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# The effects of Project Management Information Systems on decision making in a multi project environment

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**Abstract**

Project Management Information Systems (PMIS) should provide project managers with decision making support for planning, organizing and controlling projects. Most project managers are dissatisfied with the information produced by PMIS. Based on a survey among 101 project managers the interactions between six factors related to PMIS information quality and usage and their effect on decision making are examined in a multi project environment. Using structural equation modeling, new insights were gained in these complex relationships. Results indicate that the use of a project management information system is advantageous to project managers, while no adverse effects were observed due to project and information overload. PMIS information quality is positively related to quality of the decisions, satisfaction of project managers with PMIS and use of PMIS information. Simultaneous handling of multiple projects causes project managers to extend conclusions about the information quality for one project to all projects at hand.


*Keywords:* Project management; Information systems; Multi project environment

## 1. Introduction

The current business environment is complex. Managers need to make fast decisions, allocate scarce resources efficiently, and have a clear focus. In organizations that are engaged in many projects simultaneously, management is faced with multiple challenges (Elonen and Artto, 2003). Project managers handling different projects with different scopes, complexities and timelines face particular problems. These can be related to resource conflicts and throughput times (Maylor et al., 2006; Platje and Seidel, 1993). Inadequate balancing of scarce resources often results in additional pressure on the organization, which leads to poor quality of information and longer lead times of projects (Elonen and Artto, 2003). Interdependencies and interactions between projects (Patanakul and Milosevic, 2008b) and information and project overload (Engwall and Jerbrant, 2003; Zika-Viktorsson et al., 2006) present specific challenges as well. Managers may become overwhelmed by the amount of information that is available for decision making, losing sight of relevant information or being unaware of inaccuracies.

In general, poor information quality leads to poor decision making (Blichfeldt and Eskerod, 2008; Elonen and Artto, 2003; Engwall and Jerbrant, 2003). The use of *Project Management Information Systems* (PMIS) is considered advantageous to project managers because of the alleged contribution regarding timelier decision making and project success (Raymond and Bergeron, 2008). The implementation of PMIS in a multi project environment may help to accomplish a realistic project assignment, which is an effective strategy when managing multiple projects (Patanakul and Milosevic, 2008a).

Studies on the use of PMIS have predominantly focused on single projects with high complexity, and PMIS are considered advantageous in such environments (Raymond and Bergeron, 2008). Project managers who deal with single projects that are less complex may not be willing to use PMIS, because the time they

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have to invest in keeping the system up to date may exceed the benefits gained from utilizing the system (Ali and Money, 2005; Bendoly and Swink, 2007). However, little research has been done to find out whether project managers handling multiple but less complex projects benefit from PMIS. The objective of our study is to gain better understanding of the elements of PMIS that contribute to adequate decision making in a multi project environment, and to provide insights in the relationship between PMIS information quality and the project manager's satisfaction with PMIS.

In this study we define a multi project environment as a setting in which project managers are in charge of several (more than one) projects on the operational level at the same time (see also Zika-Viktorsson et al. (2006) for characteristics of a multi project setting). Hence, a project manager simultaneously supervises several teams performing product development work according to a project specific delivery plan. Multi project managers allocate resources to various projects on a short term basis in an attempt to achieve maximum progress for each project. Multi project management differs from project portfolio management. Whereas portfolio managers have projects that are strategically related, the projects of a multi project manager might be related on a strategic level, but projects might also be independent strategically, and only share scarce time and resources with other projects (Dye and Pennypacker, 2000).

Concrete, this study is of an empirical nature and aims to identify and quantify the effects of PMIS information use on decision making in a multi project environment, as perceived by project managers. PMIS information use is seen as a function of PMIS satisfaction and the quality of PMIS information. On the basis of a survey among 91 project managers in a multinational pharmaceutical company this study will provide insights in the problems that project managers encounter in a multi project environment, namely: (1) The extent to which PMIS information quality is perceived by project managers to contribute to enhanced decision making in a multi project environment. PMIS information quality reflects whether the information generated by the PMIS is perceived to be readily at one's disposal (available); sound and dependable (reliable); closely connected or appropriate to the matter in hand (relevant); correct in all details (accurate) and understandable (comprehensible) (O'Reilly, 1980; Zmud, 1978). (2) The extent to which project overload and information overload is perceived by project managers to influence the quality of PMIS information.

The organization of the paper is as follows. The next section will review the literature about project management, PMIS and the factors that influencing decision making in a multi project environment. This section will also introduce the research model. Subsequently, we present the research methodology. Then, the results are reported, followed by the discussion and conclusion, and limitations and issues for further research.

## 2. Literature review

### 2.1. (Multi) project management

Project management "covers all project management processes that are related to planning, controlling, and coordinating projects" (Ahleman, 2009: 19–20). Project management is an intricate task regarding the complexity, uncertainties and large number of activities involved, even in a single project environment (Mota et al., 2009). In a multi project environment it is common that one project manager leads multiple concurrent projects at the same time (Patanakul and Milosevic, 2008a).

Issues related to (multi) project management are addressed in many studies, see Table 1 for an overview. Empirical studies regarding (multi) project management have largely focused on resource allocation issues (Blichfeldt and Eskerod, 2008; Hendriks et al., 1999; Laslo and Goldberg, 2008; Payne, 1995), managerial problems in the form of delayed projects, stress and lack of overview (Blichfeldt and Eskerod, 2008), differences between single and multi project environment (Aritua et al., 2009), projectification and programmification (Maylor et al., 2006), and planning and control (Dvir et al., 2003; Platje et al., 1994; Platje and Seidel, 1993; Turner and Speiser, 1992). All these studies have in common that they

Table 1
Overview of studies on project management and PMIS.

