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The agility-control-nexus: A levers of control approach on the consequences of agility in innovation projects

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ABSTRACT

Recent developments indicate a fast-growing relevance of the agile project methodology in innovation. Besides the benefits, agile projects also pose several challenges. Organizations need to come up with an answer to cope with the inherent risks of agile projects. The adaption of management control mechanisms is key to foster the benefits of agile. However, the ongoing debate on the benefits of control systems for innovation and the harm of control systems for achieving agility creates a nexus. Further research on how to adapt existing mechanisms is required to obtain a better understanding and provide guidance for organizations. Building on Simon's levers-of-control (LOC), this study specifies the consequences of different control levers applied by top managers on the outcome of innovation projects considering the respective project agility and the agility of the projects' environment. We follow the calls of existing research on the nexus of control and agility and adumbrate which control levers can positively influence the outcome of agile and non-agile innovation projects. Using survey data of 316 project managers and product owners across different industries, this study reveals that the impact of control on innovation project performance depends on the design of control systems and the emphasis on different control levers used by top managers. Furthermore, the findings reveal a moderation effect of agility in this context. The combination of the LOC and agile project management for innovation projects contributes to the literature on innovation management, project management, and management control.

1. Introduction

The management of innovation projects is confronted with challenges such as shorter product development cycles and constantly changing project requirements (Chin, 2004). This corresponds to a need for more flexibility (Candi et al., 2013) and an increasing relevance of agile project methodology (Augustine, 2005; Chin, 2004). Originating from software development and manufacturing, the paradigm of agility has gained importance in different corporate functions like agile hardware development and agile supply chain management (Sommer et al., 2015; Centobelli et al., 2020). This also applies to different industries such as mining, automotive industry, utilities, and consumer goods which vary greatly in customer requirements, e.g., project vs. product business (Conforto et al., 2014; Andresen et al., 2020; Lill et al., 2020a). Thereby, the focus is particularly on the principles of self-organization and responsiveness to constant change. These are expressed as desired goals at the organizational level (Howell et al., 2010). The hallmarks of agile organizations are flat hierarchies, changing interdisciplinary teams, and a focus on rapid, direct communication for problem-solving (Almeida et al., 2012). Through agility, organizations can adapt more quickly to changing environments and reduce time to market for innovative products (Cervone, 2011).

Innovations are closely associated with risks (Reid and De Brentani, 2004). To be successful, organizations need to show a willingness to take these risks (Hock-Doepgen et al., 2020). However, blind faith in the success of these uncertain bets would be fatal. Therefore, organizational structures and control mechanisms aim to reduce this risk while still allowing for room to innovate (Bedford, 2015). Due to the unique risks of agile projects, the adoption of agile project management (AP) approaches requires organizations to adapt existing management structures, work processes, communication patterns, and responsibilities (Gandomani et al., 2014; Walczak and Kuchta, 2013). The new paradigm creates tensions in terms of alignment, commitment, collaboration, and efficiency on the top management level as well as on the team level (Stettina and Hörz, 2015). Top management, the project team, and the customers need to coincide with the level of agility and its alignment

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with the project environment to be successful (Storde et al., 2009).

Developing an understanding of how organizations adapt their supporting structures and processes of agile projects can contribute significantly to understanding the phenomenon (Lill et al., 2020a; White Baker, 2011). Despite the assumption of a detrimental effect on innovation projects, mainly formal control mechanisms at the top management level have emerged as a vehicle to positively influence the success of projects from the outside (Bedford, 2015). Dreesen and Schmid (2018) elaborate that formal control mechanisms can master the challenges and foster the benefits of AP. However, they also point out the necessity to further study the nexus between agile principles including self-organization of teams and control mechanisms. Management control systems (MCS) can provide flexibility as well as transparency and serve as decision-support for coordinating and aligning multiple self-organizing agile teams (Dingsøyr et al., 2017). Early adopters of previous insights on the control in AP faced recurring challenges, such as the mismatch "between the requirements of agile and the company's reward systems" (Cooper and Sommer, 2018: 20). Thus, how to tailor MCS to the new requirements yet remains a challenge (Ciric et al., 2018).

The non-existence of a universal conceptualization of agility prevents the comparability of existing studies (Kettunen, 2009). Recent developments to combine traditional and agile methods exacerbate this instance (Sommer et al., 2015). To sharpen the understanding of agile methodologies, comparisons of different agile and non-agile applications are needed. Especially empirical research outside the software context is supposed to be beneficial for the ongoing debate (Ciric et al., 2018; Andresen et al., 2020).

The paper at hand aims to make a threefold contribution. First, the analysis of the effects of different control levers in relation to the respective agility constitutes an essential contribution to the debate on the adaptation of organizational processes to the management of agile projects (Dingsøyr et al., 2017; Dreesen and Schmidt, 2018; Lill et al., 2020a). In doing so, we advance theory by introducing the concept of MCS to the field of innovation project management and more specifically, AP. Secondly, the use of a non-dichotomous approach to measure agility allows us to provide a more granular picture of success factors for innovation management (Kettunen, 2009; Sommer et al., 2015). Thirdly, by testing our hypotheses based on a large sample, we respond to calls for empirical studies to better understand agile methodologies and their performance impacts (Ciric et al., 2018). Consequently, we seek for answers to the following research questions:

- What are the impacts of different levers of management control on innovation project performance?
- What impact does agility have on the relationship between management control and innovation project performance?

