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Does flexibility in project management in early project phases contribute positively to end-project performance?

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Abstract

Purpose – The purpose of this paper is to study the effect of project management flexibility in early project phases on end-project performance including its mediating role on the effect of complexity over project performance.

Design/methodology/approach – Out of 13 hypotheses, 6 hypotheses regarding the relationships between areas of flexibility and project performance, 1 regarding the effect of complexity on performance and 6 other hypotheses regarding the mediating effect of six areas of flexibility were formulated. Statistical analysis was performed using partial least squares–structural equation modeling on data gathered from 111 surveys.

Findings – Research results revealed that flexibility of "how-attitude" and "how-organization" has positive significant effects on project performance. "How-attitude" contributes to the flexibility of project management processes by having an "open attitude," "wide approach" and "proactive attitude" while "how-organization" put the emphasis of flexibility on "facilitate planning," "outer organization" and "inner organization." Moreover, this research confirmed that complexity has a negative effect on project performance. Among the six areas of flexibility, flexibility of "how-organization" mediates the effect of complexity on project performance.

Originality/value – The increased project complexity requires some degree of flexibility in project management to deal with project dynamics. However, whether such flexibility in early project phases has an effect on end-project performance has not been empirically investigated. This research contributes to filling the gap in literature about the relationship between project management flexibility and project performance. Such effect was investigated by studying the direct effect of flexibility on project performance and the mediating role of flexibility on the negative effect of project complexity on project performance.

Keywords Project management, Flexibility, Project performance, Front-end loading, Project complexity

Paper type Research paper

1. Introduction

Project management is a growing subject in different disciplines in the field of research. Fernandes *et al.* (2015) believe that realizing effective project management still is a challenge although project management has developed and spread significantly in science. Sanjuan and Froese (2013) claim that weak project management practices continue to be commonplace. In their eyes, one of the contributing factors to poor PM practices is that project organizations are unaware of and unconvinced about the value offered by various PM practices.

Literature indicates that projects over time have become more complex (Hillson and Simon, 2007; Williams, 1999; Baccarini, 1996; Philbin, 2008; Harvett, 2013). Construction projects are no exceptions due to the increased complexity as claimed by Ourdev *et al.* (2008). Van Marrewijk *et al.* (2008) believe the large infrastructure projects are characterized as complex, uncertain, sensitive to political conditions and known for the involvement of a large number of stakeholders. Floricel *et al.* (2016) noted that complexity as a major source of uncertainty and risks would affect project costs and performance if not addressed well from the planning phase of the project.

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While conventional project management put the emphasis on hard project management practices and strict control (Larsson, 2018), Cooke-Davies *et al.* (2008) argue that a paradigm shift is needed from such conventional project management concepts, in order to deal with future project management challenges and requirements of modern practice. It was argued that all projects have some degree of dynamism represented by "constantly changing characteristic" which requires dynamic management approaches (Collyer and Warren, 2009). With the awareness that projects are embedded in a changing and dynamic environment (Bosch-Rekveldt, 2011), Klein *et al.* (2015) also discuss that in dynamic environments, particular project management theories (fit-for-purpose project management) can help in achieving projects' objectives. Recognition of dynamic environments and its effects on projects has been researched from different perspectives such as human resource management (Momeni and Martinsuo, 2018).

The alternative is a more organic approach like what Koppenjan *et al.* (2011) called as prepare-and-commit approach. In this approach overcoming uncertainty and complexity is a constant and shared task, with less focus on the front-end. It is inevitable that the scope will change because of the unknowns and the learning curve of the client (Koppenjan *et al.*, 2011).

Several research works indicate that a combination of two management approaches is needed (Hertogh and Westerveld, 2010; Geraldi, 2008; Boehm and Turner, 2003; Koppenjan *et al.*, 2011). Still, most of the current project management methodologies seem to underestimate the influence of the dynamic environment. Combining both approaches means that a certain degree of flexibility is needed or, in other words, a balance needs to be found between controlling complexity and uncertainty and maintaining flexibility (Koppenjan *et al.*, 2011; Geraldi, 2008). A study by Ahrens and Chapman (2004) showed that control systems can simultaneously support flexibility. Floricel and Miller (2001) argued that achieving high project performance requires such combined approach: a robust and control oriented to manage the anticipated uncertainty and a flexible, or governable approach to manage the unforeseen and unexpected circumstances. A recent study by Eriksson *et al.* (2017) reveals that the adaptation in project management contributes significantly positive to time performance. We define such flexibility in project management as the readiness to adapt to the project conditions, which is characterized by a certain degree of dynamism.

It was evident from the literature that conventional project management needs to gain flexibility to deal with dynamics of nowadays projects, especially when it comes to early project phases of infrastructure construction projects. Early project phases are mostly known as fuzzy phases where there is a high level of uncertainty (Kim and Wilemon, 2002). The importance of project management in early project phases or co-called front-end phase is also addressed by Edkins *et al.* (2013). Therefore, it is assumed that the flexibility of project management can deliver a higher value to project management processes in this phase. Those dynamics are known as sources of uncertainty and complexity. The effect of such management flexibility on end-project performance in the domain of infrastructure construction projects has not been studied empirically. Therefore, the first objective of this research is to study the effect of project management flexibility in early project phases on end-project performance. Adding flexibility into the practice of project management is assumed to improve project performance by better dealing with project complexity. Hence apart from the direct effect of flexible project management on project performance, the secondary objective of this research is to study the mediation role of flexible project management on the relationship between project complexity and project performance. The conceptual research model is presented in Figure 1. This research paper is a part of a doctoral thesis focused on studying the project management flexibility.

Since the focus of this research is on the effect of flexibility on end-project performance, in the following sections of this paper by project performance it is meant end-project performance.

This paper is structured as follows. A brief literature review on project management flexibility and project complexity is provided in Section 2. To achieve the formulated research objectives the hypotheses are formulated in Section 3. Next, the research methodology is discussed in Section 4. Results are explained in Section 5, followed by the discussion including the takeaways and research limitations in Section 6. Section 7 elaborates on a few examples of flexibility in practice to support the results from statistical analysis. Scientific contribution and managerial implications of the research are covered in Section 8. Conclusions of the research are drawn in Section 9.

2. Literature review

After discussing the need for flexibility in project management (Section 1), this section elaborates on the definition of flexibility and how it can be embedded in practice and Agile project management as an existing "flexible" approach. It follows with presenting the framework of flexibility enablers. Next, project complexity is covered in this section.

2.1 Project management flexibility

One of the early definitions of flexibility is provided by Bateson (1972). He defined flexibility as "uncommitted potentiality for change." Olsson (2006) brings the definition of flexibility based on Husby *et al.* as "the capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project." Yadav (2016) defines flexibility as: "including adaptiveness to the dynamic environment, responsiveness to change, non-rigidity in processes, variability of parameters and specifications, informal practices that allow for adjustment, autonomy of function, agility in action, customized solutions, and responding to changing customer requirements."

Flexibility relates to the ability of a development method to "create change, or productivity, reactively, or inherently embrace change in a timely manner, through its internal components and its relationship with its environment" (Dingsøyr *et al.*, 2012). The value of managerial flexibility lies in obtaining new information from the project and its uncertainties and consequently change its course of action (Huchzermeier and Loch, 2001).

Mostly literature addresses flexibility as a requirement to deal with changes and to manage uncertainty (Kreiner, 1995; Sager, 1990; Olsson, 2006) while uncertainty challenges the stability of conventional project management (Kreiner, 1995). Technical complexity, shorter project duration, reduction of upfront costs and unexpected project changes are addressed as challenges of nowadays projects which ask for flexibility both in terms of product and process (Gil *et al.*, 2005).

Flexibility can also be seen as a response to environmental uncertainty (Olsson, 2006). Hertogh (2014) discussed the fact that project managers should be open for opportunities, not only at the start, but also during the course of the project. This so-called opportunity framing is supposed to be a recurring, iterative process, aiming at maximum value creation.

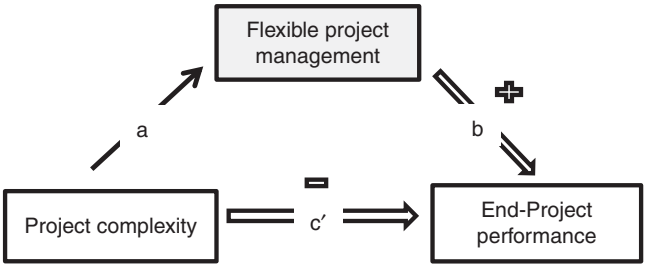


Figure 1. Conceptual research model

However, usually project managers stick to their scope, missing potential enrichment of their projects.

Flexibility in the planning and implementation phase of a project may be accomplished not only by flexible decisions, but also through the possibilities for adjustments in the entire planning system: departing from plans, changing them or side-stepping them together (Sager, 1990).

