (Martinsuo and Lehtonen, 2007; Söderlund, 2004). Our study highlights the importance of the interaction between the single project and project portfolio level in line with Martinsuo and Lehtonen (2007). Furthermore, we extend their findings by showing the interaction effects between the two types of formalization, the mechanisms by which formalization affects performance, and a contingency perspective. We find that the effects of formalization are completely mediated by PPM quality. Finally, the results suggest that the positive effect of formalization is moderated by project portfolio complexity. With rising complexity, the benefits of formalization become even stronger. Drawing from these results, this study contributes to the literature on project and project portfolio management in several ways.

First, the results of this study suggest that formalization that is implemented solely at one level, without provisions for the other, has an inferior effect. Thus, it is necessary and strongly recommended to establish formalization at both management levels simultaneously and to integrate these mechanisms with regard to context.

Second, the tested framework offers a deeper understanding of the performance impact of formalization. The mediating effect of PPM quality explains the mechanisms by which formalization affects project portfolio processes and, consequently, their performance. Thus, the present study provides insight into what these mechanisms are and how they function. For example, formalization at both levels is positively associated with transparency across the project portfolio, which, in turn, facilitates the appropriate allocation of resources. Hence, the overall cooperation between projects may be improved because the reasons for conflicts and resource haggling are reduced. This situation has direct consequences for the overall success of the portfolio.

Third, by adopting a contingency perspective on formalization in project portfolios, the results suggest that formalization becomes even more important for success in more complex portfolios. This finding is validated by the fact that it does not matter whether complexity is measured by portfolio size or project interdependency. These results imply that formalization is not an end in itself but rather must correspond to the specific requirements for the complexity of the individual project portfolio to achieve an optimal level of success. In other words, there is no single method of formalization that fits all portfolios (Chenhall, 2003). Thus, the portfolio size and the project interdependencies between the individual projects in the portfolio must be carefully considered.

This study has implications for the theory and practice of project portfolio management. Research on formalization is substantially complemented by the conceptualization of two distinct types of formalization in a project portfolio environment. The interaction effect demonstrated between these two kinds of formalization illustrates the need for comprehensive and integrated formalization. Therefore, we suggest that single project management formalization fundamentally belongs to project portfolio management formalization. Future studies should consider this interaction effect to ensure the accommodation of improved outcomes due to integrated formalization. A similar multi-level research design that integrates the perspective of single projects and project portfolios may be applied to other management aspects in future studies, such as distinct risk management practices for the project and the portfolio levels and their interaction. The findings on the mediating relationship of PPM quality may also be useful in future studies. For example, future analysis may consider the role of PPM quality in the relationship between project management offices, another mechanism to formally coordinate the steering of project portfolios, and project portfolio success.

Finally, the results of this study emphasize the importance of contingency factors in single project and project portfolio management (Howell et al., 2010). In this context, other aspects of portfolio content might be relevant. For example, when high levels of creativity are required (as is the case in R&D activities), formalization may systematically create barriers to innovation and reduce opportunities for creativity (Bonner et al., 2002; Mirow, 2010; Sethi and Iqbal, 2008). This situation will eventually reduce success and discourage key innovators. Salomo et al. (2007) show that uncertainty measured as innovativeness negatively moderates the performance impact of the formalization of new product development projects. Thus, the formalization of R&D project portfolios needs to be carefully administered to prevent these adverse effects. No clear guidelines can be offered for project portfolios that are both complex and highly innovative because the complexity and innovativeness of the two task conditions have conflicting implications, depending on the strength of the moderation effects and the interaction of these conflicting contingencies. For theory building, it is therefore very important to avoid bundling these task characteristics under a wider umbrella construct (Howell et al., 2010). Instead, focused constructs must be defined and the interdependencies between their moderating effects analyzed. Future research should address such conflicting contingency aspects and analyze how other task characteristics interact with project portfolio complexity.

Different types of managers in project portfolio management may benefit from this study. Practitioners may benefit most from applying the finding that both types of formalization must be implemented simultaneously and in an integrated fashion to achieve the highest process quality. This includes acknowledging the reduced effectiveness of formalization at only one level of management. First, designers of project portfolio management systems are advised to define and to integrate single project management formalization in accordance with project portfolio management formalization because the former is the basis of harmonious formalization. Second, supervisors or coordinators of project portfolios are advised to apply well-structured and consistently configured processes, tight controls, and standard tools for the respective levels of

management. Furthermore, these coordinators must ensure that all stakeholders closely adhere to the formalization requirements of both levels to yield the positive interaction effect of joint formalization. Benefits for these practitioners include operating processes in an integrated manner, making better decisions in critical situations (e.g., at the gates of a formal approval process) and achieving faster process implementation, better process quality, and higher quality results congruent with portfolio goals (Ahlemann et al., 2009; Garcia, 2005). Third, the information on the relevance of contextual factors for formalization may have managerial implications. Less complex project portfolios do not profit as much from a high degree of formalization. Thus, a high degree of formalization might not be necessary due to the excessive cost incurred for set-up. In certain cases, the implementation of highly formalized processes might incur more costs than benefits (Ahlemann et al., 2009).