The remainder of this paper is organized as follows. We first provide an overview of the conceptualization of AP and the LOC. After developing our hypotheses and describing the underlying research model, we present the findings of our empirical study. Finally, we discuss these results in the light of previous research, derive theoretical as well as practical implications, and conclude with an agenda for future research.

2. Conceptual framework

2.1. Traditional vs. agile project management

As a reaction to a high number of failing innovation projects, AP gained in. Originating from software development, the concept of AP evolved further to a suitable tool for the development of customer-oriented product, process, and business model innovation (Dybå and Dingsøyr, 2008; Ghezzi and Cavallo, 2020; Andresen et al., 2020). We follow the definition of AP as "the continual readiness […] to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value" (Conboy, 2010: 340). Although considered as predecessors of AP, iterative methodologies such as rolling wave techniques still show considerable differences to the current use of the term AP (Serrador and Pinto, 2015).

In a detailed comparison of traditional project management (TP) and AP, Dybå and Dingsøyr (2008) exposed seven principal differences: fundamental assumption, management style, knowledge management, communication, development model, desired organizational form/structure, and quality control. The fundamental assumption of fully specified and predictable systems and the mentioned "command and control" management style in TP as opposed to the inclusion of rapid feedback to continually revise and change the project scope with a management focus on leadership and personnel improvement in AP are among others the most significant differences. In particular, the differences in the desired organizational form – mechanistic in TP and organic in AP -, as well as quality control mechanisms of both methodologies, require further consideration.

Within agile practices, individuals have greater responsibility and are expected to engage in more self-organization and dedication (Augustine, 2005; Andresen et al., 2020). However, there is a need for a higher level of collaborative, more informal communication among team members and knowledge management of tacit knowledge to manage a project in an agile manner (Schwaber, 2004; Vázquez-Bustelo and Avella, 2006). Hereby, the development model needs to be evolutionary as the project scope is subject to frequent changes and requires the implementation of a strong communication component to enable feedback and learning effects with the customer (Kettunen, 2009; Salameh, 2014). However, we argue that recent research exaggerates the radical newness of agile approaches as we can see similar constituents in the TP literature. For instance, collaborating with lead users to develop new products requires continuous design improvement and testing as well as customer collaboration in the ideation phase (Urban and Von Hippel, 1988). Traditional formal control mechanisms, such as flexible budgeting, create opportunities to adapt requirements throughout a project (Yang et al., 2009). Furthermore, the explicit recognition of informal control mechanisms, such as an innovative culture and social networking (Chenhall et al., 2011) opposes the assumption that TP is characterized exclusively by formal command-and-control structures (Bisbe and Sivabalan, 2017). Hence, seeing TP and AP as binary concepts is not suitable to face this reality. As pointed out by recent research, projects can have varying levels (degrees) of agility (Andresen et al., 2020; Lill et al., 2020a). Accordingly, we consider project agility on a continuous scale, i.e., each project can be more or less agile.

2.2. Project environment

In agile projects, the environment displays a significant contributor to performance (Sheffield and Lemétayer, 2013). Three intra-organizational components determine a strong project environment: top management support for self-organization, fostering entrepreneurial mindsets, and risk-taking willingness for exploratory actions (Howell et al., 2010). An environment with a strong emphasis on these factors is also referred to as an agile environment (Bonner, 2010). However, we also find these factors among the significant contributors to the success of traditional projects (e.g., Lindner and Wald, 2011). Especially, taking and managing risks is a key contributor to success in all innovation projects (Gurd and Helliar, 2017). Top management establishes formal and informal control mechanisms that increase the willingness to take risks and facilitate entrepreneurial actions of the development team (Highsmith, 2009; Howell et al., 2010; Misra et al., 2009). Moreover, they need to forge a feeling of top management support for the decisions made by the development team (Howell et al., 2010; Ratbe et al., 1999). Thus, organizations need to implement practices adapted to the project team and its organizational context to foster the benefits of these determinants and reduce the likelihood of large-impact conflicts (Ramesh et al., 2012; Wysocki, 2014).

2.3. Control in agile project management

Vidgen and Wang (2009) state that agility is promoted by self-organization while centralized control harms project performance. Similarly, Bonner et al. (2002) argue an adverse effect of top management control for innovation projects that can only be moderated by a project team's responsibility to design its control mechanisms independently. Contrary, Slaughter et al. (2006) explicitly state the necessity of process, product, and strategy alignment to increase efficiency and to avoid conflicts between different projects. Alignment in these three dimensions can be achieved using MCS (Dahlgren and Söderlund, 2010; Poskela and Martinsuo, 2009). There is growing evidence that MCS on the top management level are beneficial for project performance when designed according to the needs of the context (Dunk, 2011). However, research on control mechanisms for AP is scarce. Most research is focusing on single elements, such as the "Agile-Stage-Gate process" (Sommer et al., 2015). Only a few researchers are trying to get a hold of a more comprehensive control approach. For, example Ramesh et al. (2012) propose a stronger emphasis on process-oriented controls for agile projects.

