

An empirical investigation on how portfolio risk management influences project portfolio success

Juliane Teller*, Alexander Kock

Technische Universität Berlin, Chair for Technology and Innovation Management, Straße des, 17. Juni 135, Sekr. H71, 10623 Berlin, Germany

Abstract

Project risk management is recognized as essential in order to cope with the challenges arising from the environment. Literature suggests a portfolio-wide perspective for managing risks in project portfolios. However, research on risk management and its success in a project portfolio context is scarce. This study examines how portfolio risk management influences project portfolio success. Using a sample of 176 firms, this study provides evidence that portfolio risk identification, the formalization of the portfolio risk management process, and risk management culture directly influence risk transparency, whereas risk prevention, risk monitoring, and the integration of risk management into project portfolio management are directly connected to risk coping capacity. The findings also suggest that both risk transparency and risk coping capacity have a direct impact on project portfolio success. However, the results did not confirm the hypothesis that risk transparency and risk coping capacity have a complementary effect on success. Implications for scholars and project portfolio managers are discussed.

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1. Introduction

The management of risks is a crucial element of project portfolio management. Risk management enables the organization to cope with arising opportunities and threats. In a project portfolio environment it is no longer sufficient to manage solely the risks of single projects (Olsson, 2008). Organizations tend to run several projects concurrently to maintain flexibility and efficiency. New risks emerge additionally to single project risks due to the dependencies between projects (Project Management Institute, 2008b). Therefore, literature suggests a portfolio-wide risk management that extends the management of single project risks (Arto et al., 2000; Lee et al., 2009; Olsson, 2008; Pellegrinelli, 1997).

A portfolio-wide approach for risk management supports the alignment and redistribution of resources between the projects

and considers additional portfolio risks. Thus, portfolio risk management is assumed to enhance transparency, the revelation of transferences of problems (Sanchez et al., 2009), the capacity to cope with risks (Lee et al., 2009), and the profoundness of information on which decisions are based on (McFarlan, 1981). By connecting information derived from the risk management of different single projects, portfolio risk management can identify risks that emerge in multiple projects simultaneously. Therefore, activities can be consolidated and duplication of work can be prevented. Consequently, portfolio risk management avoids failure and increases the possibility of the project portfolio success (de Reyck et al., 2005; McFarlan, 1981). Besides the positive effects of portfolio risk management one also needs to consider that portfolio risk management is time consuming and involves costs. Therefore, it is worth investigating whether the benefits justify the costs (Kutsch and Hall, 2009). Portfolio risk management is rarely implemented de facto (de Reyck et al., 2005). Organizations seem to have a low consciousness of portfolio risks and of the need to view risks holistically (Olsson, 2007). The reason for this may be the

* Corresponding author. Tel.: +49 30 314 78812; fax: +49 30 314 26089.

E-mail addresses: juliane.teller@tim.tu-berlin.de (J. Teller),
alexander.kock@tim.tu-berlin.de (A. Kock).

special challenge of evaluating risks at the portfolio level. Alternatively, project portfolio managers may lack expertise and time or have a problem of cost justification (Kutsch and Hall, 2009; Ward and Chapman, 1991).

The positive effects of single project risk management have widely been acknowledged in project management literature (de Bakker et al., 2011). However, research on managing risks within a project portfolio is relatively rare (Sanchez et al., 2009). There exist some conceptual research and single-case studies on portfolio risk management (Olsson, 2008; Sanchez et al., 2008). However, to our knowledge no large-scale empirical study exists that examines risk management in a project portfolio environment. Further investigation is necessary to show where to focus when managing risks in a project portfolio. The main objective of this study is to examine the linkage between portfolio risk management practice and project portfolio success. Therefore, this study attempts to answer the following research question: How does portfolio risk management influence the success of a project portfolio?

This study makes meaningful contributions to the risk management and project portfolio management literature. This research provides a better understanding of portfolio risk management with its main constructs, underlying mechanisms, and their relationship to project portfolio success. Moreover, to measure the improvement through portfolio risk management, this study delivers a new procedure to operationalize the quality of risk management. We provide empirical evidence for the existence of a positive relationship between risk management quality, measured as risk transparency and risk coping capacity, and project portfolio success. Additionally, we show that the portfolio risk management constructs portfolio risk identification, the formalization of the risk management process, and risk management culture directly influence risk transparency, whereas risk prevention, risk monitoring, and the integration of risk management into project portfolio management are directly connected to risk coping capacity. These findings provide project portfolio managers with valuable heuristics and guidelines enhancing their decision-making. They are able to manage portfolio risks more effectively which eventually improves the success of the project portfolio. This model with its associated guidelines establishes a basis for supplemental empirical research in this field (e.g., on contingencies) and the development of tools specifically for managing risks in project portfolios. As earlier research indicates that management processes and tools are not used in practice as expected, further research in this area seems appropriate (Bannerman, 2008).

2. Portfolio risk management—a literature review

Project portfolio management has received increased attention in the last years as organizations typically undertake more and more projects at the same time. A project portfolio is a collection of single projects and programs that are carried out under a single sponsorship and typically compete for scarce resources (Archer and Ghasemzadeh, 1999; Pennypacker and Dye, 2002). The task of project portfolio management is to manage the resources and

other constraints, coordinate the group of projects, and manage the interfaces between projects (Elonen and Arto, 2003; Olsson, 2008). The focus is on the alignment of the projects and programs to the organization's strategy and the balance of the project portfolio regarding risks and benefits (Project Management Institute, 2008b). Applied to project portfolio management, portfolio theory concerns the constant allocation of resource choices (Chapman and Ward, 2004; Markowitz, 1959), taking into account the interdependencies between projects.

Risk is defined as an uncertain event or condition that, if it occurs, causes a significant positive or negative effect on at least one strategic portfolio objective (Project Management Institute, 2008b). The management of risks at the portfolio level may enhance the effectiveness of risk management compared to the independent consideration of risks at the project level (Aritua et al., 2009; de Reyck et al., 2005). A few guidelines currently exist that specifically regard the management of risks at the portfolio level. The second edition of The Standard for Portfolio Management is the first guide that offers processes and instruments particularly for portfolio risk management (Project Management Institute, 2008b). The Project Management Institute's (PMI's) Standard for Portfolio Management (2008b) describes the stakeholders and proposes four process steps for managing risks in project portfolios as well as three categories of portfolio risks (i.e., structure, component, and overall risks). Structural risks are risks associated with the composition of the group of projects, and the potential interdependencies among components. Component risks are project risks that the project manager needs to escalate to the portfolio level for information or action. The overall risk considers the interdependencies between projects and is, therefore, more than just the sum of individual project risks (Aritua et al., 2009). Furthermore, the Guide to the Project Management Body of Knowledge (PMBOK® Guide; Project Management Institute, 2008a) includes portfolio risk management. We follow the definition of the Project Management Institute (2008b) and define portfolio risk management as the management of uncertain events and conditions as well as their interdependencies at the portfolio level that cause significant positive or negative effects on at least one strategic business objective of the project portfolio and thus influence project portfolio success.