| References | Studied areas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1. Single project management | | | | | | | | |
| | 2. Multi project management | | | | | | | | |
| | 3. PMIS | | | | | | | | |
| | 4. Project overload | | | | | | | | |
| | 5. Information overload | | | | | | | | |
| | 6. Information quality | | | | | | | | |
| | 7. Satisfaction with IS | | | | | | | | |
| | 8. IS use | | | | | | | | |
| | 9. Decision making | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Ahlemann (2009) | | | x | | | | | | |
| Ali and Money (2005) | x | | | | | x | x | x | |
| Ali et al. (2008) | x | | | | | x | x | x | |
| Aritua et al. (2009) | | x | | | | | | | |
| Atkinson (1999) | x | | | | | | | | |
| Blichfeldt and Eskerod (2008) | | x | | | | | | | |
| Cooper et al. (2001) | | x | | | | x | | | x |
| DeLone and McLean (2003) | | | | | | x | x | x | |
| Dietrich and Lehtonen (2005) | x | x | | | | x | | | x |
| Dvir et al. (2003) | x | | | | | | | | |
| Engwall and Jerbrant (2003) | | x | | x | | | | | |
| Hendriks et al. (1999) | x | | | | | | | | x |
| Laslo and Goldberg (2008) | x | x | | | | | | | |
| Martinsuo and Lehtonen (2007) | | x | | | | | | | x |
| Maylor et al. (2006) | | x | | | | | | | |
| Mota et al. (2009) | x | x | | | | | | | x |
| O'Reilly (1980) | | | | | x | | | | |
| Patanakul and Milosevic (2008a) | | x | | | | | | | |
| Patanakul and Milosevic (2008b) | | x | | | | | | | |
| Payne (1995) | | x | | | | | | | |
| Platje and Seidel (1993) | | x | | | | | | | |
| Platje et al. (1994) | | x | | | | | | | |
| Raymond and Bergeron (2008) | x | | x | | | x | | x | x |
| Saeed and Abdinnour-Helm (2008) | | | x | | | x | | | x |
| Seddon and Kiew (1994) | | | | | | x | x | x | |
| Turner and Speiser (1992) | | x | | | | | | | |
| Zika-Viktorsson et al. (2006) | | x | | x | | | | | |

focus on organization design and the management of projects. However, no study has examined the use of PMIS for multi-project management.

In a multi project environment project managers make use of several pools of mostly limited resources that they must share with other project managers. This simultaneous management of the throughput times and resource allocations of projects is a complex process in which the often-conflicting interests of multiple participants have to be weighed and assessed (Maylor et al., 2006; Platje and Seidel, 1993). Sharing pools of limited resources for multiple projects makes it possible for organizations to use these resources efficiently (Zika-Viktorsson et al., 2006). Pooling resources reduces idle time, and allows sharing of expertise. However, in the case of shared resources it is likely that disturbances to one project affect other projects. Since the prerequisites for valid planning and control in such situations are impaired, there is a need to make the situation as a whole more predictable by systematic planning and control (Zika-Viktorsson et al., 2006). When it comes to multiple projects, a project manager has to manage interdependencies and interactions among projects, in addition to managing each individual project. Project managers can do so by integrating the activities of planning/scheduling, monitoring/control and resource management of different projects in order to manage them simultaneously. Project managers have few tools and techniques available to help them oversee the whole picture of all interdependencies and interactions (Patanakul and Milosevic, 2008b).

Project overload is also common in a multi project environment. Project overload is associated with over-commitment, i.e. too many projects in relation to the existing level of resources (Engwall and Jerbrant, 2003). Zika-Viktorsson et al. (2006) found that the number of simultaneous projects in which a project manager is engaged predicts project overload and that project overload results in a negative impact on project performance measured in terms of adherence to time schedules and quality of work. In order to prevent project overload it is essential to achieve balance between project demand and available human resources (Zika-Viktorsson et al., 2006). A PMIS is considered valuable in providing the information needed to manage multiple project simultaneously (Patanakul and Milosevic, 2008a). In this study we aim to advance upon the current knowledge on the use of PMIS in the decision making in a multi project environment.

### 2.2. Project Management Information Systems (PMIS)

PMIS have become "comprehensive systems that support the entire life-cycle of projects, project programs, and project portfolios" (Ahleman, 2009: 19). They can support project managers in their planning, organizing, control, reporting and decision making tasks, while evaluating and reporting at the same time (Raymond and Bergeron, 2008).

Studies have shown that there are several important factors that encourage project managers to use PMIS (Ali and Money, 2005; Dietrich and Lehtonen, 2005; Raymond and Bergeron, 2008). First, whether or not project managers will use PMIS strongly depends on the quality of the information generated by the PMIS (Ali and Money, 2005; Dietrich and Lehtonen, 2005; Gelbard et al., 2002; Raymond and Bergeron, 2008; Raz and Globerson, 1998). Second, project managers are more eager to use an information system if it provides them with the appropriate level of detail in relation to their needs (Ali and Money, 2005; Raymond and Bergeron, 2008). Third, it is important that the information generated is free of complexity, easy to understand and easy for project managers to share with the project team's members (Ali and Money, 2005). Fourth, PMIS facilitates continuous monitoring of progress (Ali and Money, 2005).

## 3. Research model and hypotheses

Our research model links PMIS information quality to decision making quality. Project and information overload are considered to influence PMIS information quality, while satisfaction with and use of PMIS, together with PMIS information quality, influence the quality of decision making.

### 3.1. Project overload

There is a limit as to how many projects one project manager can handle simultaneously, based on available resource capacity. Routines and procedures can be helpful in that if project processes are standardized, project workers know what to do and how the work has to be carried out. However, too many or too few routines can easily become a burden for project workers when effort and pay-off are not balanced. Too many procedures and the associated administrative burden shift attention from the actual project management tasks to procedural activities, while too few routines create uncertainties about what to do next (Dai and Wells, 2004). Other issues are the interdependencies and interactions between projects and managing lead times (Engwall and Jerbrant, 2003). Since schedules of different projects in a multi project environment (partly) depend on each other, knowing the available time and resources at every moment in time is crucial for project progress. The limited amount of time available has to be spread over simultaneously running projects, which might result in time pressures and few opportunities for recuperation (Zika-Viktorsson et al., 2006). Project teams acknowledge that it is very important to evaluate projects. However, in practice, due to time pressures project members are involved in the next project before having time to evaluate what went wrong and what went right in the previous project and draw lessons from this experience (Zika-Viktorsson et al., 2006). This suggests that in situations of project overload there might be too little time available for project managers to feed a PMIS with high quality information at the end of the project as well as during the project itself. Hence, we hypothesize,

**Hypothesis 1a**. Project overload has a negative impact on PMIS information quality in a multi project environment.

### 3.2. Information overload

According to O'Reilly (1980) there is a relation between information overload and reduced project performance. Beyond some optimal point more information can lead to decreased decision making performance. Too much information may cause problems in selecting relevant information, due to difficulties in identifying relevant information from the total set available and distractions that reduce the available time for information processing (O'Reilly, 1980). In a multi project environment the information available to the project manager is multiplied by the number of projects carried out simultaneously. When project information is abundant for each single project, it becomes problematic in a multi project environment. A multi project environment is characterized by a lack of transparency in project information and quality of project information (Elonen and Artto, 2003). Increased complexity leads to confusion which makes project workers uncertain about what information should be delivered to whom, when it should be delivered and in what format (Elonen and Artto, 2003). In such settings project managers may have trouble seeking out quality information. Therefore, we hypothesize,

**Hypothesis 1b**. Information overload has a negative impact on the PMIS information quality in a multi project environment.