As AP is particularly suited to innovation projects (Conforto and Amaral, 2010; Cooper and Sommer, 2016), we refer to a recent comparison of existing MCS conceptualizations where Strauβ and Zecher (2012) suggested that Simons' (2000) LOC is the most relevant for innovation activities. The LOC is suited for innovation projects as it not only includes rigid control structures but also considers more informal elements, which is particularly important in an agile context (Lill et al., 2020a). Accordingly, the LOC was repeatedly used for studying management control in innovation (Bedford, 2015; Janka and Guenther, 2018; Lill et al., 2020b; Munck et al., 2020). We follow this choice and adopt the LOC as "formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities" (Simons, 1995: 5). This framework comprises four categories for managers to choose from: diagnostic control, interactive control, boundary systems, and belief systems. Using control systems in a diagnostic way refers to mechanisms that make organizational goals and progress towards these goals transparent (Bedford, 2015). They are used to communicate and allocate deviations. In contrast, interactive control mechanisms are not only used to monitor the status quo but also for revealing emergent opportunities or uncertainties. Managers use these mechanisms to motivate subordinates and facilitate their work (Lopez-Valeiras et al., 2016).

Boundary control systems refer to mechanisms that define appropriate domains of organizational activity. By setting restrictions or minimum standards for actions and behavior, boundary controls provide both, flexibility and control. A comprehensive MCS is complemented by the implementation of belief systems which are defined as "the explicit set of organizational definitions that senior managers communicate […] to provide basic values, purpose, and direction" (Simons, 1995: 34). This includes elements such as mission statements or value statements.

Despite recognition, research specifically examining tension and the suitability of various control mechanisms to address agile challenges is still scarce (Ciric et al., 2018; Maruping et al., 2009). However, the lack of a comprehensive study of MCS is crucial for several reasons. The iterative nature of agile methods increases the mutual influence of individual decisions, causing a need for overarching control elements (McAvoy and Butler, 2009). Furthermore, the inclusion of multiple control elements when analyzing the phenomenon is imperative to account for the organizational tensions inherent in the innovation process (Bedford, 2015). Thus, the described levers of control provide a suitable conceptualization to address these shortcomings.

3. Hypotheses development

3.1. Project agility and project environment

Three different components determine a strong project environment: top management support for self-organization, fostering entrepreneurial mindsets, and risk-taking willingness for exploratory actions (Howell et al., 2010). However, environmental factors such as management commitment also play a decisive role in projects conducted with TP (Lindner and Wald, 2011).

The influence of self-organization on the motivation of team members lacks an agreement as to the positive influence of the challenge of autonomy, and the negative influence of related stress contradict each other (Bendoly and Hur, 2007). Managers need to compose their project team in a way that self-organization enables the team to use inherent capabilities as it gives a team the freedom to approach new ideas experimentally and creatively (Das and Joshi, 2007; Tatikonda and Rosenthal, 2000).

Furthermore, top management support is a crucial factor across all project phases (Mazur et al., 2014). Kissi et al. (2013) argue that the degree of perceived top management support directly impacts the team members' level of motivation and their contribution to project success. Appropriate leadership guides performance standards and role descriptions without interfering too much with detailed project work (Gundersen et al., 2012). Conclusively, we found all factors that are conducive to a strong project environment, also among advocates of TP.

A second determinant of agility refers to project characteristics that differ in three dimensions: Requirement uncertainty, procedural empowerment of the team, and customer collaboration (Sheffield and Lemétayer, 2013). The lack of flexibility to react to requirement changes can contribute to the failure of projects. It limits the room for maneuver so that the non-occurrence of underlying assumptions inevitably leads to an unsuccessful outcome (Collyern et al., 2010). To achieve flexibility, top management must support the project teams' efforts of self-administration and build a relationship of trust (Kirkman and Rosen, 1999). The ensuing perception of procedural empowerment increases individual intrinsic motivation and creativity (Vallon et al., 2018). Dikert et al. (2016) argue that employees only make use of exploring new solution spaces if they feel encouraged to do so. As the solution space is not clearly defined and a matter to change, agile projects require a higher dependency on customer involvement as opposed to more traditional projects (Wysocki, 2014). Customers and the project team must build mutual trust, which ultimately leads to better project performance (Misra et al., 2009; Sheffield and Lemétayer, 2013). Summarizing the insights on the project environment as well as the project characteristics, we propose the following:

H1. Agility has a positive impact on project performance.

3.2. Diagnostic control

Diagnostic control systems are associated with mechanistic structures characterized by strict control and highly structured communication channels Henri (2006). A high degree of formalization of processes and communication restricts the individual and the resulting project performance (Vidgen and Wang, 2009). With a high degree of task security, efficiency gains, especially regarding time and costs, can be achieved (Bedford, 2015). However, over-emphasizing a diagnostic use of control can lead to an overly strong orientation on short-term targets which contradicts the necessity to create new knowledge during innovation projects (Chiesa et al., 2009). Furthermore, in situations in which managers are unable to identify clear preferences and define goals unambiguously, diagnostic control systems often give rise to unproductive discussions about the significance and reliability of control mechanisms instead of developing concrete measures for management (Chapman, 1997). We, therefore, argue that:

H2a. The use of diagnostic control has a negative impact on innovation project performance.

However, we find different reasoning for projects with a higher degree of autonomy. Allowing the team to design its control mechanisms, attenuates the adverse effects (Bonner et al., 2002). In this case, diagnostic control systems are assumed to provide transparency among different stakeholders (Widener, 2007). A high degree of transparency ensures the required alignment of stakeholders in AP (Silaen and Williams, 2009). Thus, both within a team and with stakeholders such as top management or customers, the implementation of diagnostic control mechanisms can improve cooperative behavior and coordination if individuals take advantage of this situation (Smets et al., 2015). Boehm and Turner (2005) argue that organizations should implement market-oriented diagnostic controls to create an open culture within organizations and to enhance customer interaction. Furthermore, diagnostic control systems define a goal without interactively developing concrete measures. Team members are thus somewhat flexible in achieving their goals (Adler and Chen, 2011). As agile methodologies acknowledge the autonomy of the project team and the rigidity of time frames, we assume the neglection of the prior stated negative effects of unproductive discussions between top management and the project team. We hypothesize:

H2b. Agility negatively moderates the negative impact of diagnostic control on innovation project performance.