Few studies have specifically investigated the management of risks in the context of project portfolios. Pellegrinelli (1997) emphasizes a distinction between risk management at the project level and risk management at the program level, highlighting that risk management at the program level implies a wider perspective with a focus on strategic issues. He suggests using strategic management techniques including benchmarking and competitor analysis in this context. According to McFarlan (1981), an aggregated view on project risks will enhance decision-making and success. Olsson (2008) conducted a case study and developed a framework that compares project risk management to the management of risks in project portfolios. The findings suggest that portfolio risk management helps to identify common risks and trends for the project portfolio and makes the gained experiences easily accessible. Petit (2012) investigates how uncertainty affects project portfolios in dynamic environments.

Based on a qualitative study of four project portfolios in two organizations he provides improvements for managing project portfolios in highly dynamic environments, indicating that risk management may not always be sufficient for managing high uncertainty and complexity. Sanchez et al. (2009) present a literature review on risk management in projects, programs, and project portfolios. His review shows that portfolio risk management is still in its infancy. All in all, these authors suggest that portfolio risk management enables the portfolio manager to take an aggregated view on risks (McFarlan, 1981), transfer knowledge about risks between projects (Olsson, 2008), and regard strategic issues at the portfolio level (Pellegrinelli, 1997; Sanchez et al., 2008). Studies investigating the influence of risk management on success are limited to the project level. Here, several studies suggest a positive relationship between single project risk management and project success (de Bakker et al., 2011; Jiang et al., 2002; Raz et al., 2002; Ropponen and Lyytinen, 1997). However, there is hardly any research on the linkage between portfolio risk management and project portfolio success. Nevertheless, the investigation of portfolio risk management and its success is essential because single project risk management is no longer sufficient for the management of risks in a project portfolio environment (Olsson, 2008).

3. A portfolio risk management framework and hypotheses

The framework used in this study describes portfolio risk management and its linkage to project portfolio success (see Fig. 1). To investigate the underlying mechanism for the effects of portfolio risk management, the framework incorporates the quality of risk management that mediates the relationship between portfolio risk management and portfolio success, in addition to project portfolio success as the eventual outcome measure. The main idea is that portfolio risk management does not increase project portfolio success per se; rather, portfolio risk management enhances project portfolio success by

improving risk management quality—by increasing risk transparency and enhancing risk coping capacity. Thus, the mediator risk management quality is understood as the mechanism by which portfolio risk management affects portfolio success. The framework includes not only the direct effects of risk transparency and risk coping capacity but also their interaction. The underlying hypothesis is that the simultaneous use of risk transparency and risk coping capacity will have a complementary effect that leads to a greater benefit than the sum of both individual effects. The following section describes the constructs and their relationships in detail.

3.1. Project portfolio success

The project portfolio management objectives are well established in literature: the maximization of the portfolio value, the balance of the portfolio, and the project alignment to strategic goals (Cooper et al., 2001; Elonon and Arto, 2003). Following the approaches of Cooper et al. (2001), Jonas et al. (in press), Martinsuo and Lehtonen (2007), Meskendahl (2010), and Müller et al. (2008), project portfolio success comprises the following dimensions: (1) average project success, (2) average product success, (3) strategic fit, (4) portfolio balance, (5) preparing for the future, and (6) economic success.

Average project success includes the classical success criteria budget, schedule, and quality adherence, as well as customer satisfaction of all projects in the portfolio (Martinsuo and Lehtonen, 2007; Shenhar et al., 2001). Average product success encompasses commercial effects such as goal-achievement regarding market success, Return-on-Investment, break-even, or profit of all projects in the portfolio (Meskendahl, 2010; Shenhar et al., 2001). The strategic fit incorporates the extent to which all projects reflect the corporate business strategy. A regular reflection of the current project portfolio regarding strategy helps to align both the project goals and the resource allocation with the corporate business strategy (Dietrich and Lehtonen,

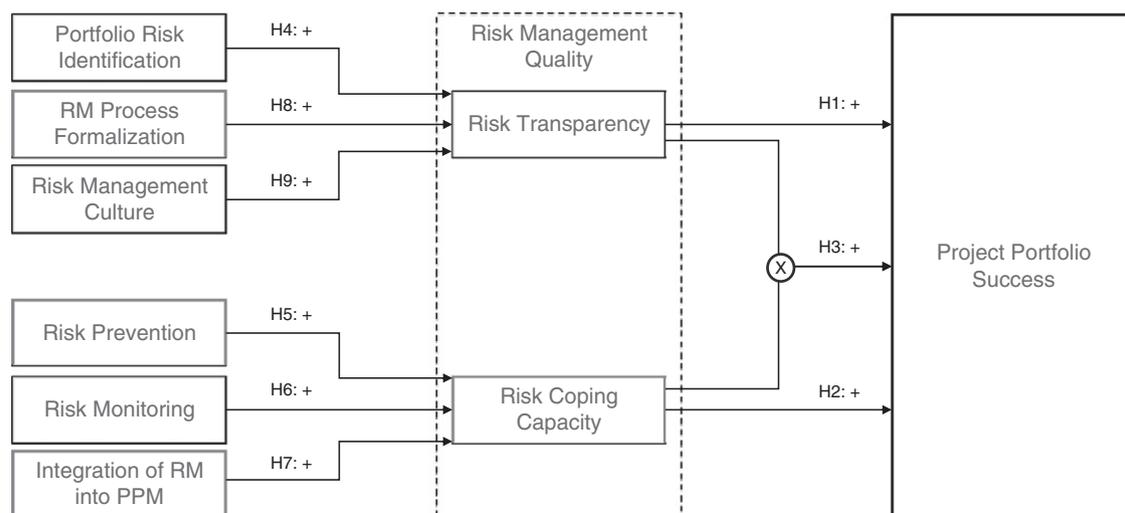


Fig. 1. Framework on the relationship between portfolio risk management, risk management quality and project portfolio success. RM: risk management, PPM: project portfolio management.