### *3.3. PMIS information quality*

With regard to PMIS information quality we found empirical evidence that it directly as well as indirectly relates to timelier decision making and therefore project success (Martinsuo and Lehtonen, 2007; Raymond and Bergeron, 2008).

Dietrich and Lehtonen (2005) found a strong statistical correlation between the availability, topicality and validity of information and project success as well as adequate decision making. This indicates the importance of high quality information as an enabler for organizations to successful project management. Cooper et al. (2001) state that many of the go versus kill decisions of managers are made in the absence of solid information and therefore are questionable. Having the right – relevant, accurate and reliable – information quickly available, allows project managers to make deliberate decisions. However, the focus of these studies was on project management in general and not explicitly on the use of PMIS as the source of information.

Saeed and Abdinnour-Helm (2008) explicitly study information systems. In particular, they explore the effects of characteristics of the information system on its perceived usefulness. They find that the availability of high-quality information in an information system is essential, because it assists a user in making sound decisions and thereby improves a project manager's work performance. In contrast, information systems that provide users with unreliable and inaccurate information have an adverse impact on its usefulness. Gelbard et al. (2002) show that reliability of estimations regarding time and effort is crucial for successful project management.

Research on project risk management pointed out that firms widely use tools to analyze, track and control project risks. Raz and Michael (2001) identified several tools that have a great potential for contribution to successful risk management. These tools, like for example risks impact assessment and risk classification and ranking, are typically present in PMIS software packages like Primavera and Microsoft Project and are expected to support and ameliorate decision making.

On the basis of extant literature we expect that PMIS information quality is positively associated with adequate decision making in a multi project environment. Thus,

**Hypothesis 2**. Greater PMIS information quality is associated with more adequate decision making in a multi project environment.

### *3.4. Project manager satisfaction with PMIS*

User satisfaction is generally defined as fulfillment of one's wishes, expectations, or needs, or the pleasure derived from this (Seddon and Kiew, 1994). Ali and Money (2005) reviewed several studies that relate relevance, accuracy, availability, reliability, consistency and timeliness of information to user satisfaction with an information system. They conclude that the information quality has a crucial effect on the use of project management software. Project managers appear more eager to accept PMIS when the quality of the information output is high (Raymond and Bergeron, 2008), and willing to use software that provides them with data that has an appropriate level of details, fits their work needs, is free of complexity, and is easy to understand and share with project team members. In a study about Departmental Accounting Systems, Seddon and Kiew (1994) found evidence that the level of information quality generated by an information system is an important determinant of user satisfaction with the system. In addition, Raymond and Bergeron (2008) find that PMIS information quality has a positive impact on the self-image of the project manager. Access to high quality project information stimulates the use of PMIS.

A multi project environment increases the need for high quality information being readily available, since project managers have little time to check the accuracy and reliability of the information. Hence, we hypothesize,

**Hypothesis 3**. Greater PMIS information quality is associated with greater satisfaction of the project manager with PMIS in a multi project environment.

### *3.5. PMIS information use*

Many authors have employed the term 'use' as an objective measure of system success. Note that, use and user satisfaction are strongly interrelated because a user can only be satisfied when he has first used the system. Positive experiences during the use of the system will automatically cause greater user satisfaction which then in turn lead to an increased intention to use, and thus use (DeLone and McLean, 2002). A multi project environment generates repeated encounters of the project manager with the PMIS. If the project manager is not satisfied with the accuracy or depth of the information generated by the PMIS, he will not solicit PMIS for the next project (Raymond and Bergeron, 2008). Conversely, if the information provided by the PMIS is in accordance with or even exceeds the project manager's expectations and hence the satisfaction with PMIS is high, then the project manager is likely to use PMIS information. This is in line with DeLone and McLean's (2003) finding that increased user satisfaction will lead to increased intention to use, and in turn increased use. Thus,

**Hypothesis 4**. Greater satisfaction of the project manager with PMIS is associated with intensified use of PMIS information in a multi project environment.

### *3.6. Quality of decision making*

Raymond and Bergeron (2008) examined the effect of PMIS use on project success, but they did not find support for a direct relationship. However, they did find an indirect relationship between PMIS use via project manager performance to timelier decision making. To our knowledge, no literature explicitly examines a direct relationship between the use of PMIS information and the quality of decision making. It is reasonable to assume that the use of PMIS information will lead to better decision making, especially when we take into account the hypothesis that PMIS information will only be used in a multi-project setting if this information has proved to be satisfactory in past projects. We hypothesize:

**Hypothesis 5**. Intensified use of PMIS information has a positive impact on the quality of decision making in a multi project environment.

The resulting research model is shown in Fig. 1.

## 4. Methodology

### *4.1. Sample and data collection*

The target respondents for this questionnaire were project managers with at least two simultaneously active projects. We solicited the support of a large Dutch pharmaceutical company for identifying project managers with multiple projects. This company develops and produces prescription drugs through pharmaceutical research. All respondents belonged to project oriented departments operating within a rather complex multi-project environment, e.g. process development, engineering, clinical trials, R&D and quality control. Several PMIS are in use to support the project managers in managing their projects. Project managers are free to choose a PMIS, since the company does not have a central project management organization or a specific PMIS policy.

Data for this study was collected using a survey of 142 project managers, identified from a list of project managers managing at least two simultaneously active projects. The total number of project managers in the company is about 200. Respondents were screened and questionnaires were handed out personally. Completed questionnaires were returned anonymously. A total of 110 responses were received. The answers were reviewed by two researchers independent from each other. Afterwards the independent judgments were compared and proved to be identical. An answer was judged ambiguous when more than one answer option was circled for one question (2 cases), an answer was judged missing as no answer option was circled at all (6 cases). Respondents that indicated that they were handling only one project at a time, were removed from the database as well (1 case). Removing all responses containing incomplete or ambiguous answers resulted in 101 valid responses. Ten respondents indicated that they used Excel or Access as a PMIS. Since these programs are not primarily designed for project management tasks, their use could lead to poor information quality and thereby influence user's satisfaction. Hence, these ten respondents were removed from further analysis. This procedure resulted in 91 valid responses (64% response rate). The respondents' demographics are presented in Table 2. Note that the majority of respondents used Primavera as PMIS software. Primavera is a project-management software package that enables users to track and analyze performance. It is a multiuser, multi project system with scheduling and resource control capabilities (Primavera P6 Project Management Reference Manual Version 6.2, p. ix). Microsoft Project has comparable features to Primavera.