Regarding flexibility in planning, Sager (1990) defines robustness, resilience and stability as other related qualities to flexibility. Robustness can be defined as: "Robustness of a decision or decisions must be measured in terms of the numbers of the good end-states for expected external conditions which remain as open options" (Gupta and Rosenhead, 1968). Resilience is about "how quickly a system is likely to recover or bounce back from failure once failure has occurred" (Hashimoto *et al.*, 1982). Stability of a plan or a project was defined as "the maximum deviation between predicted and realized value of the key variables which renders the planning product satisfactory" (Sager, 1990). In the same line of reasoning, Priemus and van Wee (2013) believe the best way to deal with complexity is to adapt redundancy, resilience, alternatives and options, starting in the early project phases.

Flexibility can also be considered as a competency of the project management: "the project manager should be empowered with flexibility to deal with unforeseen circumstances as they see best, and with the owner giving guidance as to how they think the project should be best achieved" (Turner, 2004). The need for flexibility is also recognized in leadership capabilities. According to Singh and Jampel (2010), flexibility in leadership is required for better decision making. Flexibility can be seen as a way of postponing irreversible decisions until more information is available to make reversible decisions (Olsson, 2006).

The above references share two ideas about flexibility in common: taking the dynamic context into account and readiness for changes. Therefore, the definition of project management flexibility in this research is: the ability and readiness to deal with dynamics in a project.

2.2 Agile project management

Talking about flexible project management approaches Agile project management is the most-known flexible approach among practitioners and scholars. Agile emerged from the desire of several experts in the information and communication technology (ICT)-world to form an alternative for the existing more heavyweight software development processes. These experts all came from different fields in software development and they all represented a different software development tool (Extreme Programming, Crystal, Scrum, etc.). In 2001, they came together to discuss what each of their tools had in common. From this the Agile manifesto arose, with Agile Software Development as their umbrella name (Highsmith, 2001). Agile is a collective term for methodologies (and practices) aiming at increasing the relevance, quality, flexibility and business value (Sohi *et al.*, 2016). Agile is developed based on 4 values and 12 principles (Beck *et al.*, 2001). Agile is at its best when you can bring together the elements that allow for visibility, flexibility and responsiveness (Daneshgari, 2010). Customer satisfaction, change acceptance, delivery in small timespans, close relationship between business people and developers, building project around motivated individuals and trust, face-to-face conversation, sustainable development and self-organizing teams are outstanding features of Agile compared to waterfall approaches (Cobb, 2011). Agile approaches recognize that changes are inevitable and achieving value for the client should be the most important consideration which can be realized by accelerating the feedback cycle and actively involving the customer in the prioritization of the requirements and design of the product (Collins, 2014). Daneshgari (2010) believes that the flexibility Agile offers helps in increasing the reliability of estimations. Cobb (2011)

states that for accepting Agile principles there should be trade-offs between the level of control and predictability.

Research proved that Agile has a positive effect on project performance (Serrador and Pinto, 2015). This can be also achieved by management of complexity by use of Agile approaches (Sohi *et al.*, 2016; Blom, 2014). The success Agile brought into practice made its usage become widespread since it has been developed (Dingsøyr *et al.*, 2012). Its widespread use is not only limited to ICT industry where Agile was born in, but also other industries such as construction industry have adopted the Agile approach (Owen *et al.*, 2006). The implementation of Agile in practice gives room for understanding the flexibility that project management can offer in order to improve project performance.

2.3 Project management flexibility framework

In Section 2.1, it was concluded that some literature only sheds light on the importance of flexibility in project management without explaining further what flexibility is (Olsson, 2006; Kreiner, 1995; Koppenjan *et al.*, 2011). Some others define areas of flexibility (Geraldi, 2008; Osipova and Eriksson, 2013). A number of studies look into flexibility as one aspect like human resource management or scheduling among others (Kellenbrink and Helber, 2015; Gupta and Rosenhead, 1968; Gil and Tether, 2011; Chan and Chan, 2010). In a recent study, Jalali Sohi, Bosch-Rekveldt and Hertogh (2017) explored the flexibility of project management in current practice. They proposed a framework of 26 flexibility enablers to check the essence of flexibility in practice. Additional data from subsequent research (Jalali Sohi *et al.*, 2019) revealed four more flexibility enablers in addition to the proposed framework by Jalali Sohi, Bosch-Rekveldt and Hertogh (2017). The adjusted version of their framework is used for measuring the flexibility of project management in this research (see Table I). The contribution of flexibility enablers in the framework will be further validated in this research.

2.4 Project complexity

The importance of studying project complexity lies in different facts. It is argued that many subsequent decisions in the practice of managing projects are influenced by the complexity of the project as a key independent variable (Geraldi *et al.*, 2011). Several scholars investigated complexity, either aiming at defining project complexity, finding the sources of complexity in projects or studying the effect of complexity on project performance.

Despite the fact that project complexity has been defined by many scholars, there is no unanimity in defining the project complexity (Zaman *et al.*, 2019). However, most of the definitions of project complexity are inspired by the very first definition provided by Baccarini (1996). For example, Sheard (2012) defined complexity as "the inability to predict the behaviour of a system due to a large number of constituent parts within the system and dense relationships among them." Kermanshachi *et al.* (2016a) based their research on the following definition of complexity: "project complexity is the degree of interrelatedness between project attributes and interfaces, and their consequential impact on predictability and functionality."

Bosch-Rekveldt (2011) identified 47 elements of flexibility in large engineering projects grouped in 3 categories being technical, organizational and external (TOE). Geraldi *et al.* (2011) proposed a framework of complexity with five dimensions being: structural, uncertainty, dynamics, pace and socio-political complexity. They believe recognition of these five dimensions help individuals and organizations to be prepared to respond to each dimension. In their eyes, by understanding complexity it is possible to develop the management competences. Li and Guo (2011) mentioned that complexities in managing mega construction project can be derived from three aspects being technical, social and managerial. While technical complexity is determined by the design and technologies

Category	Label	Flexibility enablers	Main source
What	FlexA	Broad task definition	Koppenjan *et al.* (2011)
	FlexB	Embrace change as much as needed	Olsson (2006), Priemus and Van Wee (2013)
	FlexC	Functional-realization-based contract	Koppenjan *et al.* (2011)
How	FlexD	Self-steering of the complete project team	Koppenjan *et al.* (2011)
	FlexE	Open information exchange among different groups	Koppenjan *et al.* (2011)
	FlexF	Shared interface management	Koppenjan *et al.* (2011)
	FlexG	Contingency planning	Olsson (2006)
	FlexH	Seizing opportunities and coping with threats	Blom (2014)
	FlexI	Trust among involved parties	Atkinson *et al.* (2006)
	FlexJ	Standardize the process and design	Giezen (2012), Perminova *et al.* (2008)
	FlexK	Visualized project planning and progress	Beck *et al.* (2001)
	FlexL	possible alternatives	Priemus and Van Wee (2013)
	FlexM	Network structure rather than hierarchical structure	Beck *et al.* (2001)
	FlexN	Continuous learning	Giezen (2012), Perminova *et al.* (2008)
Who	FlexO	Consensus among team members	Cobb (2011)
	FlexP	Stable teams	Beck *et al.* (2001)
	FlexQ	Self-assigned individuals to tasks	Cobb (2011)
	FlexR	Team priority over individual priority	Beck *et al.* (2001)
	FlexS	Team members as stakeholders	Beck *et al.* (2001)
When	FlexT	Late locking	Olsson (2006), Huchzermeier and Loch (2001)
	FlexU	Short feedback loops	Cobb (2011)
	FlexV	Continuous locking (iterative)	Olsson (2006)
	FlexW	Iterative planning	Cobb (2011)
	FlexX	Iterative delivery	Beck *et al.* (2001)
Where	FlexY	Joint project office	Osipova and Eriksson (2013)
	FlexZ	Have flexible desks	Osipova and Eriksson (2013)
Added flexibility enablers			
How	FlexAA	Management support	
How	FlexAB	Interactive decision making	
Who	FlexAC	Delegation of responsibilities to team level	
How	FlexAD	Close involvement of stakeholders	

Table I.
Flexibility enablers (indicators) adapted from Jalali Sohi *et al.* (2019)

employed in the design and construction processes, social aspects are determined from the inadvertent impact of mega-projects on the environment and social systems within their location of implementation, and managerial complexity is caused by the business and governance aspects of projects. Nguyen *et al.* (2015) identified 36 factors of complexity grouped into 6 components. According to their research socio-political complexity was the most defining component of complexity. By identifying and ranking the top 30 complexity factors, Kermanshachi *et al.* (2016b) conclude that "peak number of participants on the project management team during engineering/design phase of the project," "magnitude of change orders impacting project execution" and "frequency of the workarounds" are the top three complexity indicators. By means of a systematic literature review from 1990 to 2015, Bakhshi *et al.* (2016) conclude a list of 127 independent complexity factors in 7 categories. Reviewing these literature studies on identification and categorization of project complexity factors, it can be said that no matter in how many categories the project complexity factors fit, the factors identified by different scholars have many in common. The differences in categorization stem from the viewpoints of each scholar and the purpose of categorization.