2005). Portfolio balance can be the balance of the project portfolio concerning risks and expected benefits. The objective is to have a project portfolio with a reasonable level of risk, as too many high risk projects could be dangerous for the organization's future (Archer and Ghasemzadeh, 1999). Further criteria to balance project portfolios can be the duration of the projects (long vs. short term projects) or the use of technologies (mature vs. new). Preparing for the future deals with the long-term aspects and considers the ability to seize opportunities that arise after the projects have been brought to an end (Shenhar et al., 2001). Finally, economic success addresses the short-term economic effects at the corporate level, including overall market success and commercial success of the organization or business unit (Meskendahl, 2010; Shenhar et al., 2001).

3.2. Risk management quality

The main objective of risk management is to decrease negative effects of occurring risks by recognizing and managing threats to prevent potential losses and enhance the organization's responsiveness to occurring risks. Portfolio risk management in particular aims at increasing the transparency regarding risks (Sanchez et al., 2009), enhancing decision-making (McFarlan, 1981), and improving risk coping capacity (Lee et al., 2009). Derived from these objectives, this study focuses on the following two dimensions for risk management quality: (1) risk transparency and (2) risk coping capacity. Risk transparency characterizes the capability to identify the major risks, recognize the risk sources as well detect cross-portfolio risks due to interdependencies within the project portfolio. Risk coping capacity refers to the ability to recognize and counter occurring risks. This includes having enough freedom of action to react to risks adequately and the ability to neutralize the recognized sources of risk.

Risk transparency allows the manager to realize potential issues, understand the feasible impact of potential events on business objectives, make realistic assumptions (de Bakker et al., 2010; Ropponen and Lyytinen, 1997), and recognize and understand interdependencies. Managers that make use of risk information are able to enforce and influence decisions. Consequently, the decision-making process becomes more profound and faster (McFarlan, 1981; Project Management Institute, 2008b). Realistic assumptions and the ability to assess the potential impact of risk improve the fulfillment of the projects' budget, schedule, quality, and economic objectives (Raz et al., 2002). Understanding the interdependencies between projects and their risks allows the manager to use synergies between projects. The overview on the risks enables the manager to continually monitor whether new risks materialize within the project portfolio and alleviates the communication and collaboration between stakeholders (de Bakker et al., 2011). Therefore, portfolio risk management may enhance the strategic alignment of projects to the corporate strategy (Sanchez et al., 2008). Furthermore, risk transparency allows for balancing the project portfolio regarding risks (Sanchez et al., 2008). This is of importance as a threat in one project can mean an opportunity for another

(Olsson, 2008). In light of these arguments, we suggest the following hypothesis.

Hypothesis 1. Risk transparency is positively related to project portfolio success.

The higher the risk coping capacity the more options has an organization to bear realized risks. This implies that riskier but potentially more profitable projects can be selected for the project portfolio, because the potential impact of occurring risk is less alarming. Controlled risk-taking decreases the effort put into fire-fighting, consequently allows for a focus of energy (de Bakker et al., 2011) and increases the probability of achieving strategic objectives and aligning projects to strategy (Sanchez et al., 2008). If several projects face the same risk, actions could be focused. This enables the manager to use synergies. In the long run, the manager can quickly respond to environmental changes and seize opportunities. However, portfolio risk management may not be beneficial for all organizations, because of costs that need to be invested for portfolio risk management. This might be the case for project portfolios with a low degree of interdependencies between projects. Nevertheless, based upon the outlined arguments, we assume that risk coping capacity will have an overall positive effect on project portfolio success.

Hypothesis 2. Risk coping capacity is positively related to project portfolio success.

Portfolio risk management can only operate if information about the risks is available. Risk transparency enables the manager to quickly reveal common portfolio risks and trends and, therefore, enhances decision-making (Olsson, 2008). Risk coping capacity improves the ability to respond to occurring risks. Without risk transparency, the risk coping capacity is elusive because the actions might not regard all major risks. Therefore, an increase in risk coping capacity without risk transparency will be ineffective in enhancing project portfolio success. However, risk transparency alone will not be effective either because it lacks actions responding to risks. Furthermore, an increase in risk transparency will increase and reinforce risk coping capacity. These arguments suggest that both aspects of risk management quality have a complementary effect that leads to increased project portfolio success.

Hypothesis 3. Risk transparency and risk coping capacity complement each other in their positive effect on project portfolio success (i.e., risk transparency increases the positive effect of risk coping capacity on success and vice versa).

To illustrate the underlying mechanism for the performance effects of portfolio risk management, the overall hypothesis is that the risk management effects are fully mediated by the risk management quality. The assumption is that portfolio risk management does not increase project portfolio success inherently but only via enhanced risk management quality, i.e., by improving

transparency and enhancing risk coping capacity. Improvement of risk management quality is thus seen as the mechanism which explains why and how portfolio risk management affects project portfolio success.

Hypothesis 4. Risk transparency and risk coping capacity mediate the relationship between portfolio risk management and project portfolio success.

3.3. Portfolio risk management

Kwak and Stoddard (2004) suggest that organizations that implement risk management processes may be more successful compared to those that do not. However, implementing risk management to manage portfolio risks may rise to a challenge for many organizations or some organizations may decide not to apply a process to manage portfolio risks due to the problem of cost justification (Kutsch and Hall, 2009). The PMI proposes four process steps for managing risks in project portfolios (Project Management Institute, 2008b):

1. Portfolio risks identification
2. Portfolio risks analysis
3. Risk prevention
4. Risk monitoring

Moreover, it is essential to incorporate the information about the risks into the project portfolio management process (Kwak and Stoddard, 2004; Sanchez et al., 2008) and to examine the efficiency and effectiveness of the risk management phases and the response actions (Olsson, 2006). A well-defined risk management process enables the manager to recognize and resolve potential problems in time and, therefore, increases the probability of success (Dey et al., 2007). Several authors suggest to formalize processes such as the risk management process (Cooper et al., 2001; Kwak and Stoddard, 2004; Liu et al., 2008; Ropponen and Lyytinen, 2000). Moreover, risk management instruments and procedures have evolved to carry out proper processes for managing risk and improve success (Kwak and Stoddard, 2004; Raz et al., 2002). However, to carry out the risk management process and tools efficiently a strong risk culture is needed (Karlsen, 2011; Mongiardino and Plath, 2010; Sanchez et al., 2009). Risk management culture encompasses the general awareness of risks and the potential contribution of their management, the acceptance and commitment to risk management procedures as well as the communication and coordination between stakeholders (Project Management Institute, 2008b; Ropponen and Lyytinen, 2000).