Even though the pharmaceutical company openly endorsed that the study the data were collected and analyzed without company involvement. Also, the respondents were not required to report on their experiences specifically with this company, thereby reducing the risk of social desirability bias. Since the company has no specific PMIS policy forcing project managers

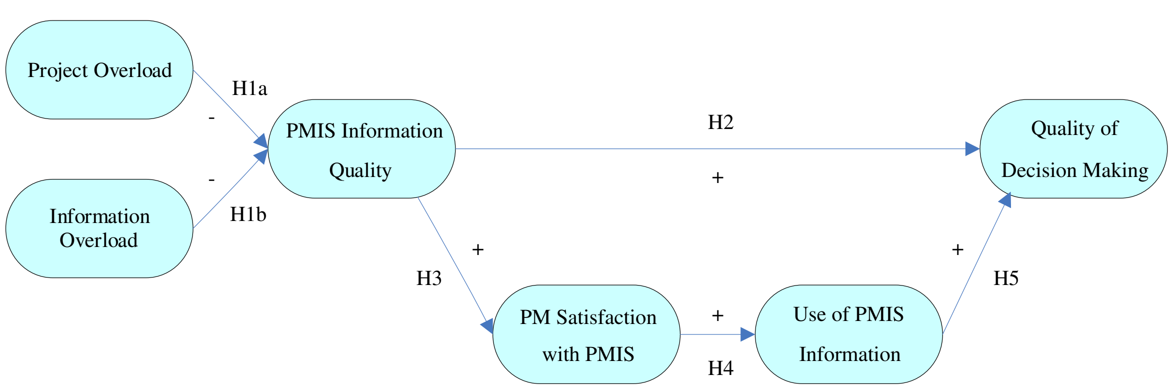


Fig. 1. Research model.

Table 2
Characteristics of the sample.

| Characterization of the respondents (n=91) | % of sample |
|---|---|
| *Project management experience* | |
| More than 20 years | 7 |
| 15–19 years | 10 |
| 10–14 years | 24 |
| 5–9 years | 38 |
| 0–4 years | 21 |
| *Gender* | |
| Male | 85 |
| Female | 15 |
| *Age in years* | |
| 60–69 | 3 |
| 50–59 | 16 |
| 40–49 | 49 |
| 30–39 | 30 |
| 20–29 | 2 |
| *PMIS software used* | |
| Primavera | 76 |
| MS Project 90 | 24 |

to use a certain PMIS, social desirability bias is further reduced. The questionnaire was accompanied by a cover letter stating the purpose of the study and an assurance of confidentiality and anonymity. Prior to the distribution of the questionnaire, three subject-matter experts were asked to provide comments and suggestions on the clarity and readability of the questionnaire's items. Based on their feedback, the content of the cover letter and the design of the questionnaire were slightly adapted. These procedures also reduce social desirability (Podsakoff et al., 2003). To encourage submission of the questionnaire, each respondent was given a chance to win a gift worth € 20.

Independent and dependent variables were measured with self-reports, therefore correlations between constructs may be overstated as a result of using a monomethod design (Podsakoff et al., 2003). To minimize common method bias the following procedural remedies were undertaken. First, the respondents' anonymity was protected, respondents were assured that there are no right or wrong answers, and they were urged to answer questions as honestly as possible (Podsakoff et al., 2003). Second, several questions were reverse coded, reducing the threat of respondent "guessing", which is one possible source of common method variance, together with social desirability (Malhotra et al., 2006). In this way respondents cannot easily combine related items and produce the correlation needed to produce common method variance biased pattern of responses (Chang et al., 2010; Murray et al., 2005). Third, the research model (Fig. 1) is quite complex, hence it is not likely that the hypothesized relationships are part of the respondents cognitive map (Chang et al., 2010; Harrison et al., 1996). Fourth, our questionnaire contained only 35 items. Therefore, it was short enough to avoid boredom and fatigue, which might shift the cognitive effort of respondents away from response accuracy to response speed (Yu and Cooper, 1983). This would make the last items of the questionnaire vulnerable to biases in the direction of consistency with previous responses, and stereotypical responding, such as all midrange responses or all extreme responses (Lindell and Whitney, 2001).

We examined the potential for common method variance via Harman's one-factor test recommended by Podsakoff and Organ (1986). Specifically, we performed an unrotated, principal components factor analysis with all manifest variables, extracting five factors with eigenvalues larger than 1, and the first factor accounting for only 37.6% of variance. If common method variance existed, a single factor would have emerged in the analysis, or one general factor would have accounted for most of the covariance in the independent and criterion variables. Overall, we consider the threat of common method variance in our sample to be low.

We tested for non-response bias in our sample using the procedure recommended by Armstrong and Overton (1977). T-tests indicated that no statistical significant differences existed with respect to any of our study variables between first respondents and late respondents. Hence, the threat of non-response bias in the data is believed to be low.

### 4.2. Measures

Multiple-item scales, closely following previous studies, were used to measure each construct. Appendix A reports the items that were used to assess the construct variables as well as their internal consistency. All items were measured on 5-point Likert scales. We provided verbal labels for the midpoint of scales and avoided using bipolar numerical scale values (e.g., −2 to +2) in order to reduce acquiescence bias (Tourangeau et al., 2000). Table 3 presents the main construct variables with definitions and item sources.

In addition, the following demographical and control variables were included in the survey: age, gender, years of project management experience and name of the used PMIS. We checked whether control variables were correlated with the core variables of interest. For none of the control variables we found significant correlations with the core constructs of our model. Hence, we excluded the controls in the analysis of our model. In this way we avoided the inclusion of "impotent control variables" (Becker, 2005) and thereby an unnecessary reduction of the power of our analyses.

## 5. Results

A component based structural equations modeling (SEM) method, more specifically Partial Least Squares (PLS), was used to test the hypotheses. SEM was chosen because it allows the analyses of systems of independent and dependent variables at the same time, whereas multiple regression analysis does not. We found component based SEM, and in particular PLS, more adequate for our purposes than covariance based SEM methods such as LISREL and EQS (Fornell and Larcker, 1981), as PLS is robust with respect to multicollinearity (Cassel et al., 2000), small sample sizes (Haenlein and Kaplan, 2004), complex modeling including models with hierarchical constructs, mediating and moderating effects (Chin et al., 2003; Wetzels

Table 3
Constructs with definitions and item sources.