In this research project complexity is taken as the independent variable to study its effect on project performance and the mediating effect of flexible project management on management of project complexity.

3. Hypotheses

3.1 The effect of flexibility on project performance

This research aims at studying the effect of project management flexibility in early project phases on end-project performance, including the effect of project complexity on performance. According to what literature suggests regarding the necessity of making project management more flexible (Ahrens and Chapman, 2004; Geraldi, 2008; Kreiner, 1995; Olsson, 2006; Osipova and Eriksson, 2013; Wirkus, 2016; Wysocki, 2007; Yadav, 2016), a main hypothesis to be tested was formulated as: "flexible project management in early project phases has a positive effect on end-project performance." This hypothesis is shown in the conceptual model (Figure 1) as the arrow from flexible project management to project performance (arrow *a*). But since this hypothesis seemed to be very vague and broad, it was decided to break this hypothesis down into more hypotheses based on the suggested areas of flexibility in literature (what, how, who, when and where as suggested by Osipova and Eriksson, 2013). Looking at the flexibility enablers in each category, it was concluded that enablers belonging to flexibility of "how" can be regrouped in two smaller categories: one category including the enablers focusing on the attitude and one which focuses more on organization. This resulted in six hypotheses:

H1. Project management flexibility in terms of project scoping and contracting (what) has a positive effect on end-project performance.

H2. Project management flexibility in terms of attitude (how-attitude) has a positive effect on end-project performance.

H3. Project management flexibility in terms of organization (how-organization) has a positive effect on end-project performance.

H4. Project management flexibility in terms of project team organization (who) has a positive effect on end-project performance.

H5. Project management flexibility in terms of scheduling the project and task delivery (when) has a positive effect on end-project performance.

H6. Project management flexibility in terms of location of team (where) has a positive effect on end-project performance.

The seventh hypothesis is about the effect of project complexity on project performance. Antoniadis *et al.* (2011) studied the effect of socio-organization complexity on project performance. Zhu and Mostafavi (2017) proposed a framework for assessing project performance based on its complexity. Shen *et al.* (2012) studied the effect of project complexity on project efficiency in case of infrastructure projects. Bosch-Rekveldt (2011) studied the moderation role of project complexity on the effect of front-end activities on project performance. Although these research works confirm that project complexity has an effect on project performance, to study the effect of flexibility on project performance it is needed to know whether the negative effect of project complexity on project performance indeed is still the case. This resulted in the following hypothesis (arrow *b* in the conceptual model):

H7. Project complexity has a contrary effect on end-project performance (the less complex the project, the better the project performance).

3.2 The mediating role of flexible project management

The second objective of this research was to check whether flexible project management mediates the effect of project complexity on project performance. Hence, the structure of input–mediator–output was adapted to build the research model. Literature indicates that project management is in place to manage project complexity (Reilly, 2000; Smith and

Irwin, 2006; Van Marrewijk *et al.*, 2008; Bosch-Rekveldt, 2011). It can be done by choosing the appropriate management approach (Hertogh and Westerveld, 2010) or, for example, by application of right tools and practices such as value improving practices (Bosch-Rekveldt, 2011). While project complexity implies a negative effect on project performance, proper project management may mediate the negative effect. The idea is that flexible project management mediates the negative effect of project complexity on project performance. The mediation effect is shown in the conceptual model (Figure 1) by the arrows a and b (mediation effect = ab). This resulted in another six hypotheses:

H8. The negative effect project complexity has on end-project performance is mediated by flexibility of "what."

H9. The negative effect project complexity has on end-project performance is mediated by flexibility of "how-attitude."

H10. The negative effect project complexity has on end-project performance is mediated by flexibility of "how-organization."

H11. The negative effect project complexity has on end-project performance is mediated by flexibility of "who."

H12. The negative effect project complexity has on end-project performance is mediated by flexibility of "when."

H13. The negative effect project complexity has on end-project performance is mediated by flexibility of "where."

4. Methodology

Rarely any empirical research has been reported checking the statistical (inter)relationships between the constructs of flexible project management and project performance. Since the research topic is not well developed in literature, it was decided to use structural equation modeling (SEM) method which is suitable for this research context.

SEM is a multivariate statistical technique largely employed for studying relationships between latent variables (or constructs) and observed variables (Qureshi and Kang, 2015). Latent variables are those of interest to test but not directly measurable, whereas observed variables (sometimes called as indicators) are those which directly can be measured. The possibility of SEM to model complex dependencies and latent variables (Nachtigall *et al.*, 2003) was regarded as the main advantage and the main reason for using SEM. SEM is based on two multivariate techniques: factor analysis and multiple regression analysis.

There are two main modeling approaches in partial least squares–structural equation modeling (PLS–SEM) and covariance based approaches (Hair, Hult and Christian, 2013; Hair, Ringle and Sarstedt, 2013). For this research, PLS–SEM was chosen because of its exploratory character, the possibility of using reflective and formative constructs, its suitability for small sample sizes and its statistical power.

4.1 Survey set up

An online survey was designed for collecting data in order to statistically test the hypotheses. The respondents were asked to answer the questions based on the last finished project they played a significant role in. The survey consisted of several parts: some general questions regarding the project, questions regarding the complexity of the project, the management of the project (in terms of flexibility), the performance of the project and finally some questions about the profile of respondents.

For measuring project complexity the adjusted version of the TOE framework developed by Bosch-Rekveldt (2011) was selected (22 complexity elements). For measuring project performance, the model of Khan *et al.* (2013) was selected (25 indicators in five categories).

To measure flexibility of project management, the respondents were asked to rate the implementation of flexibility enablers (Table I) in their last finished project from 1 to 5: 1 is strongly disagree and 5 means strongly agree with the implementation of the flexibility enabler in the project. Apart from the five-point Likert scale, two other possible answers were included: "do not know" and "not applicable." Respondents could choose "do not know" in case they are uncertain whether any of those enablers have been applied or not. If any of the flexibility enablers has not been applied in the practice for any reason, respondents could choose "not applicable" as the answer.

4.2 Sample and data collection

The focus of this study was on infrastructure projects in the construction industry in their early phases (front-end phases).

The invitation for participation was sent to a large number of practitioners (client organizations, consultancies and contractors) who were free to distribute the survey-link among their colleagues with relevant working experience in the early phases of infrastructure construction projects. In total, 160 respondents opened the survey, of which 111 completed it (69 percent). The time frame of data collection was April until October 2017.

Role-wise the majority of respondents were project managers and the rest played a role in projects as project directors, engineers, project manager assistants or project consultants among others (see Figure A1). Years of working experience of respondents ranged from very few (less than 5) to more than 30 years. The majority of respondents had civil engineering/architecture background studies. They work either for public, private or both sectors.

The respondents indicated that the front-end phases of their projects ranged from less than 6 months to more than 24 months (see Figure 2). The projects were mostly public projects.

The measurement scale used for measuring the indicators (observed variables) was a five-point Likert scale (strongly disagree, disagree, neutral, agree and strongly agree). Besides the scale, there were two other possible answers: "Do not know" and "Not applicable." These two answers were treated as missing values. In total, 254 missing values were detected out of 8547 values, which is equal to 2.97 percent of the total amount of values. In order to select an appropriate missing value treatment method, it is necessary to identify the pattern of missing values (Hair *et al.*, 2010). By using SPSS, the data were tested to determine whether the missing values in the data set were Missing Completely at Random. The null hypothesis is that the missing values are missed completely at random. The missing value analysis via Little's test (Little and Rubin, 2014) results in $\chi^2 = 4{,}151.335$, $df = 4{,}070$ and $sig. = 0.183$. Since the χ^2 is not significant, the null hypothesis cannot be

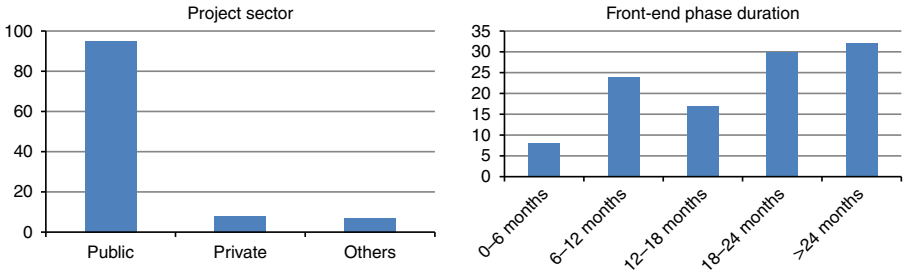


Figure 2.
Projects sector and front-end phase duration

rejected, meaning that the missing value is Missed Complete at Random. Hair, Hult and Christian (2013) recommended using mean replacement for missing values in order to not to reduce the number of data points, which was applied accordingly.