Based on this review of existing approaches to risk management we analyze the following six components of portfolio risk management in our study: (1) portfolio risk identification, (2) risk prevention, (3) risk monitoring, (4) integration of risk management into project portfolio management, (5) formalization of the risk management process, and (6) risk management culture. We have not followed the PMI suggestion to differentiate between the two stages “portfolio risks identification” and “portfolio risks analysis.” We bundle them in one component

because they are closely linked and we assume that portfolio risk identification implicates portfolio risk analysis. Further, we assume that they are hard to discriminate empirically.

3.4. Portfolio risk identification

According to Kwak and Stoddard (2004), the identification of risks is the most critical activity in risk management. In addition to the observation of single project risks, portfolio risks need to be considered including structural risks, component risks, and overall risks (Project Management Institute, 2008b). This includes the identification, assessment, and management of interdependencies and goal conflicts between projects (Lee et al., 2009; Sanchez et al., 2009). This knowledge allows analyzing whether problems from one project can transfer to other projects, because resource shortage in one project can affect other projects (Kitchenham et al., 2002). However, it may be that risk managers fail to oversee interdependencies and, therefore, tend to ignore risks which could be foreseen with better risk management processes and cultures. It is a debatable point whether portfolio risk identification increases risk transparency for all kinds of project portfolios. Project portfolios with little interdependencies between their projects may not benefit as much as project portfolios with highly interdependent projects. All in all, it is assumed that the estimation of the risk level becomes more precise and reliable through the identification of portfolio risks. Furthermore, the findings of Olsson (2008) suggest that common portfolio risks and trends for the portfolio may be revealed for the entire portfolio. Better information in turn may lead to more precise estimates (de Bakker et al., 2010). Based upon these arguments, we propose that the explicit search for portfolio risks will increase transparency.

Hypothesis 4. Portfolio risk identification is positively related to risk transparency.

3.5. Risk prevention

To prevent the identified risks from materializing, risk response measures need to be adopted ex-ante. Ropponen and Lyytinen (1997) find that the development of risk management measures enhances the organization’s capacity to cope with risks and increases the effectiveness of risk management. The main strategies to respond to risks are the avoidance of risk, the transfer of risk, and the mitigation of risk (Project Management Institute, 2008b). Risk avoidance may imply a change in the portfolio structure, for example, by terminating a project. Risk transfer means that a third party takes responsibility for the risks (e.g., insurance, supplier, or customer). Risk mitigation involves a decrease of the risk probability or the risk impact. Risk management measures can either focus on the causes of risks (etiological risk response measures) or on the consequences of risks (palliative risk response measures). Etiological risk response measures may help to decrease the probability that risks materialize and increase flexibility and the ability to react together with

decreasing costs. Palliative actions intend to reduce the impact of the negative effects (Thun and Hoenig, 2011). Both etiological and palliative risk prevention measures are implemented ex-ante and are assumed to be necessary to enhance risk coping capacity. Based upon the above described arguments, we propose that risk prevention may help to react more quickly to risks and, therefore, decrease the negative effects of risk.

Hypothesis 5. Risk prevention is positively related to risk coping capacity.

3.6. Risk monitoring

A periodical review of risks and the communication of the results of the review to the responsible stakeholders are positively associated with project success (de Meyer et al., 2002; Deutsch, 1991). The monitoring of risks is intended to identify newly occurring risks at an early state and improve the responsiveness of the organization, because the project portfolio manager can reallocate resources when a risk materializes. Moreover, the efficacy of risk response actions can be monitored. The knowledge about what risk response actions have been successful and which identified risks did actually materialize enables the manager to transfer knowledge from one project to another. The lessons learned, in turn, may enhance the risk coping capacity and the assumptions for future projects become more realistic. It is worth investigating whether these benefits justify the costs of risk monitoring in terms of manpower (Kutsch and Hall, 2009). In line with above described arguments, the following hypothesis is put forward.

Hypothesis 6. Risk monitoring is positively related to risk coping capacity.

3.7. The integration of risk management into the project portfolio management

Literature suggests that information about the risks needs to be integrated into the decision-making process in general (Dey et al., 2007) and especially into the project portfolio management process, for instance portfolio planning or portfolio steering (Sanchez et al., 2008). Risk information helps the project portfolio manager to get a better overview of the portfolio's state of affairs as well as to enforce and influence decisions. Project portfolio managers that base their portfolio steering on risk information are able recognize changes needed, to make appropriate adjustments, and to align the risk management practices with the project portfolio management policies. The alignment of strategic planning and risk management actions may increase the strategic fit. Hence, we suggest the following hypothesis.

Hypothesis 7. The integration of risk management into the project portfolio management process is positively related to risk coping capacity.

3.8. Risk management process formalization

A formal risk management process is associated with a significant impact on performance (Cooper et al., 2001; Kwak and Stoddard, 2004; Liu et al., 2008; Ropponen and Lyytinen, 2000). A formal process involves the definition of clear rules and the consistent use across all projects (Cooper et al., 2001; Teller et al., 2012). Well-defined procedures facilitate a better quality of the process and, therefore, a fast recognition and reaction to risks (Ahlemann et al., 2009). Moreover, process formalization provides control and predictability, which in turn increase risk transparency (Liu et al., 2008). A consistently applied process lays the foundation for a common understanding of risks and their management, because the same procedures and tools can be followed and used. Having the same foundation facilitates knowledge exchange between project managers. The increased level of shared knowledge in turn improves the efficiency of the risk management process and increases performance (Nelson and Coopridge, 1996). Furthermore, a consistently applied assessment of risks across all projects allows distinguishing between different risk levels among projects and, therefore, differentiating between acceptable and unacceptable alternatives (Archer and Ghasemzadeh, 2004). However, formalization may not be beneficial for all types of project portfolios. Project portfolios with a high degree of innovativeness may have a stronger need for flexibility than formalization. Nevertheless, based upon the above described findings and arguments, we suggest the following hypothesis.

Hypothesis 8. The formalization of portfolio risk management is positively related to risk transparency.