3.3. Interactive control

Interactive control systems, in contrast to diagnostic systems, are characterized by more intensive communication between the top management and the project team (Simons, 1995). This interaction opposes a pure command-and-control structure and thus provides the foundation needed to utilize creativity. Therefore, top management installs interactive systems to create a fertile base for autonomy (Silaen and Williams, 2009). Using interactive control systems increases the dynamic capability to seize emerging opportunities and master strategic uncertainties (Simons, 2000). Through the interactive use of performance measures or budgets, performance improvements can be achieved in both service innovation (Abernethy and Brownell, 1997) and product innovation (Bisbe and Otley, 2004). In innovation projects, tacit knowledge can play an important role whose codification is insufficient (Gupta and Wilemon, 1990). Therefore, a stronger focus on verbal communication and interaction can promote the exchange of this type of knowledge among all stakeholders (Turner and Makhija, 2006). The continuous exchange offers the ubiquitous opportunity to express concerns about the existing as well as to introduce and experiment with new to increase variance. This variance is reflected in better performance (McGrath, 2001). Dunk (2011) argues that a direct positive impact of interactive systems on project performance can be assumed.

Interactive control also positively influences individual aspects of project success, such as invention speed (Rijsdijk & van den Ende, 2011) or innovativeness (Mackey and Deng, 2016). Additionally, market-oriented interactive systems can discover changes in customer requirements earlier, which enables the team to react more quickly. The focus on interaction enables a constant adaption of these mechanisms to the particular situation and thus allows for a reduction of ex-ante planning (Davila et al., 2009). We, therefore, hypothesize as follows:

H3a. The use of interactive control has a positive impact on innovation project performance.

By implementing interactive control systems, top management delegates decision-making to the project team. This transfer of power can create a feeling of top management support for every team member's decision (Chen et al., 2015). Interactive control systems entail instruments that allow top management to influence the teams' actions directly and as such, oppose the agile principle of self-administration (Dybå and Dingsøyr, 2008). However, interactive systems create the cognition of psychological empowerment that ultimately stimulates self-administration and individual creativity (Moulang, 2015). This beneficial interplay enables all stakeholders to constantly adapt to uprising challenges, and it also allows for a reduction of ex-ante planning (Davila et al., 2009). Summarized, we argue that:

H3b. Agility positively moderates the positive impact of interactive control on innovation project performance.

3.4. Boundary systems

Boundary systems, defined as "explicit statements embedded in formal information systems that define and communicate specific risks to be avoided" (Simons, 2000: 764), seem to limit the individuum in its strive for exploration. Research, however, also stressed the freedom that can arise from this type of control (Chiesa et al., 2009). In projects with extensive ex-ante planning, managers often tend to restrict employees in their search for radical change (Bedford, 2015). Boundary systems often fail to generate the dynamic tension between control and freedom necessary for success (Curtis and Sweeney, 2017). Hence, many areas of the potentially feasible solution space can remain unexplored (Rodan, 2005). Also, Abernethy and Brownell (1997) postulate that the use of behavioral guidelines does not make sense, especially when there is a great deal of task uncertainty. In uncertain environments, e.g., innovation projects, the definition of exact boundaries is difficult (Bedford, 2015). It can, therefore, be assumed that this effect will increase for this type of project implementation.

H4a. The use of boundary systems has a negative impact on innovation project performance.

However, boundary systems allow for a high degree of flexibility within the defined area by describing restrictions and minimum requirements. Simons (1994) concretizes that this flexibility is explicitly aimed at breaking up old structures fostering strategic renewal. Despite its connotation of boundaries, the formality, at the same time, offers security and thus suggests top management support for action within the set limits (Adler and Chen, 2011). This can also reflect in increased motivation and the will to design and manage oneself (Frow et al., 2010). The iterative process of agile projects allows for a constant adaption of the designed boundaries throughout a project life cycle and thus have the potential to adapt the boundaries of the solution space to the respective requirements. The low level of ex-ante planning results in a broad boundary setting by the top management and ultimately leads to a wide solution space to explore (Bedford, 2015). Hence, we argue that:

H4b. Agility negatively moderates the negative impact of boundary systems on innovation project performance.

3.5. Belief systems

Simons (1995: 34) labels "the explicit set of organizational definitions that senior managers communicate formally and reinforce systematically to provide basic values, purpose, and direction for the organization" as belief systems. Their positive, encouraging character is seen as conducive to the exploration of new ways of working and the generation of new knowledge (Chiesa et al., 2009). At the same time, these mechanisms represent a stable reference point assuring top management support for those actions which are in line with the shared values. However, top management only provides an indication of goals without making any further restrictions on how they are to be achieved (Mundy, 2010). Ylinen and Gullkvist (2014) confirm a positive effect of belief systems on performance, in particular, of exploratory projects. Adler and Chen (2011) explain that the internalization of shared values strengthens each's commitment and that, as a result, corporate or project goals become their own. A familiar canon of values offers a basis for constructive knowledge exchange and thus for generating new ideas

(Hansen, 2002). Hence, we expect that:

H5a. The use of belief systems has a positive impact on innovation project performance.