4.3 Measures (indicators)

For both dependent (project performance) and independent variables (flexible project management), a number of indicators were used to measure the latent variables indirectly. For project management flexibility all the indicators were treated as second-order formative measures contributing to the six first-order constructs (what, how-attitude, how-organization, who, when and where). For both independent and dependent variables (project management complexity and project performance) all first-order constructs (indicators) were also treated as formative constructs (the indicators cause the constructs (formative), not the constructs cause the indicators).

5. Results – model evaluation

For the analysis of the research model, the software SmartPLS 2.0 was used. The research model consists of two models:

(1) measurement model which evaluates if the indicators (measures) belong to their latent variables; and

(2) structural model which tests the hypotheses (the relationships between the latent variables).

5.1 Measurement model

For evaluating a formative measurement model, it is recommended to test the collinearity (or multicollinearity) of indicators and to test if the indicators contribute to their latent variables (Hair, Hult and Christian, 2013). Variance inflation factor test was performed using SPSS software. None of the indicators exceeded the threshold value of 5; collinearity was not an issue. Next, the indicators were tested on their contribution to their latent variables. The coefficients of the formative indicators (outer weights) are influenced by other relationships in the model (Hair, Hult and Christian, 2013). The more formative indicators in one construct, the smaller the outer weights of each indicator (Hair, Hult and Christian, 2013), so indicators become non-significant when a lot of them contribute to one latent variable. Following Cenfetelli and Bassellier (2009), we grouped the indicators in smaller constructs. For testing the contribution of indicators to their constructs, an iterative process was applied by eliminating single indicators with negative values or small coefficients in each round of analysis. The assessment of the measurement model is provided in Table AI.

5.1.1 Flexibility indicators. To validate whether flexibility enablers are applicable and if they contribute to their clusters of flexibility, confirmatory factor analysis was performed. This has been done first by checking the coefficient value of the enablers to their clusters (latent variables) and second by the direction of contribution. The negative sign means that the measure (in this case the flexibility enabler) is contributing to cluster in an opposite direction than a measure with a positive sign.

The final list of flexibility enablers of which the contribution to the latent variable was confirmed by the analysis is presented in Table II.

5.1.2 Project performance indicators. First, the indicators with more than 5 percent missing values were eliminated as suggested by Hair, Hult and Christian (2013). From the 25 indicators, 11 indicators had more than 5 percent missing values. The remaining 14 indicators were checked on their contribution to their constructs. Among all, "finished within budget" had a negative coefficient value. The negative sign of the coefficient value

Category	Label	Flexibility enablers
What	FlexA	Broad task definition
	FlexC	Functional-realization-based contract
How		
How-attitude		
Open attitude	FlexAB	Interactive decision making
	FlexAD	Close involvement of stakeholders
Wide approach	FlexE	Open information exchange among different groups
	FlexL	Possible alternatives
Proactive approach	FlexG	Contingency planning
	FlexH	Seizing opportunities and coping with threats
How-organization		
Facilitate planning	FlexK	Visualized project planning and progress
	FlexN	Continuous learning
Outer organization	FlexD	Self-steering of the complete project team
	FlexF	Shared interface management
	FlexI	Trust among involved parties
Inner organization	FlexAA	Management support
	FlexM	Network structure rather than hierarchical structure
Who	FlexR	Team priority over individual priority
	FlexS	Team members as stakeholders
	FlexAC	Delegation of responsibilities to team level
	FlexO	Consensus among team members
	FlexP	Stable teams
When	FlexU	Short feedback loops
	FlexV	Continuous locking (iterative)
Where	FlexY	Joint project office

Table II. Confirmed flexibility enablers to the five areas of flexibility

means that the indicator does not contribute to the construct in the same direction as the other indicators belonging to the same construct. Hence, this indicator was eliminated. The rest of indicators were kept in the model although some had small coefficients and were not significant. According to Hair, Hult and Christian (2013), it is possible to retain indicators with small positive coefficients if a prior research already proved the inclusion of indicators to their constructs. In this case, the five constructs of project performance were concluded from an exploratory factor analysis (Khan *et al.*, 2013). At the end, the five constructs of project performance were formed by 13 indicators (see Table III).

Construct	Label	Success criteria
Project efficiency	Prf A	Finished on time
	Prf C	Minimum number of agreed scope changes
	Prf D	Activities carried out as scheduled
	Prf E	Met planned quality standard
	Prf F	Complied with environmental regulations
	Prf H	Cost effectiveness of work
Organizational benefits	Prf I	Learned from project
	Prf J	Adhered to defined procedures
	Prf M	New understanding/knowledge gained
Project impact	Prf O	Project achieved its purpose
Future potential	Prf S	Motivated for future projects
	Prf T	Improvement in organizational capability
Stakeholder satisfaction	Prf X	Met client's requirement

Table III. Confirmed performance indicators (success criteria) to their constructs

5.1.3 Project complexity indicators. After removing the variables with more than 5 percent missing values and those with negative coefficients, the 3 constructs of complexity were defined by 11 indicators. For simplifying the interpretation of results, the data from the complexity variables were scaled reversely meaning that in the range of 1 to 5, 1 corresponded to more complex situations and 5 corresponded to less complex situations. The confirmed elements of complexity and their constructs (clusters) are presented in Table IV.

5.1.4 Formative–formative measurement model. The whole model includes a formative–formative measurement model since the lower order and higher order constructs are all formative. A formative–formative type of model, apart from the logic behind the model, is useful to structure complex formative constructs with many indicators into several sub-constructs (Becker *et al.*, 2012). For assessing the effect of sub-constructs on the second-order constructs, the repeated indicator approach (Becker *et al.*, 2012) was used. For the PLS–SEM algorithm, the analysis was performed using the inner path weighting scheme. To check the effect of sub-constructs on the latent variables (in this case "how-attitude," "how-organization" and "who") bootstrapping of 5,000 subsamples as suggested in the literature (Hair, Hult and Christian, 2013) was performed. Bootstrapping is a nonparametric resampling method based on the main sample which does not impose the normality of sample distribution (Preacher and Hayes, 2008). In each bootstrap, a subsample with the same size (or bigger) as the main sample with replacement is drawn (Hair, Hult and Christian, 2013). The results revealed that all the sub-constructs' weights are significant on their latent variables (Figure 3). Also, the three sub-contracts of project complexity (TOE) as well as the five sub-constructs of project performance (efficiency, organizational benefit, project impact, future potential and satisfaction) have loaded significantly on their latent variables (project complexity and project performance).

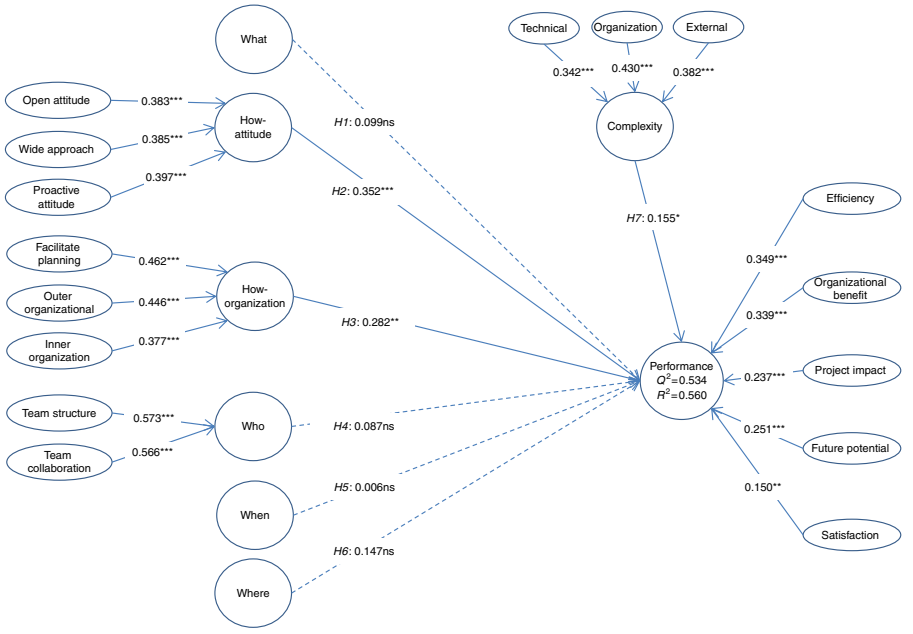
5.2 Structural model

Using software SmartPLS version 2.0 (Ringle *et al.*, 2005), the structural model was evaluated to test the hypotheses. The analysis was performed by calculating the paths' coefficients and signs using a path weighting scheme. Next, to determine the significance of the paths' coefficients, bootstrapping with 5,000 subsamples for 111 cases was performed. The two-stage modeling process (Hair, Hult and Christian, 2013) was followed: in the first stage, the measurement model was evaluated and in the second stage the structural model is being evaluated (testing of hypotheses).