3.9. Risk management culture

A strong risk management culture has been suggested to significantly influence the efficacy of the risk management process (Karlsen, 2011; Mongiardino and Plath, 2010; Sanchez et al., 2009). Risk management culture involves the awareness that projects are tainted with risks (Ropponen and Lyytinen, 2000), the commitment to the management of risks (Project Management Institute, 2008b), the acceptance of risk management as a routine component (Raz et al., 2002), the communication of risks, the openness toward risks, the risk tolerance (Burger and Buchhart, 2002; Project Management Institute, 2008b) as well as trust (Karlsen, 2011). A strong risk management culture can sharpen the stakeholders' awareness that projects and their interdependencies are tainted with risks that need to be managed. A manager that is aware of risks and manages them can in turn reduce the level of risk (Ropponen and Lyytinen, 2000). A strong risk culture is also associated with a high degree of commitment to risk management, consciousness that the organization benefits from risk management as well as a high degree of organizational significance of risk management. The commitment of the project portfolio manager and the project manager to consistent and proactive risk management procedures is essential for project portfolio management (Project Management Institute, 2008b), because

this kind of commitment increases trust, strengthens the sense of responsibility, and encourages problem solving and innovative solutions. Hence, risk management procedures obtain acceptance and are seen rather as a chance for optimization than an obligation. The [Project Management Institute \(2008b\)](#) suggests an open and honest communication of risks to enhance the understanding of them and their interdependencies. Furthermore, criteria to measure the risk tolerance need to be established wherever possible ([Project Management Institute, 2008b](#)). Managers that fear to disclose bad news may deny the existence of risks or tend to downgrade the risk to a reasonable level to prevent the potential termination of a project ([Kutsch and Hall, 2009](#); [Machlis and Rosa, 1990](#); [Royer, 2000](#)). Consequently, we propose that a strong risk management culture enhances risk transparency.

Hypothesis 9. A strong risk management culture is positively related to risk transparency.

4. Method

4.1. Data collection

We tested our hypotheses based on a cross-industry sample of German medium-sized and large firms. To obtain a high number of participants, we collaborated with project management institutions. We sent an invitation letter with general information about the study and a call for registration to the members of these institutions. Subsequently, we conducted brief telephone calls with the registered informants to ensure their appropriateness. Our object of analysis was the project portfolio of a firm or business unit. To examine the effect of portfolio risk management in a meaningful way, we restricted our study to firms with project portfolios of 20 or more projects managed concurrently. Two informants were identified for every participating project portfolio: (1) a project portfolio coordinator and (2) an informant from senior management. The project portfolio coordinator was typically accountable for the operative management of the project portfolio as well as conceptual and advisory activities to shape the project portfolio procedures. Hence, the project portfolio coordinator was well-suited for judging the applied procedures, methods, and processes for managing the project portfolio. The project portfolio coordinators typically carried job titles such as portfolio manager, head of project management office, division manager, or department manager. The senior management informant had the authority to decide over the organization's project portfolio. Their job description usually encompassed titles such as chief executive officer, head of business units, or head of R&D. The project portfolio coordinator assessed portfolio risk management as well as risk management quality. The informant of the senior management assessed project portfolio success. We adopted this dual informant design including two different levels of management to reduce the risk of bias due to common-method variance ([Podsakoff et al., 2003](#)). One hundred seventy-six fully completed questionnaires were returned. The sample comprised firms from diverse

industries: manufacturing (27%), financial services (19%), information and communication technologies (19%), energy and infrastructure (10%), pharmaceuticals and chemicals (9%), and other industries (16%). Of these firms or business units, 29% had fewer than 500 employees, 26% had between 500 and 2,000 employees, and 45% had more than 2,000 employees.

4.2. Measures

We used multi-item measurement scales with items drawn from the literature on project portfolio management, risk management, and related fields. Informants were asked to assess each item on a Likert scale from 1 ("strongly disagree") to 7 ("strongly agree"). A principal components factor analysis (PCFA), followed by confirmatory factor analysis (CFA) verified the validity of the item scales ([Ahire and Devaraj, 2001](#)). Cronbach's alpha indicates the scale reliability. Acceptable values are larger than 0.7. CFA was used to confirm the measurement model. The measurement model is considered acceptable if the comparative fit index (CFI) exceeds 0.90 and the standardized root mean square residual (SRMR) is below 0.08 ([Hu and Bentler, 1998](#)). All item scales meet the above described criteria and can therefore be considered adequate. The wording of all items and validation statistics are specified in [Appendix A](#).

Project portfolio success is assessed by the informant of the senior management as a second-order construct based on the dimensions of average project success (three items), average product success (three items), strategic fit (three items), portfolio balance (three items), preparing for the future (three items), and economic success (four items). Dimensions and items are based on [Cooper et al. \(2001\)](#), [Jonas et al. \(in press\)](#), [Müller et al. \(2008\)](#), and [Teller et al. \(2012\)](#). The validity of the second-order construct is assessed by CFA with the six dimensions as first-order factors. The model fit is acceptable ($\chi^2=310.32$ (df=146; $p<0.00$), SRMR=0.077, RMSEA=0.08, CFI=0.90) and the first-order factors had factor loadings between 0.64 and 0.80.

Risk management quality is measured using two separate constructs: risk transparency (six items) and risk coping capacity (four items). These items are conceptually based on [Bauer \(2002\)](#), [Zhang \(2007\)](#), and [Bannerman \(2008\)](#). Portfolio risk identification is captured using four items that measure the degree to which portfolio risks are identified. These items are conceptually based on [Project Management Institute \(2008b\)](#). Risk prevention has four items based on [Chapman and Ward \(2003\)](#) and [Zhang \(2007\)](#). Risk monitoring is assessed using three items following [Gunkel \(2010\)](#). The integration of risk management into project portfolio management is measured using six items that assess the degree to which risk information influences project portfolio management. These items are conceptually based on [Sanchez et al. \(2008\)](#). Risk management process formalization is measured using four items that assess the degree to which formal rules and procedures, such as the existence of standardized forms and workflows, exist for the portfolio risk management process. These items are based on [Willauer \(2003\)](#). Risk management culture is assessed using

four items and is conceptually based on de Bakker et al. (2011) and Project Management Institute (2008b).