For agile projects, belief systems are likely to be associated with considerable advantages, since the high uncertainty inherited in these projects makes it difficult to define targets explicitly (Bedford, 2015). Furthermore, AP requires an increased degree of individual creativity from all participants, which in turn is receptive to belief systems (Adler and Chen, 2011). They explicitly legitimize deviations from previous thought patterns (Davila et al., 2009) and have the ability to take a more excellent account of the customers' wishes, which inevitably leads to higher customer satisfaction (Haustein et al., 2014). We, therefore, argue that:

H5b. Agility positively moderates the impact of belief systems on innovation project performance.

We illustrate the underlying research model to address these hypotheses in Fig. 1.

4. Research methodology

4.1. Sample and data collection

To test our hypotheses, we targeted the population of project managers and product owners of innovation projects. The need to target managers of innovation projects can be challenging as no national register of this population exists, and the size of the population is unknown. Therefore, a statistical validation in relation to the population is not possible. We followed earlier research which relied on project managers as informants (Andresen et al., 2020; Goetz and Wald, 2020; Nuhn et al., 2019; Tyssen et al., 2014) and distributed an online questionnaire via a newsletter to the members of GPM, Germany's largest project management association with approximately 8000 members from different industries and companies of varying size. Project managers are highly knowledgeable about details related to daily routines and project characteristics, thus making them a reliable source to address our questions (Henard and Szymanski, 2001). This targeted sampling strategy allows for generalizations (external validity) regarding similar innovation projects (Bjorvatn and Wald, 2018), and therefore, the advantage of targeting knowledgeable respondents of innovation projects outweighs the disadvantage of an undeterminable population.

To enhance the quality of our results, we provided a clear definition of innovation projects as independent temporal units that exist for more than 30 days have an assigned budget and consist of project teams of at least three members. The inclusion of GPM members of different sectors, i.e., manufacturing, information & telecommunication, and service industries, as well as various forms of innovations, further enhances the generalizability of our findings (De Brentani and Kleinschmidt, 2004).

We asked project managers to assess the performance of their last fully completed project to create randomness and to minimize potential biases related to that process. To ensure the relevance of the project for this study, we further asked for the project purpose, i.e., product, service, process, business model innovation, which we included as another control variable in our final model. Secondly, we followed the approach of Podsakoff et al. (2005) and introduced a separation between the measures of project performance and MCS to control for potential common method biases. The inner Variance Inflation Factors (VIF) in our model of below 3.3 also indicate the absence of such a bias (Kock, 2015).

In total, we contacted project managers on a random basis via the newsletter and received 335 responses. After the removal of those failing to meet our inclusion criteria, we analyzed a final database of 316 innovation projects of different levels of agility. Those respondents, we excluded either executed non-innovation projects, failed to complete the survey, or completed the survey in an unreasonable amount of time. As we cannot gather information about the number of innovation project managers receiving the newsletter and, hence, of their newsletter impressions, the closest proxy for the response rate we can derive is the ratio of those project managers who used our survey-link (620) to the number of participants in our final database (316) which results in a response rate of 50,9%. The final database represents a reasonable split across different industries as well as various types of innovation (for details see Table A1 in the appendix).

To reduce drop-out and therefore non-response bias, we offered every participant an individual report of the findings of our study. Secondly, we compared early and late respondents to test for non-response bias (Armstrong and Overton, 1977). This test did not show significant differences for any of our variables, including innovation type, firm size, or team size. The comparison of the distribution of the firms in our sample across different industries, as well as the ratio of female and male respondents in our sample to the total numbers of project managers in Germany, also indicates the absence of a non-response bias.

4.2. Measurement

We identified validated scales for the constructs under observation. We adapted items and constructs in wording where necessary and pretested the survey with 18 experts in the fields of management control and project management for comprehensiveness and unambiguity to enhance validity. We measured every construct with a multi-item scale applying a seven-point Likert scale anchored on a score 1 "strongly disagree" and 7 "strongly agree" to form latent variables (Churchill Jr, 1979). We applied the measures of LOC's four dimensions from Bedford (2015). The scale items are similar to those in previous studies, but

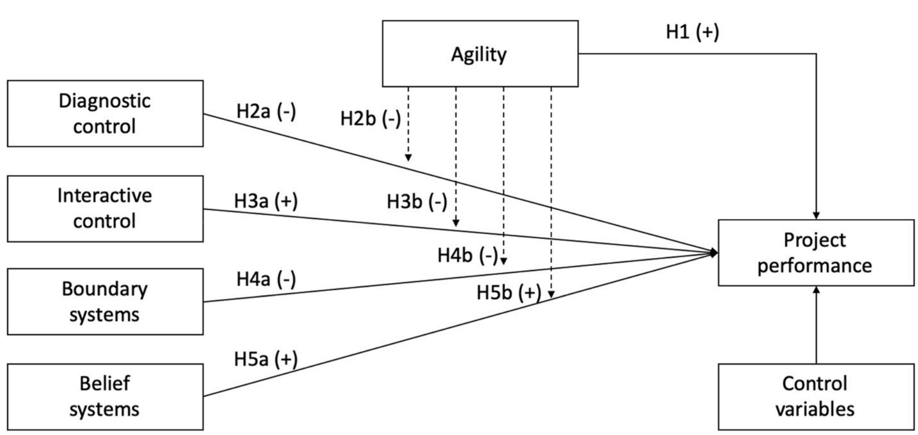

Fig. 1. Research model.