The coefficient of determination R^2 and predictive relevance Q^2 were checked for the structural model. The Q^2 value of project performance as the dependent variable was greater than zero ($Q^2 = 0.534$) which means that the predictive relevance of the structural

Cluster	Label	Complexity element
Technical complexity	Cmplx A	Clarity and certainty of project goals
	Cmplx B	Clarity and certainty of tasks and their dependencies
	Cmplx R	Project duration
Organization complexity	Cmplx D	Number of contracts
	Cmplx H	Lack of trust
	Cmplx I	Size of project team
	Cmplx K	Availability of required experiences in the organization
	Cmplx T	Information availability
External complexity	Cmplx G	Stability of project environment
	Cmplx P	Company strategies/internal support
	Cmplx V	Number of financial resources

Table IV.
Confirmed elements of complexity to their constructs



Notes: *p<0.05 (t>1.96); **p<0.01 (t>2.58); ***p<0.001 (t>3.29)

Figure 3.
Structural model

model is met. A Q^2 value above 0 indicates that the structural model has a positive significant level of predictive validity on the dependent variable, which is "project performance" in this case. The R^2 value of the dependent variable (project performance) is 0.560 which means the structural model accounts for 56 percent of the variance in project performance. This proves the predictive accuracy of the structural model.

5.2.1 The effect of project management flexibility on project performance. The full structural model is presented in Figure 3. The results of the analysis revealed that both latent variables "how-attitude" and "how-organization" have positive significant effects on project performance (*H2*: 0.352, $p < 0.001$ and *H3*: 0.282, $p < 0.05$). This means that *H2* and *H3* are supported by the statistical analysis. The other four hypotheses were rejected.

As can be seen in Figure 3, complexity (as a control variable) has a significant effect on project performance (*H7* is also supported). As it was discussed in the previous section, complexity indicators were scaled reversely, so the positive sign of the relationship indicates that a "less complex project" results in "better project performance."

5.2.2 The relative effect of first-order constructs (sub-constructs). It was discussed that for the sake of reducing the model complexity, the indicators belonging to the latent variables "how-attitude," "how-organization" and "who" as well as the control variable "project complexity" and the dependent variable "project performance" were grouped in sub-constructs. Now the relative effect of sub-constructs on their latent variables is explained.

The latent variable of "how-attitude" is formed formative by three sub-constructs: "open attitude," "wide approach" and "proactive attitude." The effects of these three sub-constructs are almost the same (coefficients are 0.383, 0.385 and 0.397).

The latent variable of "how-organization" is also formed formative by three sub-constructs: "facilitate planning," "outer organization" and "inner organization." Among the three, "facilitate planning" and "outer organization" had slightly stronger effects (0.462 and 0.446) on their latent variable than "inner organization" (0.377).

The latent variable of "who" is formed formative by two sub-constructs: "team structure" and "team collaboration." The effect of both sub-constructs is very close to each other (0.573 and 0.566).

5.3 Results: mediation effect of project management flexibility

To test the mediation effect of flexible project management on the relationship between project complexity and project performance, the bootstrapping approach was used. Following the process recommended by Hayes (2013), SPSS software using a macro code (PROCESS) was used for evaluation of the mediation effect. Since there are six flexibility areas acting as mediators, multiple mediation effects apply.

The analysis of bootstrapping of 5,000 subsamples of 111 cases with 95% confidence intervals revealed that the mediation effect exists (total indirect effect coefficient = 0.1419, lower limit confidence interval = 0.0245 and upper limit confidence interval = 0.2657) (see Table V). Knowing the fact that mediation exists is not enough since the model includes multiple mediators. Hence, it is important to know which mediator(s) mediate(s) the relationship.

It was found that project complexity has a significant relationship with project performance in an opposite way. It means that the lower complex the project, the better the project performance (coeff. = 0.252, $p = 0.000$ and t-value = 3.971). Also it revealed that project complexity has significant effect on three flexibility areas: "how-organization" (coeff. = 0.4934, $p = 0.000$, t-value = 5.222), "who" (coeff. = 0.3201, $p = 0.011$, t-value = 2.597) and "when" (coeff. = 0.2647, $p = 0.24$, t-value = 2.285). Among these three paths only "how-organization" has a significant effect on project performance (coeff. = 0.181, $p = 0.003$, t-value = 3.090). Because both a_3 and b_3 paths are significant, "how-organization" flexibility might play the mediator role in the relationship between project complexity and project performance. The mediation effect exists when the confidence interval does not include the value of 0. As it can be seen in Table V, the results of bootstrapping analysis with 5,000 subsamples on 95% confidence intervals revealed that "how-organization" flexibility mediates the effect of project complexity on project performance (coeff. = 0.09, CI = 0.024–0.169). In addition, the results indicate that the direct effect of project complexity on project performance after including the mediation effect is still significant but smaller in coefficient value (coeff. = 0.110, $p = 0.043$, t-value = 2.051). This means that the mediation effect is partial mediation rather than full mediation (Figure 4).

The existence of mediation effect means that if "how-organization" flexibility applies in practice, the negative effect of project complexity on project performance becomes less.

6. Discussion

In this section, the validation of latent variables and its indicators including the sub-constructs is discussed (Section 6.1). Next, the validation of the structural model is discussed in Section 6.2 and the mediating role of flexible project management in Section 6.3.

6.1 Defined constructs

Since the primary focus of this research is on validation of flexibility measures we discuss the elimination of seven indicators. "Embracing change" was weighted negatively on its latent variable which is "what" flexibility. "Embracing change" is one of the core values of Agile project management which is known as a flexible project management approach (Cobb, 2011). However, in context of infrastructure construction projects "embracing change" especially when it comes to scope changes is less favorable (Jalali Sohi, Hertogh and Bosch-Rekveldt, 2017; Jalali Sohi, Bosch-Rekveldt and Hertogh, 2017; Sharma *et al.*, 2017). Whyte *et al.* (2016) in their research addressed challenges regarding the flexibility of managing changes in the context of complex projects. "Standardized processes and design

	Total effect		Direct effect		Indirect effect			
	Coeff.	p	Coeff.	p	Point estimate		95% CI – LL	95% CI – UL
Complexity → performance	0.252	0.0001***	0.11	0.042*				
Complexity → "what" flexibility → performance					a_1b_1	−0.003	−0.024	0.013
Complexity → "how-attitude" flexibility → performance					a_2b_2	0.040	−0.012	0.108
Complexity → "how-organization" flexibility → performance					a_3b_3	0.090	0.024	0.169
Complexity → "who" flexibility → performance					a_4b_4	0.015	−0.011	0.049
Complexity → "when" flexibility → performance					a_5b_5	0.001	−0.030	0.029
Complexity → "where" flexibility → performance					a_6b_6	0.000	−0.029	0.028

Table V.
Mediation effect of flexibility areas on project performance

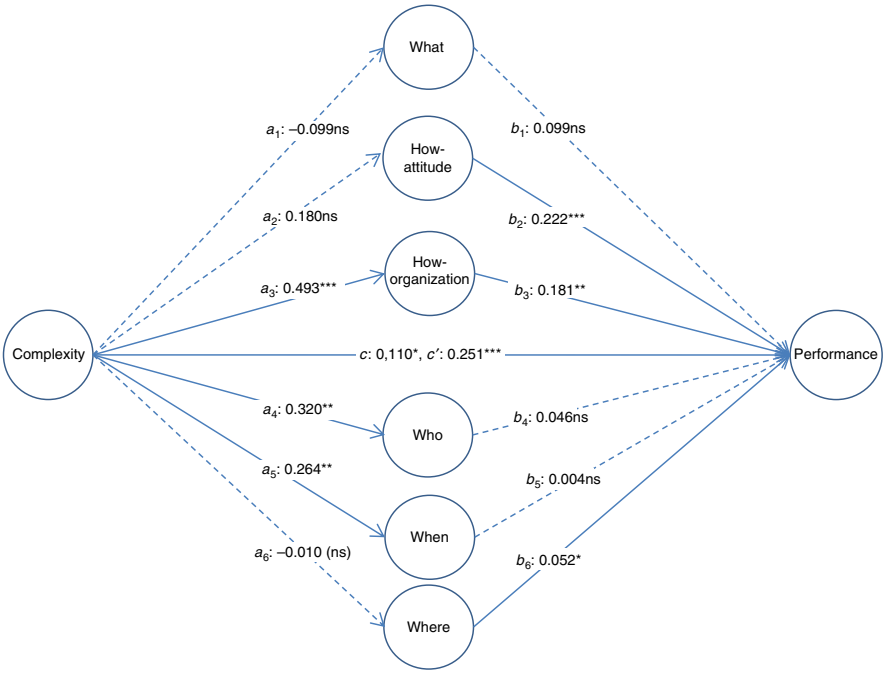


Figure 4.
The mediation role of flexible project management

Notes: *p<0.05 (t>1.96); **p<0.01 (t>2.58); ***p<0.001 (t>3.29)

layout" weighted not significantly on "how" flexibility. From earlier research, it was evident that "standardization" is interpreted differently by practitioners (Jalali Sohi, Hertogh and Bosch-Rekveldt, 2017). They believe that "standardization" kills flexibility although the idea of "standardization" is to provide flexibility in terms of choosing the right "standard" based on the situation (Giezen, 2012).