| Construct | Definition | Items adapted from |
|---|---|---|
| Project Overload (PO) | Project overload is defined as having not enough capacity to deal with the amount of given projects and their unique schedules, tasks and deadlines at the same time. The assessment of project overload is a subjective appraisal. | Hochdorfer and Bjarnason (2007, p. 28) |
| Information Overload (IO) | The information overload construct measures the extent in which respondents feel that their processing capabilities differ with the information load encountered. The assessment of information overload is a subjective appraisal. | O'Reilly (1980) |
| PMIS Information Quality (IQ) | PMIS information quality is measured by assessing the degree in which information from the PMIS is (1) available, that is whether the PMIS information is readily at one's disposal; (2) reliable, that is whether the PMIS information is sound and dependable; (3) relevant, that is whether the PMIS information is closely connected or appropriate to the matter in hand; (4) accurate, that is whether the PMIS information is correct in all details; and (5) comprehensible, that is whether the PMIS information is understandable. | Raymond and Bergeron (2008) |
| Project Manager Satisfaction with PMIS (SAT) | Project manager satisfaction represents the affective attitude towards using the PMIS. An example of an item is "The PMIS is very useful in managing projects". The construct evaluates the PMIS' perceived adequacy, effectiveness and efficiency. | Raymond and Bergeron (2008) |
| Use of PMIS Information (USE) | The use of PMIS information measures the perceived use of the PMIS for different project management tasks, including using overview reports, project summary reports, project budget reports, resource usage reports and task in progress reports. | Raymond and Bergeron (2008) |
| Quality of Decision Making (DM) | The quality of decision making construct is composed of items such as: a perceived increase in the quality of decisions and reduction of the time required for decision making. | Raymond and Bergeron (2008) |

et al., 2009) and even violations of the normality distribution assumption (Cassel et al., 1999; Haenlein and Kaplan, 2004). For an overview of conditions under which PLS might be more appropriate than covariance based SEM see Wetzels et al. (2009).

To carry out PLS we used SmartPLS software (Ringle et al., 2005). PLS examines the significance of the relationships and their resulting $R^2$ (Gefen et al., 2000). Path coefficients in PLS indicate the strength of the relationship between constructs and can be interpreted as regression coefficients between standardized variables. The sample size requirement for PLS analysis was met (Gefen et al., 2000). A power analysis was performed using G*Power 3.1.2 (downloaded from http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3) and showed that our sample size was suitable (Erdfelder et al., 1996; Faul et al., 2009). Tenenhaus et al. (2005) suggest a goodness of fit (*GoF*) measure for PLS path modeling that is defined as the geometric mean of the average communality and average $R^2$ for endogenous constructs $GoF = \sqrt{\overline{AVE} * \overline{R}^2}$. Wetzels et al. (2009) have derived the following *GoF* criteria for small, medium and large effect sizes of $R^2$. $GoF_{small}=0.1$, $GoF_{medium}=0.25$ and $GoF_{large}=0.36$. For our model *GoF* was 0.39, exceeding the cut-off value of 0.36 for large effect sizes of $R^2$. Hence we conclude that our model performs well compared to the baseline values as defined by Wetzels et al. (2009).

### 5.1. Reliability and validity

Reliability was assessed by evaluating the unidimensionality of items through their factor loadings and by noting composite reliability as calculated in the PLS analysis. Unidimensionality is usually satisfied by retaining the items whose loadings (λ) are above 0.7, indicating that they share sufficient variance with their related construct (Ringle et al., 2005). A few items were excluded from the constructs in order to fulfill unidimensionality of each construct. See Appendix A for all items and their respective loadings.

Following Kaiser and Ahlemann (2010), we determined the composite reliability of all the constructs to ensure that the items of the measurement models were consistent internally. Composite reliability scores for each construct exceeded the 0.7 value recommended by Hock and Ringle (2010), and are shown in Table 4. A composite reliability score greater than 0.7 indicates that the variance of a given construct explains at least 70% of the variance of the corresponding measure, as is the case for all constructs in our research model. Since composite reliability is above 0.7 for all constructs, the measures are reliable (Lewis et al., 2005).

Convergent and discriminant validity were assessed by examining the average variance extracted (AVE) and the item construct correlations as generated by PLS. Convergent validity tests whether the measures of constructs that should be related, are related (Trochim, 2010). AVE is the percentage of the total variance of a measure represented or extracted by the variance due to the construct and ranges from 0 to 1. It should be 0.50 or above to exhibit convergent validity (Fadel and Brown, 2010;

Table 4
Means, standard deviations, PLS composite reliabilities.

| Construct | No. of items | Mean | SD | Composite reliability |
|---|---|---|---|---|
| Quality of Decision Making | 4 | 3.45 | 0.67 | 0.84 |
| Information Overload | 3 | 3.31 | 0.51 | 0.76 |
| PMIS Information Quality | 4 | 3.22 | 0.52 | 0.84 |
| PM Satisfaction with PMIS | 3 | 3.09 | 0.56 | 0.80 |
| Project Overload | 3 | 3.46 | 0.44 | 0.70 |
| Use of PMIS Information | 3 | 2.92 | 0.82 | 0.76 |

Table 5
Construct AVE's and Inter-Construct Correlations.

| # | Construct | AVE | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 1 | Quality of Decision Making | 0.561 | 0.749 | | | | | |
| 2 | Information Overload | 0.530 | 0.068 | 0.728 | | | | |
| 3 | PMIS Information Quality | 0.576 | 0.563 | 0.185 | 0.759 | | | |
| 4 | PM Satisfaction with PMIS | 0.571 | 0.577 | 0.084 | 0.591 | 0.756 | | |
| 5 | Project Overload | 0.458 | 0.111 | −0.069 | 0.221 | 0.171 | 0.677 | |
| 6 | Use of PMIS Information | 0.519 | 0.630 | 0.039 | 0.459 | 0.388 | 0.287 | 0.721 |

Hock and Ringle, 2010). Table 4 shows the AVE values for each construct. Except for project overload all constructs meet the criteria for convergent validity. Retaining the minimum of three items per construct (Ringle et al., 2005), resulted in an AVE of 0.46 for project overload. Hence, strictly speaking project overload does not meet the criterion for convergent validity, but we feel that its AVE value is close enough to 0.50 to be able to maintain this construct into our analysis.

Discriminant validity tests whether believed unrelated measures of constructs are, in fact, unrelated (Trochim, 2010). Adequate discriminant validity at the construct level is established if the square root of AVE values (on the diagonal of Table 5) is larger than the off-diagonal correlations. The criteria for this test are met for all constructs. Cross-loadings are another test of discriminant validity, the item-construct cross-loadings are shown in Appendix B. Each block of items should load higher for its respective construct than for the block of items of the other constructs. The criteria for this test is also met for all constructs, hence both tests indicate adequate discriminant validity.

### 5.2. Structural model

The structural model represents the relationships between constructs that were hypothesized in the research model. In PLS there are not well-established overall fit measures. Paths coefficients (statistical and practical significance) and coefficients of determination ($R^2$) together indicate how well the model performed. The $R^2$ are measures of the variance in endogenous constructs accounted by other constructs that were hypothesized to have an effect on them. Therefore, they can be interpreted as $R^2$ in regression analysis (Gil-Garcia, 2005). The hypotheses are tested by analyzing the direction, the value and level of significance of the path coefficients (gammas) estimated by the PLS method. A bootstrapping resampling procedure (200 samples) was used to test the significance of path coefficients. Fig. 2 shows the results of the analysis.