Additionally, we control for some portfolio characteristics that might influence portfolio risk management and/or project portfolio success. Portfolio size is captured by the logarithm of portfolio budget in M€. Larger project portfolios might have a higher maturity of risk management in general. Furthermore, we control for the regulation of the organization. Regulation is captured by measuring the percentage of must projects in the project portfolio (from 0 to 1=100%). Must projects are projects that have to be realized, for example due to regulation policies, and do not allow for autonomy of decision. If an organization operates in a highly regulated environment, the portfolio manager is less flexible in project selection and termination. Hence, risk management might become more prominent in highly regulated environments. R&D is the percentage of R&D projects in the project portfolio (from 0 to 1=100%). Thus, we control for potential differences in the management of R&D portfolios and non-R&D portfolios. Project portfolio complexity is assessed using six items to measure project interdependency and to capture the extent to which the projects in the portfolio depend on and are influenced by each other. The descriptive statistics and correlations of all variables are provided in Table 1.

5. Results

We use hierarchical multiple regression to determine the effects of portfolio risk management on risk management quality, measured as risk transparency and risk coping capacity, and project portfolio success. Model 1 tests the direct effects of portfolio risk identification, risk management process formalization, and risk management culture on risk transparency. Model 2 shows the direct effects of risk prevention, risk monitoring, and integration of risk management into project portfolio management on risk coping capacity. Model 4 tests the direct effects of risk transparency and risk coping capacity on project portfolio success. Model 5 shows the interaction

effect by adding the multiplication term into the model and comparing the model to the simple model 4. To test the interaction effects between risk transparency and risk coping capacity, we used the procedures proposed by Aiken et al. (1991). The product term was included in the regression model after mean-centering the variables. An interaction effect can be assumed if the interaction term is significant and the inclusion of the term significantly increases the explained variance of the model. Table 2 displays the results.

Model 1 shows that portfolio risk identification has a significant positive impact ($b=0.24, p<0.01$) on risk transparency, as do risk management process formalization ($b=0.06, p<0.10$), and risk management culture ($b=0.51, p<0.01$). Consequently, the hypotheses 4, 8 and 9 can be supported. This model explains 23% of variance in risk coping capacity. Model 2 reveals that risk prevention has a significant positive impact ($b=0.18, p<0.05$) on risk coping capacity, as do risk monitoring ($b=0.13, p<0.05$), and integration of risk management into project portfolio management ($b=0.13, p<0.05$). Consequently, hypotheses 5, 6 and 7 are supported. In addition, the control variable percentage of must projects shows a significant and strong negative impact on risk coping capacity. This model explains 59% of variance in risk transparency. Model 4 shows that risk transparency has significant positive impact ($b=0.17, p<0.05$) on project portfolio success, as does risk coping capacity ($b=0.10, p<0.10$). Consequently, hypotheses 1 and 2 can both be supported. Furthermore, risk prevention shows a significant positive direct impact ($b=0.16, p<0.01$) on project portfolio success, whereas risk monitoring has a strong negative direct influence ($b=-0.16, p<0.01$) on project portfolio success. However, no significant interaction effect between risk transparency and risk coping capacity is found in Model 5. Thus, hypothesis 3 is not supported. To test whether risk management quality serves as a mediator, we use the procedure proposed by Zhao et al. (2010). A bootstrap test popularized by Preacher and Hayes (2004) is used to test the significance of the indirect effects of the independent variables. Model 3 shows the direct effects of the independent variables

Table 1
Descriptive statistics and correlations.

	Mean	Std.-Dev.	1	2	3	4	5	6	7	8	9	10	11	12
1 Project portfolio success	4.95	0.70												
2 Risk transparency	4.74	1.12	0.34**											
3 Risk coping capacity	4.40	1.08	0.30**	0.45**										
4 Budget (ln)	3.61	1.72	-0.01	0.08	0.06									
5 Must projects	0.18	0.23	-0.11	0.11	-0.15*	0.11								
6 R&D	0.39	0.38	0.05	0.01	0.15*	-0.14	-0.29**							
7 Portfolio complexity	4.61	1.00	0.02	0.07	0.03	0.01	0.14*	0.08						
8 Portfolio risk identification	4.49	1.32	0.26**	0.56**	0.30**	-0.11	0.10	-0.08	0.10					
9 RM process formalization	3.91	1.83	0.14	0.44**	0.25**	0.01	0.17*	-0.15*	0.01	0.54**				
10 RM culture	4.58	1.19	0.22**	0.70**	0.46**	0.12	0.11	0.05	-0.03	0.40**	0.34**			
11 Risk prevention	4.21	1.22	0.30**	0.62**	0.37**	0.26**	0.13	0.07	0.15*	0.49**	0.46**	0.53**		
12 Risk monitoring	4.43	1.50	0.08	0.60**	0.35**	0.15	0.12	-0.02	0.16*	0.48**	0.49**	0.60**	0.64**	
13 Integration of RM into PPM	3.86	1.29	0.22**	0.53**	0.29**	-0.04	0.14	0.10	0.08	0.64**	0.36**	0.34**	0.43**	0.38**

* $p<0.05$; ** $p<0.01$; $n=176$. RM: risk management, PPM: project portfolio management.

Table 2
Regression results.

	Risk transparency	Risk coping capacity	Project portfolio success		
	(1)	(2)	(3)	(4)	(5)
Budget (ln)	0.03	0.01	-0.02	-0.02	-0.02
Must projects	-0.05	-0.93**	-0.51*	-0.37	-0.31
R&D	0.04	0.20	-0.08	-0.08	-0.05
Portfolio complexity	0.07	-0.02	0.03	0.02	0.01
Portfolio risk identification	0.24**		0.07	0.05	0.06
RM process formalization	0.06 [†]		0.00	-0.01	-0.01
RM culture	0.51**		0.11*	0.01	0.01
Risk prevention		0.18*	0.19**	0.16*	0.15*
Risk monitoring		0.13*	-0.15**	-0.16**	-0.16**
Integration of RM into PPM		0.13*	0.04	0.00	0.01
Risk transparency				0.17*	0.18*
Risk coping capacity				0.10 [†]	0.11 [†]
Risk transparency × Risk coping capacity					0.05
Constant	0.66 [†]	2.68**	3.89	3.59**	4.83**
R ²	0.59	0.23	0.18	0.23	0.24
Delta R ²					0.01
Adjusted R ²	0.57	0.19	0.13	0.17	0.18
F	34.10**	7.01**	3.67**	4.03**	3.87**

Hierarchical regression models with risk transparency (Model 1), risk coping capacity (Model 2) and project portfolio success (Models 3–5) as dependent variables; unstandardized regression coefficients are reported; all variables are mean-centered; [†] $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; $n = 176$. RM: risk management, PPM: project portfolio management.

on project portfolio success. Model 4 includes the mediators risk transparency and risk coping capacity. The results indicate that portfolio risk identification (indirect effect is 0.09**), formalization (0.06**), risk management culture (indirect effect is 0.15**), and integration of risk management into project portfolio management (indirect effect is 0.04*) imply an indirect-only mediation, while risk prevention (indirect effect is 0.05[†]) indicates a complementary mediation, and risk monitoring (indirect effect is 0.05*) portends a competitive mediation (Zhao et al., 2010). Model 4 explains 23% of variance in project portfolio success.