"Self-assigned tasks to individuals" was weighted negatively on its latent variable "who" flexibility. Research shows that "self-assigned tasks to individuals" was ranked relatively low from practitioners' perspective based on its importance to make project management more flexible (Jalali Sohi, Hertogh and Bosch-Rekveldt, 2017). This explains why it is not weighted significant on its construct but the fact that it weighted negatively might be because it belongs to a different flexibility construct. Since PLS–SEM does not do exploratory factor analysis, it is impossible to confirm. Two indicators, "locking decisions at the last responsible moment" and "minimize upfront planning" were negatively contributing to the latent variable "when" flexibility. This could have been expected given earlier results (Jalali Sohi, Hertogh and Bosch-Rekveldt, 2017) that showed very different interpretations of practitioners for these enablers. Indicator "iterative delivery" is also weighted negatively on "when" flexibility. "Flexible desks" is weighted not significant on "where" flexibility. These two indicators were also ranked relatively low from practitioners' perspective in earlier research. Overall, it can be said that the seven indicators which did not positively significant contributed to their constructs might contribute to other constructs. This, however, requires further research using exploratory factor analysis which was beyond the scope of the current research.

It was said before that for sake of simplifying the research model, where the latent variables were formed by a relatively higher number of indicators, the indicators were clustered to sub-constructs. As it was mentioned in Section 5.2.2, all sub-constructs' effect

was significant on their latent variables. And it was evident that the effect size of sub-constructs belonging to each latent variable was almost the same. In such condition, no priority can be given to any of the sub-constructs belonging to one latent variable. Only in case of latent variable "how-organization" the effect size of "inner organizations" is smaller than the other two sub-constructs (outer organization and facilitate planning). This means that "how-organization" flexibility is influenced relatively higher by "outer organization" and "facilitate planning" rather than by 'inner organization.

6.2 Evaluating the hypotheses

Among the six hypotheses regarding the existence of positive relationships between project management flexibility and project performance, two were supported; "how-attitude" and "how-organization" (see Table VI). The significant positive relationship here means that the higher the flexibility of "how-attitude" and "how-organization," the better the project performance. The existence of this significant relationship is supported by the literature. Suprapto *et al.* (2015) conclude that relational attitude, joint team capability and collaborative practices have a significant positive effect on project performance through the mediation effect of teamwork quality. "Interactive decision making" and "close involvement of stakeholders" in our research model could be seen as equivalent to "joint working" and "team integration" in their research model. The effect of "management support" on project performance is also confirmed in their research model (in the positive effect of relational attitude which includes senior management commitment as a sub-construct).

Several studies, including the research performed by Lu *et al.* (2016), show that "trust" also has a positive effect on project success. They also mentioned that asymmetric information between the parties has a relationship with an opportunistic view (trust). "Asymmetric information" partly supports the idea of "open information exchange" in our research model. Other research proved that adequacy of available information plays an important role in uncertainty and complexity of projects (Pich *et al.*, 2002). Ahn *et al.* (2016) researched the effectiveness of shared interface management on dealing with project complexity. The effect of interface management was proven in dealing with project complexity in their research. It is also evident that project complexity affects project performance (Bosch-Rekveldt, 2011). This can confirm why "Shared interface management" in our research model was significantly weighted in its construct and consequently the significant relationship of its latent variable with project performance. The role of lessons learned on performance is also highlighted in the literature (Cooper *et al.*, 2002). Hence, it is concluded that the empirical results in this study (the existence of a significant positive

How	
How-attitude	
Open attitude	Interactive decision making
	Close involvement of stakeholders
Wide approach	Open information exchange among different groups
	Possible alternatives
Proactive attitude	Contingency planning
	Seizing opportunities and coping with threats
How-organization	
Facilitate planning	Visualized project planning and progress
	Continuous learning
Outer organization	Self-steering of the complete project team
	Shared interface management
	Trust among involved parties
Inner organization	Management support
	Network structure rather than hierarchical structure

Table VI. Flexibility of "how" including its constructs and enablers

relationship between "how" flexibility enablers and project performance) are supported in literature studying the effects of individual indicators on project performance.

The other four hypotheses, regarding the relationships between flexibility of "what," "who," "when" and "where," were not supported by statistical analysis. It was mentioned that the path coefficients in PLS–SEM are calculated relatively (in comparison to all paths in the model). Second, this result could be influenced by the complexity of the whole model (structural and measurement). The main model consists of latent variables with a different number of indicators ranging from 1 to 7. The latent variable with more indicators might come out as significant compared to the latent variable with only one indicator.

The research on exploring the practitioners' perspectives on flexible project management showed that indicators related to the flexibility enablers of "where" ranked low compared to other indicators (Jalali Sohi, Hertogh and Bosch-Rekveldt, 2017). The same applies to the flexibility enablers of "when." The overall ranking of the indicators belonging to the flexibility enablers of "what" is lower compared to the flexibility of the "how" but higher compared to the flexibility of "where" (Jalali Sohi, Hertogh and Bosch-Rekveldt, 2017).

The "what" flexibility was formed by indicators regarding the scope definition and contractual flexibility. The research by Suprapto *et al.* (2016) showed that "contract types" has no direct relationship to project performance. Although this research did not point explicitly to contractual flexibility, the contract types in the sample were different in terms of flexibility (reimbursable contracts are much more flexible than lump-sum contracts).

The effect of project complexity on project performance revealed to be significant. The complexity indicators were scaled reversely and the sign of relationship was positive. This means that the less complex the project, the better the project performance. This was previously confirmed in other research works (Bosch-Rekveldt, 2011; Antoniadis *et al.*, 2011). Complexity was considered as a control variable in the whole research model. The existence of this relationship together with the effect of "how" flexibility means that while complexity has a contrary significant effect on project performance, the flexibility of "how" has a positive effect on project performance.

6.3 Mediating role of Flexible project management

While the negative effect of project complexity on project performance was confirmed, it is important to know if flexible project management can mediate this effect. It was discussed that both "how-attitude" and "how-organization" have a significant positive effect on end-project performance. But the mediation analysis revealed that only "how-organization" can mediate the effect of project complexity on end-project performance among all possible mediation effects. This means that if indicators belonging to "how-organization" flexibility would be applied in practice, the negative effect of project complexity is significantly mediated. However, it is not possible to tell the effect of which complexity category (technical, organization or external) or which complexity aspects will be mediated because complexity was treated as one single independent variable.

7. Examples for flexibility in practice

To support the results from the statistical analysis, some examples for implementing flexibility in practice are given in this section. In the survey, respondents were asked about the application of any of those flexibility enablers in their projects and also regarding the managerial practices. The following paragraphs elaborate on some of those examples given by the respondents to serve as encouragement for project teams to become more flexible in project management processes.

7.1 Motives for adopting flexibility

The motives for different project teams or project managers for bringing flexibility into their daily routine differ. One of the respondents in this research mentioned that the experience of the project team did not fit the complexity of the project they had. The front-end phase took seven years and it costs EURO 1.5bn and it was complex due to the high political pressure and a large number of stakeholders. He mentioned that this situation forced the management team to be flexible. In this example, the motive for being flexible was simply the level of complexity that required flexibility. Another respondent highlighted that working on a project which follows a flexible path, with a creative team working together based on trust and past experiences (continuous learning) is the right way to success. The motive for the project team in this case was the project success. From these two examples, it can be observed that literature suggestions for being flexible in project management were recognized by practitioners. Whether it is about managing the project complexity or aiming at project success, project management flexibility enables the project teams to achieve these goals.