The hypothesis that project overload has a negative impact on the quality of the PMIS information output (H1a) is not supported. The hypothesis that information overload has a negative impact on the quality of the PMIS information quality (H1b) is not supported as well. The significant path coefficients ($\gamma=0.235$, $p<0.05$, and $\gamma=0.202$, $p<0.10$ respectively) indicate that there is a weak association of project overload as well as information overload with PMIS information quality. Instead of the expected negative associations, we found positive associations of project overload as well as information overload with PMIS information quality.

The second hypothesis (H2) is supported and indicates that a greater quality of the PMIS information output is significantly and positively associated with decision making by project managers in a multi project environment ($\gamma=0.346$; $p<0.001$). Hence, a significant improvement in decision making in terms of improved quality of the decisions, reduced time in making decisions, better allocation of resources and better monitoring activities can be obtained directly by improving the quality of the PMIS information output. In addition we found evidence for an indirect effect of PMIS information quality on decision making (equal to $0.591\times0.388\times0.471$). The indirect effect works via the mediating influence of the project manager's satisfaction with PMIS and the use of PMIS information. However, the indirect effect ($\gamma=0.108$) is much less than the direct effect ($\gamma=0.346$).

Path analysis also confirms the existence of a significant relationship between the quality of the PMIS information output

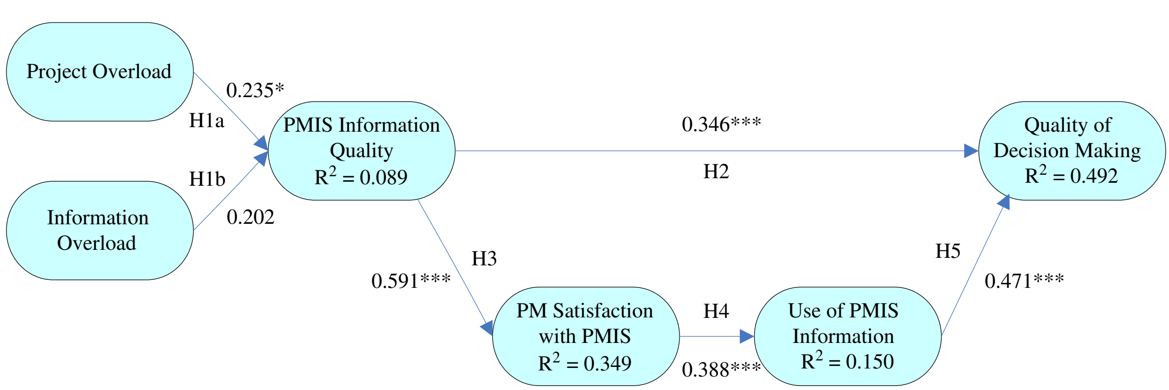


Fig. 2. Results of evaluating the research model with SmartPLS (n=91). Significance level of path coefficients: *: p<0.05 **: p<0.01 ***: p<0.001.

and the satisfaction of the project manager with PMIS ($\gamma=0.591$; $p<0.001$), Hypothesis 3 (H3). A higher quality of the PMIS information output is associated with higher levels of satisfaction of project managers with PMIS in terms of having faith in the reports generated by the PMIS, easy interaction with the PMIS and increased use of the PMIS.

The fourth hypothesis (H4) concerns the positive relation between the satisfaction of the project manager with PMIS to the intensified use of PMIS information. This hypothesis is supported ($\gamma=0.388$; $p<0.001$). Indeed, the use of PMIS information in the form of overview reports, resource usage reports and task in progress reports is positively influenced by the project manager's satisfaction with the PMIS.

The fifth hypothesis (H5) suggests a positive association between the intensified use of PMIS information and the quality of decision making. This hypothesis is supported ($\gamma=0.471$; $p<0.001$). In other words, using reports generated by the PMIS increases the overall quality of decision making by enhancing the quality of decisions, shorten the time to come to a decision, better allocating resources and better monitoring activities.

About 49% of the variance with regard to the quality of decision making is accounted for by its explanatory constructs. Similarly, the model explains about 35% of the variance in project manager's satisfaction with PMIS, 15% of the variance in the use of PMIS information and 9% of the variance in PMIS information quality. The average explanatory power of the endogenous constructs in the model is about 27% ($R^2=0.270$).

## 6. Discussion and conclusion

The aim of this study was to gain a better understanding of the elements of PMIS that contribute to adequate decision making in a multi project environment, and to provide insights in the relationship between PMIS information quality and the project manager's satisfaction with PMIS. Most of the findings of this study are in line with prior studies regarding PMIS and studies about single complex projects, however, a few deviations were found.

Two factors were expected to have a negative relationship with PMIS information quality, namely project overload and information overload. The findings of this study are not in line with what was expected beforehand. We found that project overload as well as information overload are positively, albeit weakly, related to PMIS information quality. An explanation for this seemingly paradoxical effect is as follows. Previous research has indicated that the hours worked per week are positively related to the total output of a project worker with an maximum of 60 h per week for a full time project worker. When working more than 60 h per week output drops, not only per hour but in total as well (Hochdorfer and Bjarnason, 2007). Hence, if the project overload experienced by the respondents in our study is below the maximum of 60 h per week per full time employee, there will not actually be a situation of overall overload, although the project worker perceives it as such. A similar reasoning can be given with respect to information overload. It may also be true for information overload that only beyond some optimal point too much information can lead to a decrease in the PMIS information quality (O'Reilly, 1980). Below this optimal point a respondent can still perceive information overload, but it might not result in actual problems for output, i.e. PMIS information quality. In fact, this might also provide an explanation for the weak positive relationship we found between information overload and PMIS information quality. One can imagine that up to the presumed optimal point, extra information, although being excessive in the eyes of the project manager, can lead to increased PMIS information quality. Moreover, the positive impact of project overload and information overload on information quality could also be the result of a subjective appreciation of the project managers. When facing project or information overload, the project managers might perceive PMIS information as being more valuable than they would under normal project conditions, and thus judge the information quality to be better. It is also possible that project managers in a situation of information overload consistently use a PMIS in order to master the overload situation. This would enhance the information quality.

We found that in a multi project environment the availability of higher quality information in the PMIS is associated with project managers that are more satisfied with PMIS. These findings are in line with prior research in the field of accounting systems (Seddon and Kiew, 1994), that indicate that the level of information quality generated by an information system is an important determinant of user satisfaction with the system. In addition, evidence from single project environments points in a similar direction (Ali and Money, 2005). Apparently, a multi project environment generates a high need for high quality information, since project managers are under extreme time pressures and will not often investigate whether the information is accurate and reliable.