6. Discussion

This study investigates risk management in a project portfolio environment. We provide a framework that empirically examines the relationship between portfolio risk management in terms of processes, formalization, and risk management culture, and project portfolio success.

6.1. Theoretical implications

This study contributes to the literature on project portfolio management in several ways. First, we introduce the construct

risk management quality as a mediator between risk management and success. The mediating effect of risk management quality explains why and how portfolio risk management has positive effects on portfolio success. We provide an initial measure to gauge risk management quality. Two dimensions have been put forward to describe risk management quality: (1) risk transparency and (2) risk coping capacity. An increase in risk management quality lays the foundation for an efficient management of project portfolios by supporting the balance of the project portfolio (due to the enabled risk overview) and the alignment of projects to strategy (as a focus of efforts is facilitated).

Second, for the first time, we provide quantitative, empirical evidence for the relevance of managing project portfolio risks. The explicit search for portfolio risks positively influences transparency, which in turn affects portfolio success. Thus, there is a need to identify portfolio risks beyond the risks of single projects. When portfolio risks (for example in terms of carryover effects (Kitchenham et al., 2002)) are detected in addition to project risks, the overall risk level can be estimated more precisely. Better information in turn is assumed to facilitate better estimates (de Bakker et al., 2010) and better decision-making (McFarlan, 1981). This finding supports previous conceptual and qualitative studies on project portfolio risk management. The study tests the effects of the portfolio risks proposed by the Project Management Institute (2008b) and supports the qualitative finding of Olsson (2008) that the identification of portfolio common risks and trends leads to greater visibility to senior management.

Third, we find that an open and frank risk management culture enhances the ability to reveal portfolio risks that could threaten the organization. This form of communication is crucial because it enables managers to identify interdependencies and bottlenecks. Risk management culture is the most important factor for transparency. Hence, a clear and open communication is needed in order to identify interdependencies. This is in line with the findings of Ropponen and Lyytinen (2000) who find that the general awareness of risks and their management reduces risks. Furthermore, the findings support the view of Sanchez et al. (2009) who highlight the need to establish a strong risk management culture in order to increase the efficacy of risk management processes.

Finally, this study offers a deeper understanding of the performance impact of portfolio risk management practices. Formalization of the risk management process improves the identification and analysis of new risks and, therefore, decision-making because well-defined procedures facilitate a better process quality (Ahlemann et al., 2009). This extends the findings at the project level, for which a formal risk management process is recommended (Kwak and Stoddard, 2004; Ropponen and Lyytinen, 2000). The adoption of risk reduction measures helps to reduce the probability and impact of risks. Therefore, fewer risks materialize and if risks materialize they are less alarming. This is in line with the findings of Ropponen and Lyytinen (1997) who find that risk reduction measures at the project level increase project success. The monitoring of risks and the integration of risk information

into project portfolio management decisions allow the manager to quickly detect and react to the change of risks. Furthermore, the results indicate that in project portfolios consisting of a high percentage of mandatory or regulated projects the risk coping capacity is lower. A high percentage of mandatory or regulated projects may lead to a decrease of flexibility and paralyze the organization. Regarding the direct impact of portfolio risk management on project portfolio success, risk prevention has a direct positive impact on project portfolio success, whereas risk monitoring has a direct negative impact on project portfolio success. The negative impact of risk monitoring on project portfolio success can be explained by the fact that a high degree of risk monitoring may lead to a culture of mistrust, where risks cannot be communicated openly. Managers may get bogged down in details with a high degree of risk monitoring, running after problems, instead of pro-actively managing them. Besides, managers may have a false sense of security which causes neglect of other important areas. Moreover, control can negatively impact the ability to learn as well as lead to concealment and manipulation of data by the employees (Sethi and Iqbal, 2008). The competitive mediation indicates that another omitted mediator may exist that can be investigated in future research (Zhao et al., 2010). For example, flexibility could be investigated as a further mediator. Risk monitoring might negatively influence flexibility in general which in turn enhances portfolio success. The direct effect of risk monitoring on project portfolio success might disappear when flexibility is included into the model.

Contrary to the expected interaction effects between risk transparency and risk coping capacity, we could not show that simultaneous risk transparency and risk coping capacity increase the positive impact on project portfolio success. Hence, risk transparency and risk coping capacity seem to influence portfolio success independently. In comparison to previous research, we deliver first empirical results on portfolio risk by showing how risks need to be managed in a project portfolio. This investigation answers the call to extend risk management literature to the project portfolio context (Ropponen and Lyytinen, 2000; Sanchez et al., 2008; Sanchez et al., 2009) because single project risk management is no longer sufficient in a project portfolio environment (Olsson, 2008).

6.2. Managerial implications

For managers, the findings highlight the importance of managing risks from a portfolio perspective as this will enhance project portfolio success. Therefore, senior management must ensure that the organizational structure allows for a holistic view on the project portfolio to recognize carry-over effects caused by interdependencies additionally to single project risks. Our study highlights six areas for portfolio risk management: portfolio risk identification, risk prevention, risk monitoring, integration of risk information into the project portfolio management, formalization of portfolio risk management, and risk management culture. Managers can use this knowledge as a basis for planning risk management procedures in a project portfolio. Most importantly, project portfolio coordinators are advised to integrate the risk

information from the risk management process into the project portfolio management process since this enhances decision-making (Kwak and Stoddard, 2004; Project Management Institute, 2008b). Furthermore, a strong risk management culture is emphasized because it improves the efficacy of the risk management process (Mongiardino and Plath, 2010; Sanchez et al., 2009). As the costs for portfolio risk management are difficult to justify in advance (Kutsch and Hall, 2009), portfolio managers need to be aware of the trade-off between costs and benefits of portfolio risk management.