7.2 Stakeholder involvement

One of the flexibility enablers in the category of "how" is "close involvement of stakeholders." Agile methodologies showed that close involvement of stakeholders is a key to translate the needs of stakeholders into project specifications in order to deliver the value to those stakeholders (Cobb, 2011). The level of stakeholder involvement varies in different stages of the project (Heravi *et al.*, 2015), from full to partial involvement. Lack of involvement of stakeholders in the whole process might lead to challenges for the project team. One of the participants in this research mentioned that the actual project was not well defined and underestimated in terms of the project goal and the real problem to be solved by the project by one of the main stakeholders, affecting project performance negatively. "Close stakeholder involvement" as a flexibility enabler lowers the chance of underestimation. The intensity of involvement can be determined by taking the role, the stage of project, the complexity of decision and other relevant factors into account.

7.3 Self-steering

Another example of a flexibility enabler which importance was reflected in practice is "self-steering of complete project team." One of the respondents mentioned that in their project there were less procedures to fulfill the management process. Hence, more flexibility was given to the project team itself. Such given flexibility to a self-steered team succeeded in keeping a large number of people in the team working together and achieving the results. The authors' perception is that the unnecessary procedures as mentioned by this respondent are unconstructive while a self-steered team performs better. Another respondent mentioned that the team should be self-steered in both hard and soft skills (full horizontal steering mechanism). In his opinion, self-steered team leads to creating an environment in which everybody understands each other's challenges and problems and is willing to help each other.

7.4 Trust

"Trust" is one of the flexibility enablers belonging to the category of "how" flexibility with positive effect of project performance. Both the lack of trust and its negative effect on project performance as well as existence of trust with a positive effect have been mentioned by respondents. One of the participants pointed out that the start of their project was not efficient due to a lack of trust and a difficult relationship with the client. According to him, the difficult relationship with the client led to underestimating the necessities for the scope

of the project. The consequence was that the project ended with five times bigger budget than estimated. The authors' interpretation is that establishing trust is a key to build a good relationship with other involved actors from the beginning of the project in order to achieve success. Another respondent mentioned that instead of looking for a victim, the attention should be paid to finding a solution. This reflects the importance of trust and no-blame culture. A project consultant mentioned that there was a very balanced project management team in their project with mutual trust but the flexibility was restricted by risk perception and uncertainty of changing regulations. The authors' observation from this case is that "trust" was optimal; however, there was lack of flexibility in some other aspects. We believe that "contingency planning" and "Seizing opportunities and coping with threats" are the flexibility enablers which can positively contribute to those risks and uncertainties in the project. In our opinion, flexibility should not be limited by those constraints but it should act as an enabler to mitigate the circumstances of such constraints.

These examples from practice support the results obtained from the statistical analysis regarding the positive effect of "how" flexibility on project performance.

8. Scientific contribution and managerial implications

So far, no literature was found on evaluating the direct effect of project management flexibility in early project phase on end-project performance. This research contributes to filling this gap and provides a base for further exploration of flexible project management.

Prior research showed that project management in the practice of infrastructure construction projects has some degree of flexibility but implicitly (Jalali Sohi, Bosch-Rekveldt and Hertogh, 2017). By this research, it was proven that among the five areas of flexibility (what, how, who, when and where), the "how" flexibility had a significant effect on end-project performance. Translating this into practice means that if practitioners would increase the flexibility in terms of "how" in their management in early project phases, their end-project performance could improve significantly. As it was discussed by bringing a few examples from the practice in Section 7, this can be operationalized by embedding the indicators of "how" flexibility in their daily practice. For example, when stakeholders are closely involved and decisions are made interactively with them, there is an "open attitude" among the parties in the project which improves the performance by improving stakeholders satisfaction (Edelenbos and Klijn, 2006). By seizing the opportunities and coping with threats and considering contingencies, the risk management improves which also affects project performance positively. These were a few examples that show how the indicators belonging to "how" flexibility contribute to better project performance.

From the research, it was also concluded that the four areas of flexibility have a positive effect on project performance, but not significant compared to flexibility of "how." This suggests that if the other flexibility indicators belonging to the "what," "who," "when" and "where" categories are applied in practice, the end-project performance would be improved, albeit not significantly. This only applies for the indicators which showed a positive contribution to their latent variables. An example is to define the scope of the project in terms of broad tasks, rather than pre-defined work packages (flexibility of what). Defining detailed work packages is not adding value to the project, given the risks that might occur and scope changes that might happen in the project. By defining broad tasks, there is still room to maneuver. Other examples are related to delegating responsibilities to the team level, establishing stable project teams and building consensus among team members (team structure in flexibility of who). These are assumed to improve teamwork conditions and consequently the project performance might improve positively.

Project complexity as a control variable was shown to have a contrary significant effect on project performance. Hence, in case the project is complex, still the effect of "how"

flexibility on project performance is significant. This implies that the positive effect of "how" flexibility on project performance exists while the project has any degree of complexity.

8.1 Limitations

The first limitation is about the number of data points (sample size). A considerable sample size was required to test the relationships between the six areas of flexibility and the five clusters of project performance. Hence, it was decided to simplify the model by including project performance as one dependent variable with five sub-constructs. Considering the ten-times rule[1] (Hair, Hult and Christian, 2013), a sample size of 300 respondents would have been required to test all possible relationships among flexibility clusters and project performance clusters. Further research could focus on testing the effect of each flexibility area on each cluster of performance measures.

The second limitation of the research was the lack of supporting literature. The concept of flexibility in project management and its effect on project performance is not well developed in the literature. To tackle this limitation, PLS–SEM was used, which is appropriate for underdeveloped research models.

Next, this research was performed in the Netherlands. Therefore, the research result might be influenced by the Dutch culture. Further research is suggested to test the research model including an international sample size.

Since there are numerous ongoing or recently finished infrastructure projects, it was not possible to get the exact size of population for sampling. To tackle this limitation (representativeness of sample size), PLS–SEM was used as the research method which works well on the relatively small sample sizes. For further research, it is suggested to perform this research on a focused group of practitioners to tackle the representativeness of the sample size.

PLS–SEM only performs confirmatory factor analysis. It might be the case that those indicators which were not weighted significantly on their constructs (and hence were removed from the measurement model) actually belong to other constructs. Consequently, subsequent research on exploratory factor analysis for flexibility indicators is required.

9. Conclusion

This research aimed at evaluation of the relationships between project management flexibility in early project phases and end-project performance, the effect of project complexity on project performance and the mediating role of flexible project management. Earlier research works suggested an increased flexibility of project management (Geraldi, 2008; Koppenjan *et al.*, 2011; Wirkus, 2016; Wysocki, 2007; Olsson, 2006; Osipova and Eriksson, 2013; Walker and Shen, 2002) but they did not explore the effect of such flexibility on project performance, which was explored in this research.

Using the PLS–SEM method, statistical analysis was performed on the data gathered from 111 surveys. PLS–SEM was chosen because it well fitted the research as the topic is not well developed and PLS–SEM is appropriate for small sample sizes. Seven hypotheses were tested; six hypotheses regarding the relationship of the flexibility areas (what, how-attitude, how-organization, who, when and where) on project performance and one hypothesis regarding the effect of project complexity on project performance. From all formulated hypotheses, two were supported. The flexibility of "how-attitude" and "how-organization" were shown to have a significant positive effect on project performance: the higher the flexibility of "how-attitude" and "how-organization," the better the project performance. Project complexity as a control variable also was shown to have a significant effect on project performance but in opposite direction: the less complex the project, the better the project performance.

The hypotheses regarding the relationship between "what," "who," "when" and "where" flexibility and project performance were not supported in the overall model. This might happen because PLS–SEM calculates the significance of existing paths in the model relatively (in comparison to each other) and not all latent variables (flexibility areas) had the same amount of indicators. Further research can explore the significance of each of these four relationships. Given their positive effect on performance (even if not significant), one might consider applying them in practice, still.

The mediating role of flexible project management on the relationship between project complexity and project performance was studied. The results showed that only "how-organization" flexibility mediates the negative effect of project complexity on project performance.

This research contributes to filling the gap in literature about the relationship between project management flexibility and project performance. Practitioners can benefit from it by embedding the flexibility indicators belonging to "how" flexibility into their practice.

Note

1. According to the often-cited ten times, the sample size for testing a model using PLS–SEM should be equal to the larger of ten times the larger number of formative indicators used to measure a single construct, or ten times the largest number of structural paths directed at a particular point in the structural model.