The project manager's satisfaction with PMIS was expected to be indirectly related to the quality of decision making via the use of PMIS information. In our study we found a positive effect between these constructs. These findings are in line with prior research (Ali and Money, 2005), that showed that information quality has a significant effect on the use of PMIS and that project managers are more likely to use PMIS information that is free of complexity and is easy to understand. This may indicate that the more satisfied a project manager is with the PMIS, the more he will use the information generated by the PMIS, which in turn has a positive impact on the quality of his decision making. With respect to the project manager's satisfaction with PMIS it is interesting to note that among the project managers who participated in our study, only 37% indicated to be more than averagely satisfied with the quality of the information provided by the PMIS they use. Even 90% of the participants reported that they were particularly dissatisfied with the reliability of the information. These results indicate that broadly speaking, project managers who are dependent upon a PMIS that produces low quality information, are less satisfied and as a consequence do not use the generated information in simultaneously running projects. In turn, they are to a lesser extent supported in their decision making and the quality of their decision making is negatively affected. The opposite may be true for project managers who can rely upon a PMIS that produces high quality information. In the

PMIS literature this relationship is recognized as a ‘feedback’ relationship (DeLone and McLean, 2003). As project managers perceive the PMIS information to be beneficial to them, it is likely that they will increase their use of the PMIS information. In a multi project setting this effect is enhanced, because project leaders will draw conclusions about the information quality for one project and extend this conclusion to their other simultaneously running projects. When the PMIS generates low quality information for one of their projects, project managers are likely to draw negative conclusions about the quality of information for all their simultaneously running projects, without checking whether the PMIS in for these projects might actually generate high quality information.

In this study, two factors directly influence the quality of decision making. First, we found that the quality of the information produced by the PMIS is directly related to the quality of decision making. This finding is consistent with Saeed and Abdinnour-Helm (2008) who found that high quality information helps project managers in making sound decisions and improving their performance. In addition to the quality of decision making, PMIS information quality also directly influences satisfaction with the PMIS of multi project managers. This supports the Delone and McLean (1992) model of information system success, in which information quality explained 35% of the variance in the project manager's satisfaction with PMIS. Hence, we conclude that reliability, relevance, accuracy as well as comprehensiveness of the PMIS information play an important role in the quality of decision making, especially in a multi project environment. A PMIS that produces poor quality information will not be used by project managers for their simultaneously running projects. The use of PMIS information is a second factor that directly impinges on the quality of decision making. We found that the use of PMIS information is significantly and quite strongly related to the quality of decision making.

The theoretical contribution of this research lies primarily in the fact that the study sheds light on factors that are important for the quality of decision making, specifically in a multi project environment. Our study suggests the presence of spillover effects in the opinion of the project manager about PMIS information from one project to another, simply because these are managed by the same person. Whereas project managers always are in need of high quality information from a PMIS, this need is even larger in a multi project environment. Extreme time pressures leave no time to multi project managers to investigate whether PMIS information is accurate and reliable. In a multi project environment, the perceived quality of PMIS information has an oil spotting effect. The perception of PMIS information being trustworthy or not affects the opinion, and therefore the behavior, of project managers in all of their simultaneously running projects at hand. As project managers perceive the PMIS information to be beneficial to them for one project, they extend this conclusion to their other projects, without checking whether the PMIS for these projects indeed generate high quality information.

The findings from our study also have managerial relevance. Multi project environments generate specific challenges that find their origin in increased complexity. Linkages and interdependencies between simultaneously running projects are at the root of this increased complexity. It can be concluded from this study that project managers running several projects at the same time benefit from using a PMIS. Not all companies with a substantial part of activities organized in projects adopt a central PMIS. This study suggests that the management of such firms might want to design policy on the use of project management information systems. There might be a caveat though. A central PMIS would allow top management to follow the project development and the resource allocation decisions made by the project managers. However, project managers may then be unsatisfied about the PMIS because it prevents hidden action. Top management should be aware of this moral hazard problem. Furthermore, companies that do have a PMIS policy should assess whether project managers are satisfied with its information. Especially in a multi project environment, companies should adapt their PMIS or switch to another one much sooner as compared to companies that mainly work with single projects, because the perception of untrustworthy information in one project immediately spills over to parallel running projects and hence the PMIS loses its function. Another option for companies could be to appoint an assistant to the project manager, who has the particular task of checking PMIS information quality, in order to ensure that inadequate conclusions about information do not multiply and spillover to other projects. Moreover, companies should invest in PMIS and devote time to certify that high quality information is generated by the PMIS. Since, high quality PMIS information will lead to high quality decision making.

In addition, our research suggests that up to a certain threshold no adverse effects are to be expected from project and information overload, even when project managers themselves perceive to be burdened by excess information. Management should use this finding cautiously, because further research is needed on where this threshold might lie. It would be unwise to jeopardize the well being of project managers because this will certainly affect the quality of work.

### 6.1. Limitations and issues for further research

The results of this study should be interpreted cautiously. The model explains nearly half of the variance on the quality of decision making as perceived by the project manager. The quality of decision making seems to be affected by the quality of the PMIS information and the actual use of this information. However, the quality of decision making is unexplained for the other half of the variance which may indicate that there are other technical and managerial factors, beside PMIS information quality and the use of PMIS information, that affect the quality of decision making. This also holds for the constructs of PMIS information quality and the use of PMIS information quality. The variance in the quality of the PMIS information is explained for only 8.9% by project and information overload. The variance in the use of PMIS information is explained for 15.0% by the project manager's satisfaction with the PMIS. The variance of the latter is, in turn, explained for 34.9% by the quality of the PMIS information. The unexplained parts of the variance in these constructs may indicate that there are other factors that affect these constructs. Hence, future research should take into account a larger set of factors and develop a better explanation of, especially, the PMIS information and use of PMIS information constructs.

Another interesting avenue for further research is the counterintuitive finding regarding the effect of project and information overload on the quality of the PMIS information. Future studies should focus on the extent to which project overload as well as information overload strengthens PMIS information quality. An additional interesting aspect for further research regarding information overload might be the possible positive effect of the substantial amount of graphical reports generated by PMIS to reduce the reverse affects of information overload (Chan, 2001).

In this study, the sample consisted of the multi project managers of a multinational firm. The set of respondents is certainly not a random sample of multi project managers worldwide and across all industries. Hence, the findings of this study can only be generalized with caution. Further research should show whether our findings can be generalized across industries and countries.