6.3. Limitations and avenues of future research

The results of this study need to be interpreted cautiously because this study entails some limitations. First, the independent and dependent variables have been measured in the same time period. This may incorporate the risk of halo effects or attribution bias because successful project portfolios are automatically associated with a high process quality, and vice versa. Consequently, the actual connection between portfolio risk management, risk management quality, and project portfolio success might be lower. Second, the focus of this study is on German organizations. Risks may be handled differently in other countries. Future studies can build upon our results and investigate risk management practices in other cultural surroundings. Third, some of the used measures have been newly developed for this study. While the constructs and their operationalization were based on extant literature, some measures may be subject to further refinement. For example, risk management quality could encompass further dimensions such as flexibility. Fourth, this study did not investigate contingency effects. However, literature has suggested modifying risk management practices to the characteristics of the environment and the project portfolio (Raz et al., 2002), because different strategies might be needed depending on the risk level (McFarlan, 1981). Furthermore, risk management in a project context is usually described through a probability-based framework (Loch et al., 2006), which is based on the assumption that the future states are known, predictable, and measurable (Pender, 2001). However, uncertainty implies the inability to predict the states of the environment (Milliken, 1987; Sicotte and Bourgault, 2008). Therefore, some scholars claim that risk management is not sufficient to manage uncertainty (Pender, 2001; Perminova et al., 2008). Further studies may include contingencies such as uncertainty to show the impact of environmental factors on different management approaches for handling risks.

In conclusion, the results of this study offer a platform for future efforts to develop specific tools for portfolio risk management as well as to further empirically investigate this rather new research field. Our findings on the mechanisms of portfolio risk management may be useful in future studies. Further research on risk management may consider the role of risk management quality or investigate specific measures for portfolio risk management. For example, the linkage between the different risk response measures and project portfolio success is worth investigating. Future research could also look at different management levels in an integrated

model as this could enhance understanding of the overall risk management process. Finally, a qualitative approach could more deeply investigate individual portfolio risk management practices.

Appendix A. Item wording and measurement

Project Portfolio Success (second order construct)

($\chi^2=310.32$ (df=146; $p<0.00$), SRMR=0.077, RMSEA=0.08, CFI=0.90)

Average Project Success (3 items, $\alpha=0.67$, factor loading $\lambda=0.69$)

Please evaluate the average success of completed projects:

Our projects are completed with a high degree of schedule adherence.

Our projects are completed with a high degree of budget adherence.

Our projects fulfill the defined specifications.

Average Product Success (3 items, $\alpha=0.86$, $\lambda=0.80$)

Please evaluate the average success of completed projects:

Our project results reach the level of market goals planned in the project (e.g., market share).

Our project results reach the level of financial goals planned in the project (e.g., ROI).

Our project results reach the amortization periods planned in the project.

Strategic Fit (3 items, $\alpha=0.80$, $\lambda=0.79$)

The project portfolio is rigorously oriented towards the future of the company.

The corporate strategy is optimally realized by our project portfolio.

The allocation of resources to the projects reflects our strategic thrust.

Portfolio Balance (3 items, $\alpha=0.75$, $\lambda=0.70$)

There is a good balance in our project portfolio in terms of ...

... new and old application areas.

... new and existing technologies.

... project risks.

Preparing for the Future (3 items, $\alpha=0.82$, $\lambda=0.66$)

In our projects we adequately develop new technologies/skills.

Our projects put us a step ahead of our competitors in terms of new products, technologies and services.

The projects allow us to help shape the future of our industry.

Economic Success (4 items, $\alpha=0.84$, $\lambda=0.64$)

How do you evaluate the success of your company/business area compared to your competitors in terms of ...

... overall business success.

... market share.

... sales growth.

... profitability.

A.1. Portfolio risk management and risk management quality

($\chi^2=929.41$ (df=499; $p<0.00$), SRMR=0.07, RMSEA=0.07, CFI=0.90)

Risk Transparency (5 items, $\alpha=0.90$)

We always identify all relevant risks.

We have a good understanding of the scope in which the risks can influence our goals.

Risk information helps us in the realization of decisions.

Risk information helps us influence decisions.

Risk information helps us make good decisions.

Risk Coping Capacity (4 items, $\alpha=0.85$)

We have enough freedom of action to react to risks adequately.

We can react to *identified risks* and carry out the necessary adaptive measures quickly.

We can react to *unforeseeable risks* and carry out the necessary adaptive measures quickly.

The recognized sources of risk can always be neutralized.

Portfolio Risk Identification (4 items, $\alpha=0.85$)

We check to see whether problems from one project can transfer to other projects

(precedence effect).

We check to see whether individual risks can interact and accumulate to grow into risks threatening the survival of the company.

We check to see whether problems from one project can lead to bottlenecks in other projects.

We check to see whether additional risks arise due to the portfolio structure (through resource dependencies, conflicting objectives, etc.).

Risk Management (RM) Process Formalization (4 items, $\alpha=0.91$)

Please evaluate the following statements with regard to the portfolio level.

Responsibilities in risk management are clearly defined.

The risk management process is explained in detail in a process description (e.g., manual).

We use standardized forms for risk management.

As a part of risk management there are extensive regulations regarding content, scope and the external form of risk documents (workflows).

RM Culture (4 items, $\alpha=0.84$)

The individual risk managers communicate risks openly and honestly.

The individual risk managers feel responsible for the risks and the associated measurements for their resolution.

Employees at all levels of the portfolio regard risk management as a part of their everyday business activities.

Employees at all levels of the portfolio are conscious of the necessity of the risk management (high risk awareness).

Risk Prevention (4 items, $\alpha=0.82$)

We conduct intensive analyses of causes and deviations for in terms of the sources of risk.

We take many actions aimed at the sources of risk (e.g., training, technical security precautions, improvement of work methods).

We take many actions which minimize the impact when a risk event occurs (e.g., taking out insurance, planning reserves, hedging).

We take many actions in advance, before the risk event occurs.

Risk Monitoring (3 items, $\alpha=0.92$)

We continuously monitor changes in the identified risks over time.

We continuously monitor new risks which arise in addition to those already identified.

We continuously monitor the impact of measures initiated for risk resolution.

Integration of RM into Project Portfolio Management (6 items, $\alpha=0.86$)

Risk information is integrated in project prioritization.

Individual projects are postponed based on risk information.

We cancel projects in progress based on risk information.

We initiate new projects based on risk information.

Resources are redistributed among the projects based on risk information.

We check the portfolio assumptions made for validity based on risk information.

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