Bedford was the first to adopt these items to new findings in the examination of reflective and formative constructs. As agile methodologies, in particular, Scrum, are characterized by a fixed period and a fixed budget, these dimensions do not apply to our problem. Thus, the quality of the result is the only dimension remaining. To apply a broad definition of performance, we included the customer as well as employee satisfaction and an overall performance item in our scale to still analyze time and cost aspects in our final analysis (de Bakker et al., 2010). Focusing on contributing factors of agility, we used the three-item scale from Sheffield and Lemétayer (2013) to form the construct “Project environment” and those three aspects of their “Project agility” scale which represent the most significant differences between APM and TPM. We excluded ‘co-location of the project team members’, and ‘technological uncertainty’ as these factors do not constitute a sufficient distinction to TPM innovation projects (Chiesa et al., 2009). Finally, we included control variables covering the three involved dimensions: firm-level (industry, firm size), project-level (team size, innovation type), and individual-level (gender).

4.3. Reliability and validity

We used the variance-based structural equation modeling approach of partial least squares (PLS), more specifically, SmartPLS 3 (Ringle et al., 2005) to analyze our data. PLS-SEM is suitable for our research as it (1) enables us to analyze the measures or constructs simultaneously and the underlying structural model, (2) is particularly appropriate for exploratory, survey-based analyses (Hair et al., 2012), (3) shows a higher robustness even for smaller, not normally distributed samples (Ernst et al., 2011), and (4) is suitable for formative measures and, in particular, recently created constructs, such as ‘agility’ (Gefen et al., 2011). To deal with the occasional criticism leveled at PLS-SEM, we followed the propositions of Ringle et al. (2012) for improving the use of this method.

We started with a confirmatory factor analysis to ensure the reliability and validity of the reflective constructs and the measurement model. To assure the convergence of the analysis, we set the number of maximum iterations to ‘1000’. The internal consistency of our measures was validated by the composite reliability values, which all lie within the appropriate range of 0.65 and 0.95 (Hair et al., 2016). Convergent validity has been approved by the confirmation of all item loadings being above 0.70 and the average variance extracted (AVE) of all constructs being above 0.50 (Götz et al., 2010). We assessed the discriminant validity of the latent constructs with the Fornell-Larcker criterion by estimating the cross-loadings at the indicator level and showing that all indicators load on the intended construct (Hair et al., 2013) Additionally, the VIF for all items were below 5.0, so we found no indication for multicollinearity issues. In our model, all weights of the formative constructs are positive and above 0.15 and the VIFs are below the threshold of 5.0, so there is no indication for validity and reliability issues (Petter et al., 2007) (see Tables A2, A3, and A4 in the appendix for detailed results of the measurement model).

To assess the underlying structural equation model, we started with the calculation of the coefficient of determination R^2. Values greater than 0.19 are considered acceptable (Chin, 1988; Henseler et al., 2009). To estimate the predictive relevance of each endogenous variable, we additionally calculated Q^2 by using blindfolding (Hair et al., 2016). Predictive relevance for a particular construct can be assumed if the value of Q^2 is greater than zero. Our particular endogenous variable ‘Innovation project performance’ exceeds the threshold value for medium-size effects ($0.15 < Q^2 < 0.35$) (Hair et al., 2016). The standardized root mean square residual (SRMR) value is 0.076, which can be considered a good fit (Henseler et al., 2014). In total, the results indicate acceptable reliability and validity of our model. Table 1 shows the descriptive results.

Table 1
Descriptive results.

	Mean	SD	Min	Max
1. Diagnostic control	25,40	7,02	5	35
2. Interactive control	23,30	7,05	5	35
3. Boundary systems	18,21	5,83	4	28
4. Belief systems	19,19	5,97	4	28
5. Project performance	23,24	3,83	10	28
6. Project agility	14,92	3,92	4	21
7. Project environment	14,45	3,70	3	21
n = 316				

5. Results

To test our hypotheses, we applied the two-step approach, using the latent variable score to assess path coefficients β and their significance, t-values, and p-values. We are able to provide this information for each path using bootstrapping. The results indicate that all β-values meet this criterion for all hypothesized effects. Finally, we introduced a moderation effect of ‘agility’ on each interaction between the control levers and ‘Innovation project performance’.

First, we were able to show a significant effect of agility on Innovation project performance ($\beta = 0.406$, $t = 7.498$). Furthermore, as agility is a formative second-order construct, we checked the effects of its two constituents on innovation project performance. This analysis reveals a positive, significant effect for both, ‘Project agility’ ($\beta = 0.270$, $t = 7.621$) as well as the ‘Project environment’ ($\beta = 0.215$, $t = 6.871$), on ‘Innovation project performance’. Thus, H1 is supported. Our data also supports the proclaimed effect of ‘Diagnostic control’ on innovation project performance ($\beta = -0{,}109$, $t = 2.235$). Additionally, agility seems to negatively moderate the effect ($\beta = -0.168$, $t = 3.358$). Therefore, we can support H2b. Accordingly, we detected correlations for the effects of ‘Boundary systems on innovation project performance ($\beta = -0.190$, $t = 3.354$) and the negatively moderation of agility on this interaction ($\beta = -0.135$, $t = 2.924$). Conclusively, we find support for H4b.