Finally, since the majority of our respondents indicated to be unsatisfied with the quality of their PMIS a suggestion for further research is to investigate what factors are important, in the perception of project managers, to generate high quality information with respect to availability, accuracy, relevance, comprehensiveness, and particularly, reliability. Factors like effective sizing and content definition of work packages might play a crucial role in this (Raz and Globerson, 1998) and should be the object of further study. Furthermore, multiple projects that are simultaneously managed by one project manager could be regarded as one large single project with intensive reporting if the projects are not interdependent. It could be interesting for further research to explicitly investigate the relationship between the level of projects' interdependency and perceived information quality and user satisfaction.

For the objectives of our study we focused on PMIS and whether and under what conditions PMIS can lead to better quality of decision making for project managers in a multi project environment. From the literature on strategic decision support systems we know that various computer based information systems exist that specifically are designed for supporting strategic business decision making activities (e.g. Reich and Kapeliuk, 2005). Decision support systems serve management, operations, and planning departments of an organization and help them to make decisions. It might be worthwhile for further research to explore whether project decision support systems and knowledge based systems can provide project managers with accurate predictions, help them design the desired project trajectory, and validate process changes (Donzelli, 2006), and save them from having to go through large information systems that can generate overload.

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## Appendix A. Constructs and measures

| Construct | Abbreviation | Item | PLS factor loading[1] |
|---|---|---|---|
| Project Overload (PO) | PO-1 | On how many projects do you usually work at the same time? | 0.40 |
| | PO-2 | How often do you switch between your projects? | 0.84** |
| | PO-3 | How often do you have to do the job of other people? | 0.72* |
| | PO-4[+] | How often do you change the priorities in your work? | (0.20) |
| | PO-5[+] | How often do you have the feeling that you are wasting time on a task? | (0.14) |
| Information Overload (IO) | IO-1[++] | On some occasions you might have too little information that you could consistently handle for making the best possible work-related decisions. In a typical work week, approximately how often does this situation happen? | 0.88*** |
| | IO-2[++] | Sometimes at work you may receive more information than you can efficiently use. At other times, however, you may feel that you are not receiving all the information you need. How often during a week would you say that this lack of information arises? | 0.51 |
| | IO-3 | Is the total amount of information you receive in a typical work week enough to meet the information requirements for your job? | 0.75** |
| PMIS Information Quality (IQ) | IQ-1 | Availability | (0.29) |
| | IQ-2 | Reliability | 0.80*** |
| | IQ-3 | Relevance | 0.76*** |
| | IQ-4 | Accuracy | 0.79*** |
| | IQ-5 | Comprehensiveness | 0.67*** |
| Project Manager Satisfaction with PMIS (SAT) | SAT-1 | The PMIS is very useful in managing projects | (0.57)*** |
| | SAT-2 | I really trust the reports from the PMIS | 0.79*** |
| | SAT-3 | The interaction with the PMIS is fairly easy | 0.68*** |

**Appendix A** (*continued*)

| Construct | Abbreviation | Item | PLS factor loading[1] |
|---|---|---|---|
| Project Manager Satisfaction | SAT-4 | The understanding of the PMIS is not difficult | (0.52)*** |
| with PMIS (SAT) | SAT-5 | My satisfaction with the PMIS makes me use it more | 0.80*** |
| Use of PMIS Information (USE) | USE-1 | Overview Reports | 0.70*** |
| | USE-2 | Project Summary Reports | (0.59)*** |
| | USE-3 | Project Budget Reports | (0.58)*** |
| | USE-4 | Resource Usage Reports | 0.73*** |
| | USE-5 | Task in Progress Reports | 0.73*** |
| Quality of Decision Making (DM) | DM-1 | The PMIS improves the quality of my decisions | 0.83*** |
| | DM-2 | The PMIS reduces the time of my decision making | 0.81*** |
| | DM-3 | The PMIS helps me to better manage the budget for activities | (0.58)*** |
| | DM-4 | The PMIS helps me to better allocate resources | 0.65*** |
| | DM-5 | The PMIS helps me to better monitor activities | 0.70*** |

[+] Reverse-coded for a correct calculation of the composite reliability (Ringle et al., 2005).
[++] Reverse-coded.
[1] After removing the items PO-4 and 5, IQ-1, SAT-1 and 4, USE-2 and 3 and DM-3.
Significance level of PLS factor loading: *: $p<0.05$ **: $p<0.01$ ***: $p<0.001$.

## Appendix B. Item-construct cross-loadings

| | Quality of Decision Making (DM) | Information Overload (IO) | PMIS Information Quality (IQ) | Project Overload (PO) | Project Manager Satisfaction with PMIS (SAT) | Use of PMIS Information (USE) |
|---|---|---|---|---|---|---|
| DM-1 | 0.828 | 0.074 | 0.496 | 0.113 | 0.495 | 0.568 |
| DM-2 | 0.805 | −0.004 | 0.451 | 0.007 | 0.465 | 0.445 |
| DM-4 | 0.653 | 0.006 | 0.444 | 0.110 | 0.399 | 0.442 |
| DM-5 | 0.696 | 0.146 | 0.248 | 0.105 | 0.344 | 0.408 |
| IO-1 | 0.058 | 0.876 | 0.179 | −0.059 | 0.085 | 0.042 |
| IO-2 | 0.073 | 0.512 | 0.054 | −0.069 | 0.062 | 0.124 |
| IO-3 | 0.037 | 0.748 | 0.133 | −0.039 | 0.039 | −0.023 |
| IQ-2 | 0.400 | 0.242 | 0.803 | 0.114 | 0.579 | 0.298 |
| IQ-3 | 0.531 | 0.122 | 0.757 | 0.203 | 0.423 | 0.506 |
| IQ-4 | 0.407 | 0.204 | 0.794 | 0.165 | 0.403 | 0.315 |
| IQ-5 | 0.358 | −0.051 | 0.673 | 0.202 | 0.362 | 0.252 |
| PO-1 | 0.008 | 0.139 | 0.083 | 0.400 | 0.047 | 0.081 |
| PO-2 | 0.094 | −0.117 | 0.199 | 0.838 | 0.160 | 0.252 |
| PO-3 | 0.101 | −0.064 | 0.142 | 0.717 | 0.111 | 0.210 |
| SAT-2 | 0.438 | 0.237 | 0.552 | 0.116 | 0.785 | 0.289 |
| SAT-3 | 0.285 | 0.049 | 0.373 | 0.043 | 0.675 | 0.156 |
| SAT-5 | 0.554 | −0.121 | 0.392 | 0.210 | 0.801 | 0.404 |
| USE-1 | 0.469 | 0.016 | 0.408 | 0.369 | 0.308 | 0.704 |
| USE-4 | 0.428 | 0.118 | 0.399 | 0.203 | 0.248 | 0.732 |
| USE-5 | 0.461 | −0.042 | 0.187 | 0.041 | 0.278 | 0.725 |

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