A few limitations need to be pointed out when interpreting the results of this study. First, PPM quality and project portfolio success were measured in the same time period. Thus, there may be a risk of halo or attribution bias because successful portfolios are automatically considered to have high quality processes, and vice versa. Therefore, the true relationship between PPM quality and project portfolio success might be lower. However, this relationship is not the primary focus of this study, and previous longitudinal studies have shown that PPM quality positively influences project portfolio success in later periods (Jonas et al., 2010). Second, a potential risk of common method bias cannot be excluded. However, precautions have been taken by carefully collecting information on key informants in project portfolio management, guaranteeing anonymity to the informants, and assuring the informants' evaluation competency (Podsakoff et al., 2003). Third, this study focused on German firms, but formalization may be handled differently in other regions, such as Scandinavia, where less emphasis is placed on processes than on actors (Ahlemann et al., 2009; House et al., 2004). Thus, future studies may build upon our findings and contrast practices in other cultural contexts. This would be especially beneficial for multi-national organizations that seek to equalize standards throughout their business (Clarke, 1999) or companies in cross-national, post-merger integration exercises.

Appendix. Item wording and measurement

Project Portfolio Success ($\chi^2 = 86.18$ (df=40; $p < 0.00$); SRMR=0.063; CFI=0.93)

Average Project Success (*4 items*, *alpha=0.75*)

APS1 On average our projects have a high schedule adherence.

APS2 On average our projects have a high budget adherence.

APS3 On average our projects have a high quality adherence.

APS4 On average our projects are completed with high customer satisfaction.

Synergies (*2 items*, *alpha=0.74*)

SYN1 We consistently use technical synergies between our projects.

SYN2 We consistently use market synergies between our projects.

Strategic Fit (*3 items*, *alpha=0.86*)

FIT1 Our project portfolio is consistently aligned with the firm's future.

FIT2 The firm strategy implemented by our project portfolio in an optimal way.

FIT3 Project's resource allocation reflects our strategic objectives.

Portfolio Balance (*2 items*, *alpha=0.76*)

BAL1 Our project portfolio has a good balance between new and old areas of application.

BAL2 Our project portfolio has a good balance between opportunities and risks.

Project Portfolio Management Quality ($\chi^2 = 74.78$ (df=62; $p < 0.13$), SRMR=0.066, CFI=0.99).

Information Quality (*6 items*, *alpha=0.88*)

IQ1 Transparency of our project portfolio is very good.

IQ2 We can access all relevant information on a project's status easily and quickly.

IQ3 Presentation of information on the project portfolio is standardized on the top management level.

IQ4 Project and line managers are continuously provided with relevant information on the entire project portfolio.

IQ5 Project status and resource information can be interpreted easily and quickly.

IQ6 Exactly those status and resource information are delivered that are necessary for decision making.

Resource Allocation Quality (*4 items*, *alpha=0.77*)

AQ1 There are often conflicts between project and line management (matrix problems). (reversed).

AQ2 Project managers and line managers constantly haggle about resources. (reversed).

AQ3 It requires time-consuming coordination loops until the portfolio resource allocation is finished. (reversed).

AQ4 Line managers always adhere to their resource commitments.

Cooperation Quality (*3 items*, *alpha=0.84*)

CQ1 Our project teams support each other (in cases of bottlenecks or content-related problems).

CQ2 In cases of problems project managers try to solve them directly among each other.

CQ3 Overall there is a very good cooperation among our projects.

Single Project Management (SPM) Formalization (6 items, alpha=0.77, $\chi^2 = 19.18$ (df=9; $p < .02$), SRMR=0.047, CFI=0.95))

SPMF1 We follow a standardized procedural model for single project management.

SPMF2 Projects are only started when an approved proposal exists.

SPMF3 A detailed project plan is provided for each project.

SPMF4 Each project gets assigned a defined project budget.

SPMF5 Project monitoring takes place continuously for the whole duration of a project.

SPMF6 Project progress is regularly tracked, as well as completely and routinely recorded for each project.

Project Portfolio Management (PPM) Formalization (6 items, alpha=0.87, χ^2=43.39 (df=9; p<0.00), SRMR=0.068, CFI=0.91)

PPMF1 We divide our project portfolio management process in several phases.

PPMF2 All process phases are concluded by an explicit approval gate.

PPMF3 Our process of project portfolio management is precisely specified.

PPMF4 During a portfolio review all projects are rigorously examined.

PPMF5 A shared understanding of the project portfolio management process is reflected in the activities of all participants.

PPMF6 Overall we execute a very structured project portfolio management process.

Project Portfolio Complexity

Portfolio Size (*single item*)

PS1 How high is the overall budget of the project in the portfolio (in m €)?

1: <5; 2: 5–10; 3: 11–20; 4: 21–50; 5: 51–100; 6: 101–200; 7: >200.

Project Interdependency (*5 items*, *alpha=0.79*, χ^2=*6.59 (df=5; p<0.25)*, *SRMR=0.032*, *CFI=0.99*)

PI1 In terms of scope our projects build on each other.

PI2 A high degree of alignment between our projects is required with respect to the scopes.

PI3 Output of one project is often part of another project or component of the whole system.

PI4 Scope changes of individual projects inevitably impact on the execution of other projects.

PI5 Often projects can only be continued if the precise results of other projects are known.

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