Contrary to the previous levers, H3a, representing the path between ‘Interactive control’ and innovation project performance, again indicates a highly significant positive effect ($\beta = 0.164$, $t = 2.787$). The hypotheses predicting the moderation of agility on the effect of interactive control on innovation project performance could not provide any further insights. Hence, we are only committed to support H3a. Similar reasoning can be brought forward to support H5a ($\beta = 0.197$, $t = 3.024$). The fact that the moderation effect of agility points in the postulated direction for belief systems is not statistically significant. Therefore, the results only allow to support H5a. Conclusively, none of our control variables seem to affect the outcome variable, which further supports our findings.

We summarize the results of models 1–3 in Table 2. Model 1 only includes the control variables. In model 2 we assess the direct effects of our independent variables and model 3 additionally tested the moderation effects with agility.

6. Discussion

The objectives of this study were to examine how different control levers contribute to performance in innovation projects and how this effect changes with increasing agility. We challenge the assumption that centralized control is harmful to agile projects (Vidgen and Wang, 2009). In the debate on agility, direct external intervention infers the autonomy of an innovation team and thus impedes the team’s ability to be self-organizing (Hoda and Murugesan, 2016). However, our results indicate a positive relationship between top management’s interactive control and innovation project performance regardless of the chosen project management method. This extends previous findings on TP, where the pro-active use of performance measures was found to be adequate for situations with high uncertainties (Ahrens and Chapman,

Table 2
PLS structural model: standardized path coefficients, standard errors, and R2.

	Project performance		
	(1)	(2)	(3)
Model 1: Control variables			
Firm size	-.049	-.051	-.053
	[.057]	[.044]	[.041]
Industry	-.041	-.032	-.052
	[.061]	[.046]	[.043]
Innovation type	-.096	-.038	-.044
	[.067]	[.048]	[.049]
Team size	-.111	-.094	-.087
	[.093]	[.056]	[.054]
Gender	.073	.068	.050
	[.059]	[.045]	[.043]
Model 2: Independent variables			
Diagnostic control		-.109**	-.08*
		[.049]	[.048]
Interactive control		.164***	.168***
		[.059]	[.057]
Boundary systems		-.190***	-.151***
		[.057]	[.055]
Belief systems		.197***	.201***
		[.065]	[.064]
Agility		.406***	.405***
		[.054]	[.056]
Model 3: Moderating effects			
Agility x Diagnostic control			-.168***
			[.035]
Agility x Interactive control			-.003
			[.037]
Agility x Boundary systems			-.135***
			[.046]
Agility x Belief systems			.052
			[.037]
R^2	.033	.409	.448
R^2 adjusted	.017	.398	.426

N = 316 observations from different innovation projects; standardized path coefficients reported; standard errors in brackets; ***p < .01, **p < .05, *p < .10.

2004). In combination with belief systems, interactive controls have a positive effect on motivation and job satisfaction (Carbonell and Rodriguez-Escudero, 2013). This, in turn, is directly related to the development of individual creativity needed for innovation (Moulang, 2015). The existence of significant moderation effects of agility for diagnostic control and boundary systems also contradicts the critical opinion of direct external interventions (Hoda and Murugesan, 2016). The moderating effect indicates that the use of both controls is conducive to innovation projects. This supports the need for formal mechanisms that provide the necessary transparency between innovation teams and the customer in the agile development process (Dreesen and Schmid, 2018). By revealing a moderation effect of agility on the impact of different MCS, we further support the necessity to adapt existing structures to the agile reality (Vázquez-Bustelo and Avella, 2006; Gandomani et al., 2014). Particularly, agile projects require specific supporting structures to cope with their unique inherent risks (Walczak and Kuchta, 2013).

Moreover, our findings challenge the results of Aas (2011) on the relevance of the innovation type for the design of MCS. We find an indication for interactive control and belief systems at the top management level, both to be beneficial for innovation projects. The independence of this effect from the contingency factor innovation type shows that the discussion on the impact of control in the innovation process must be conducted distinctively. By including all control levers, their interactions are also considered in our model and thus enrich the current state of knowledge (Kruis et al., 2016).

Furthermore, we confirm the assumption of Sheffield and Lemétayer (2013) that the environmental factors risk-taking willingness for exploratory activities, the promotion of an entrepreneurial mindset and top management support play a pivotal role in the success of innovation projects. These determinants encourage the project team to implement their ideas in self-administration and thus to develop a higher commitment to the project and its success (Gandomani et al., 2014). Our study implies that organizations can support innovation teams by creating a business environment in which employees feel support for their independent action regardless of the applied project management method.

6.1. Theoretical implications

The present study makes contributions to the body of research on innovation management, project management, and management control. First, our study answers the recurring calls for studies on the control of agile projects (Walczak and Kuchta, 2013). Our findings reveal positive effects of management control on innovation project performance. Furthermore, by introducing the LOC into the AP literature and allocating effect differences for different levels of agility, we expand the knowledge on the nexus of control and agility (Cobb, 2011). In doing so, we also support the necessity to adapt supporting processes and structures to the growing importance of AP (Vázquez-Bustelo and Avella, 2006).

Second, this study expands the contingency view on MCS as agility has not been considered so far. MCS research suggests that the project management method applied does not influence the effectiveness of MCS (Haustein et al., 2014). Our study, however, suggests emphasizing on different levels for AP as opposed to TP. Furthermore, Sheffield and Lemétayer (2013) have identified success factors of project agility and the project environment. Our data support these findings. We also support the positive effect of an agile project environment on innovation project performance, independent from the project management method. Therewith, our contribution is a generalization of this knowledge on any innovation project.