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Appendix 1

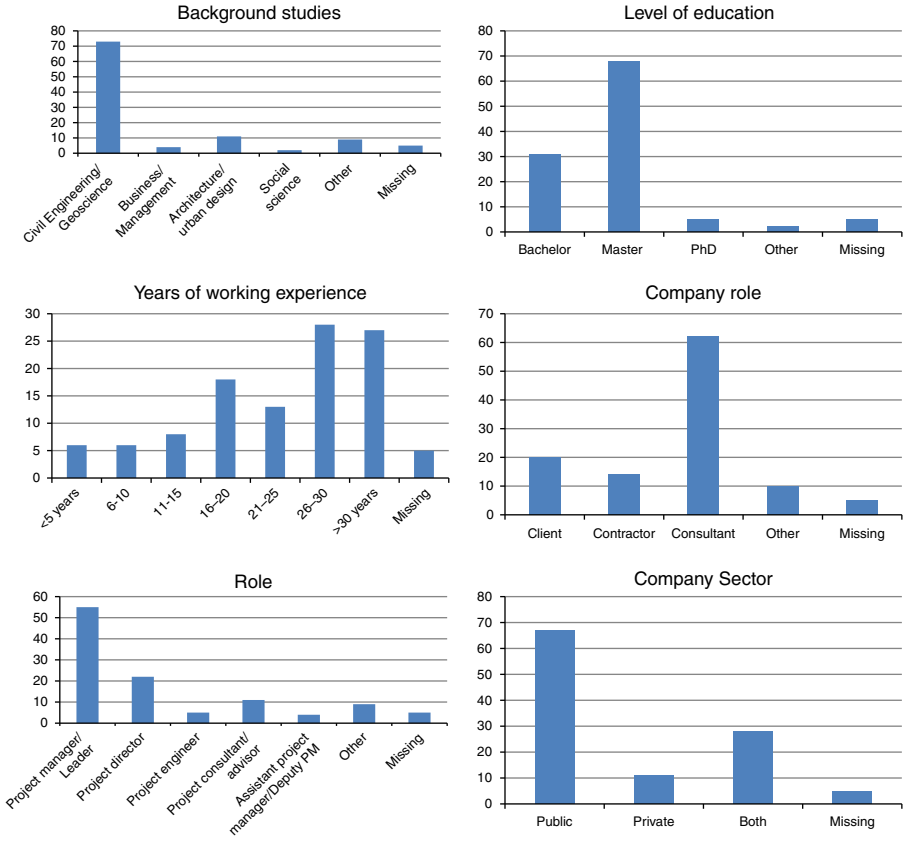

Figure A1. Demography of respondents

Appendix 2

Variables	Original sample	Sample mean	SD	SE	*t*-value
Latent variable: project complexity					
Technical complexity	0.3416	0.3384	0.0287	0.0287	11.9159
ComplexA	0.1832	0.1895	0.0945	0.0945	1.9396
ComplexB	0.7324	0.7094	0.1347	0.1347	5.4382
ComplexC	0.4222	0.4093	0.1965	0.1965	2.149
Organization complexity	0.4296	0.4269	0.0309	0.0309	13.8823
ComplexD	0.283	0.2689	0.0865	0.0865	3.2728
ComplexH	0.5521	0.552	0.1046	0.1046	5.2778
ComplexI	0.1625	0.1575	0.1232	0.1232	1.319
ComplexK	0.1968	0.1855	0.0876	0.0876	2.246
ComplexT	0.5119	0.5043	0.0942	0.0942	5.4337
External complexity	0.3818	0.3774	0.0285	0.0285	13.4129
ComplexG	0.7875	0.766	0.1218	0.1218	6.4655
ComplexP	0.4096	0.4018	0.1185	0.1185	3.4561
ComplexV	0.2245	0.2194	0.172	0.172	1.305
Project management flexibility					
Latent variable: flexibility of What					
FlexA	0.802	0.7264	0.2586	0.2586	3.1006
FlexC	0.4422	0.4446	0.3024	0.3024	1.4623
Latent variable: flexibility of How-attitude					
Open attitude	0.3827	0.3817	0.0348	0.0348	11.0064
FlexAB	0.5685	0.5599	0.1236	0.1236	4.5975
FlexAD	0.5821	0.5848	0.1105	0.1105	5.2665
Wide approach	0.3845	0.3838	0.0342	0.0342	11.2579
FlexE	0.7556	0.753	0.09	0.09	8.3962
FlexL	0.4647	0.4611	0.1204	0.1204	3.8603
Proactive attitude	0.3967	0.3945	0.0304	0.0304	13.0568
FlexG	0.3996	0.398	0.0975	0.0975	4.0962
FlexH	0.7889	0.7864	0.0733	0.0733	10.7669
Latent variable: flexibility of How-organization					
Facilitating planning	0.4616	0.4543	0.0416	0.0416	11.1093
FlexK	0.5521	0.5549	0.1756	0.1756	3.1447
FlexN	0.6704	0.6452	0.1782	0.1782	3.7631
Outer project organization	0.446	0.4331	0.0459	0.0459	9.7141
FlexD	0.3445	0.3404	0.1568	0.1568	2.1976
FlexF	0.5452	0.5238	0.1815	0.1815	3.003
FlexI	0.4425	0.433	0.1889	0.1889	2.342
Inner project organization	0.3771	0.3822	0.04	0.04	9.4295
FlexAA	0.605	0.6077	0.1288	0.1288	4.6959
FlexM	0.7879	0.7728	0.1033	0.1033	7.6259
Latent variable: flexibility of Who					
Team collaboration	0.5735	0.5675	0.0361	0.0361	15.8707
FlexR	0.3937	0.3946	0.1515	0.1515	2.5987
FlexS	0.8181	0.807	0.1023	0.1023	7.9971
Team structure	0.566	0.5659	0.0349	0.0349	16.2162
Flex AC	0.6319	0.6254	0.1341	0.1341	4.7115
FlexO	0.4516	0.4542	0.1421	0.1421	3.178
FlexP	0.458	0.4405	0.1298	0.1298	3.5287
Latent variable: flexibility of When					
FlexU	0.6732	0.658	0.1836	0.1836	3.6668
FlexV	0.6039	0.5877	0.1872	0.1872	3.226

Table AI.
Assessment formative measurement model

(*continued*)

Variables	Original sample	Sample mean	SD	SE	*t*-value
Latent variable: flexibility of Where					
FlexY	1	1	0	0	0
Latent variable: project performance					
Efficiency	0.349	0.3506	0.0549	0.0549	6.3579
PerformanceA	0.366	0.3485	0.1618	0.1618	2.262
PerformanceC	0.0648	0.0546	0.1556	0.1556	0.4168
PerformanceD	0.048	0.0532	0.1608	0.1608	0.2985
PerformanceE	0.2531	0.2438	0.151	0.151	1.6764
PerformanceF	0.3218	0.3129	0.1369	0.1369	2.3508
PerformanceH	0.4274	0.395	0.1363	0.1363	3.1351
Organizational benefit	0.3388	0.3215	0.0556	0.0556	6.0932
PerformanceI	0.5525	0.5309	0.1385	0.1385	3.9901
PerformanceJ	0.4218	0.4173	0.1312	0.1312	3.2151
PerformanceM	0.4502	0.4552	0.1303	0.1303	3.4556
Project impact	0.2365	0.2209	0.0505	0.0505	4.6862
PerformanceO	1	1	0	0	0
Future potential	0.2507	0.2382	0.0581	0.0581	4.3143
PerformanceS	0.596	0.6035	0.1871	0.1871	3.1861
PerformanceT	0.5285	0.5037	0.2018	0.2018	2.6183
Satisfaction	0.1513	0.1379	0.0502	0.0502	3.0149
PerformanceX	1	1	0	0	0

Table AI.

About the authors

Afshin Jalali Sohi was born in 1986, on March 25th in Tehran, Iran. After obtaining Bachelor's Degree in Civil Engineering at Vali-e-Asr University in Rafsanjan, Iran, he studied Construction Project Management at the University of Tehran to obtain a Master of Science Degree. Parallel to his master studies, he had worked as Project Controller in private sector in Construction Industry. In addition to work in the industry, he had worked part-time in different private educational institutes as Teacher and Educational Consultant in the field of "Construction Project Management" studies. In January 2014, he moved to the Netherlands for sake of doing a PhD in Project Management at the Delft University of Technology. In November 2018, he obtained PhD Degree by delivering a dissertation entitled as "Flexibility in project management: towards improving project performance." Next to PhD, he has been involved in different educational (BSc, MSc and online courses) and research activities (supervision of MSc graduation research projects). His research interests include, but not limited to, project management methodologies, flexibility in project management, Agile project management, project complexity and fit-for-purpose project management. Currently he is appointed at Post-Doc Researcher at the Delft University of Technology doing research on Project Management of interorganizational projects. Afshin Jalali Sohi is the corresponding author and can be contacted at: a.jalalisohi@tudelft.nl

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Marcel Hertogh (1962) studied Civil Engineering and Economics and obtained PhD Degree in Social Sciences. He is Full Professor and Head of the Research Group Infrastructure Design and Management at the Faculty of Civil Engineering and Geosciences at the Delft University of

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