The third contribution lies in carrying out a large-scale quantitative study in the field of AP using a non-dichotomous approach for measuring AP and TP and an expanded performance definition, including customer and team satisfaction. This approach follows the call for a better exploration of the fundamental phenomenon but also the call for an extension of the performance definition by further factors such as employee and customer satisfaction (de Bakker et al., 2010). This extension is necessary to consider all the benefits to be achieved by agile methods when analyzing impact relationships.

6.2. Managerial implications

The growing popularity of AP in innovation requires knowledge about various elements, implementations, and modes of action regarding the respective context. The results of our study not only prove the necessity to adapt existing control mechanisms to the new context to ensure their effectiveness. Furthermore, we provide guidance on which control levers to emphasize on. The effect of a strong project environment on the success of innovation projects point to another practical implication. It can make organizations re-think their existing approaches of designing organizational structures and control mechanisms for innovation projects.

Accordingly, managers of innovation projects should try to create a strong project environment in which self-organizing teams can thrive. To support their activities and coordinate the interaction among different teams and the organization, they should further implement interactive control as well as belief systems. This MCS should be complemented by increased individual use of diagnostic control and boundary systems parallel to the increasing agility of innovation projects.

6.3. Limitations and future research

Our study also has limitations which correspond to a need for future research. First, it should be noted that the entirety of APM methods encompasses various methodologies (Qumer and Henderson-Sellers, 2008). Although trying to cope with this phenomenon by defining agility as a continuous variable, most organizations equate Agile and Scrum or XP (Hummel, 2014). As other concepts such as Kanban or Design Thinking are gaining popularity, future studies should examine whether our results also apply to different agile concepts. Second, we believe that the LOC Framework provides a suitable basis for researching the influence of control on project success since this concept includes an extensive collection of influenceable control options. However, other factors, such as the mode of innovation, customer characteristics, or other factors that are more difficult to influence, can also contribute to the success of a project (Misra et al., 2009). Future work should try to allocate these influencing factors and investigate their effects.

APPENDIX

Table A1
Sample Characteristics

Sample Characteristics	Industry	Company size	Innovation type	Gender
Trade/Traffic	14%			
Public sector	10%			
Finance/Insurance	8%			
Manufacturing	32%			
Service	20%			
Information/Communication	17%			
<50 people		13%		
50-250 people		21%		
251-500 people		20%		
501-1000 people		38%		
>1000 people		9%		
Product innovation			30%	
Service innovation			28%	
Process innovation			22%	
Business model innovation			9%	
Other			10%	
Female				49%
Male				51%

Table A2
Fornell-Larcker-Criterion and Confirmatory Factor Analysis for reflective multi-item scales (n = 316)

	1.	2.	3.	4.	5.	6.	7.
1. Gender	*1*						
2. Team size	.08	*1*					
3. Firm size	-.073	.077	*1*				
4. Industry	.06	.036	-.18	*1*			
5. Innovation type	-.03	.049	.068	.046	*1*		
6. Project performance	.069	-.119	-.062	-.039	-.116	*.85*	
7. Diagnostic control	.106	-.015	-.019	.005	-.095	.15	*.879*

Construct	Items	Loading	AVE	Cronbach's Alpha
Diagnostic control	Identify critical performance variables	.868	0.722	0.873
	Set targets for critical performance variables	.853		
	Monitor progress toward critical performance targets	.872		
	Provide information to correct deviations from preset performance targets	.895		
	Review key areas of performance	.906		
Project performance	Quality	.8	0.773	0.930
	Customer satisfaction	.844		
	Employee satisfaction	.84		
	Overall project success	.911		

Loadings of indicators on latent constructs (original sample), 0.7 or above indicates good indicator reliability.
AVE: average variance extracted, 0.5 or above indicates good.
Cronbach's Alpha, 0.7 or above indicates good reliability.

Table A3
Confirmatory Factor Analysis for formative multi-item scales (n = 316)

Construct	Items	Weights
Interactive control	Provide a recurring and frequent agenda for top management activities	.183
	Provide a recurring and frequent agenda for subordinate activities	.163
	Enable continual challenge and debate of underlying data, assumptions and action plans	.237
	Focus attention on strategic uncertainties	.298
	Encourage and facilitate dialog and information sharing with subordinates	.304
Boundary systems	Codes of conduct to define appropriate behavior	.287
	Guidelines that stipulate specific areas for, or limits on, opportunity search and experimentation	.239

(*continued on next page*)

Table A3 (*continued*)

Construct	Items	Weights
	Active communication of risks and activities to be avoided	.329
	Sanctions for engaging in risks and activities outside organizational guidelines	.309
Belief systems	Codification of values, purpose and direction in formal documents	.190
	Active communication of core values	.277
	Formal statements of values to create commitment for long-term visions	.359
	Formal statements of values to motivate and guide subordinates in searching for new opportunities	.336
Project agility	Methodology supported by the customer	.383
	Requirement change during the project	.387
	Procedural empowerment of project team	.377
Project environment	Top management support	.418
	Level of entrepreneurship	.426
	Level of risk-taking willingness	.377

Positive weights above 0.15 indicate good indicator reliability.

Table A4
Second-order hierarchical measurement model results

Second-Order Constructs	First-Order Constructs	Weights	Sig. (t-value)
Agility	Project agility	.651	26.603
(VIF < 2.78)	Project environment	.546	25.863

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