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Beyond buying bytes: Complementing agile new product development with an agile procurement process

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ABSTRACT

Agile methodologies are widely employed in new product development (NPD) projects characterized by high task interdependence and uncertainty, in both in-house and outsourcing contexts. In outsourcing scenarios, however, the benefits of an agile NPD process are often hindered when paired with traditional procurement processes due to misalignments with (1) the agile NPD process itself and (2) the contingencies of high task interdependence and uncertainty. To address these misalignments and enhance NPD goal attainment, this study set out to develop an agile procurement process. Employing a design science approach, the research incorporates insights from 23 interviews with experts in procurement, research and development (R&D), and suppliers, alongside a case study to implement, evaluate, and refine the proposed design. The proposed agile procurement process purposefully restructures procurement into two phases – a *pre-development phase* and a *during-development phase* with iterative cycles – which reduces costs, accelerates time-to-market, and improves quality. The results contribute to the literature by developing mid-range theory, elaborating on contingency theory and assessing its applicability to this problem, and applying agility in its original conceptualization to procurement and supply chain management.

1. Introduction

In his influential article "Why software is eating the world", Andreessen (2011) predicted that all industries – including traditionally hardware-focused sectors such as automotive, home appliances, and medical equipment – would increasingly compete based on software-feature innovation. Indeed, over the past decade, this digital transformation has profoundly reshaped how firms operate and develop new products, placing software at the core of many industries. The development of new software is often marked by high levels of task interdependence, where specifications evolve during development, and task uncertainty, where specifications are unclear at the outset (Cooper, 2021; Cooper & Sommer, 2016a). Under these conditions, traditional linear NPD processes, such as the waterfall model, have proven too rigid and ineffective. In response, agile methodologies have emerged as a more flexible alternative, offering the adaptability needed to navigate these complexities through dynamic, iterative, and responsive procedures. Although agile NPD processes are most commonly associated with software development, their application is not limited to this domain. When task interdependence and uncertainty are high, agile approaches are increasingly adopted for physical product development, particularly for products incorporating software-feature innovation (Bianchi et al., 2022; Cooper, 2019; Cooper & Sommer, 2016a, 2016b).

NPD projects often involve not only in-house research and development (R&D) but also external outsourcing and collaborative arrangements with suppliers. In such settings, the procurement function, which manages supplier relationships, plays a crucial role in the success of NPD projects (Cousins et al., 2011). As Luzzini et al. (2015) state, "[n]ot only external suppliers are an important cornerstone of the buying firm's innovation strategy, but also internal sourcing processes managed by the purchasing department are at stake" (p. 115). To maximize NPD project performance, it is critical to align the processes applied by procurement (the procurement process) with the development processes applied by suppliers (the NPD process) (Hammer, 2001; Patrucco & Kähkönen, 2021; Wynstra et al., 2003). However, traditional procurement processes, as described by Van Weele (2001), fail to align with agile NPD processes: While traditional procurement processes aim to select the best supplier for a predefined development scope through a linear process completed before development begins (Van Weele, 2001), agile NPD processes divide the development scope into short, iterative sprints that

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are planned and executed dynamically during development (Beck et al., 2001). These fundamental differences create inefficiencies, which could be mitigated by reformulating the procurement process to align with the agile NPD process.

Drawing on contingency theory, processes must be aligned not only with related processes but also with their contingencies – particularly task interdependence and task uncertainty – to maximize performance (Donaldson, 2001; Van Echtelt et al., 2008). For instance, prior research highlights that NPD performance improves when the NPD process is tailored to its contingencies (MacCormack & Verganti, 2003). However, there remains a lack of research on how the procurement process can be aligned with the contingencies of *high* task interdependence and *high* task uncertainty, which are commonly encountered in NPD projects (Bäckstrand et al., 2019) and thus, how the procurement process can evolve to address increasing levels of both in the future (Zheng et al., 2007).

Agility, as originally conceptualized in the seminal "Manifesto for Agile Software Development" (Beck et al., 2001) as a methodology and philosophy for managing software development projects, has received limited attention within the fields of procurement and supply chain management. Recent studies have primarily focused on supply chain agility (Centobelli et al., 2020; Müller et al., 2023; Zhang et al., 2023) and agility as a performance metric, measured by time-to-market and responsiveness (Narayanan et al., 2015). In contrast, agility in its original idea has been extensively studied in information systems research (Lee & Xia, 2010; Maruping & Matook, 2020; Ramasubbu & Bardhan, 2021) and within the broader context of innovation and NPD projects (Malik & Orr, 2022; Sarangee et al., 2022). However, connections to related processes, such as procurement, remain largely underexplored. To address this research gap, the objective of this study is to design an agile procurement process that aligns with (1) the agile NPD process and (2) the contingencies of high task interdependence and uncertainty, thereby improving the achievement of NPD goals compared to traditional procurement processes in such NPD projects. Studying the design of an agile procurement process is critical due to procurement's central role in the success of NPD projects (Wynstra et al., 2003). As the key interface between internal R&D and external suppliers, procurement and its processes directly influence the achievement of NPD goals.

By designing an agile procurement process, the following research question is addressed: *How can an agile procurement process for agilely developed new products be designed to achieve the NPD goals of low costs, short time-to-market, and high quality?* Emphasis is placed on the process perspective of agility, focusing on the inter-organizational collaboration between procurement, R&D, and suppliers in large NPD projects. A design science approach is particularly valuable for addressing this research question, as it aims to solve novel problems and reduce the research-practice gap (Stange et al., 2022). Accordingly, this approach is employed, drawing on 23 interviews with experts from consulting, academia, and industry, capturing the perspectives of procurement, R&D, and suppliers across different design phases, as well as a case study.

The paper is structured following guidelines for publishing design science research in procurement (Stange et al., 2022): It begins by setting the stage through a review of the problem and the solution space. Next, the methodology section outlines the research approach used. In the subsequent section ('Creative leap'), an initial solution is designed and then iteratively refined in the following section. The refined solution and its application are then assessed for efficacy and pragmatic validity, followed by a discussion of the contributions, limitations, and directions for future research. The paper concludes by summarizing the findings.

2. Problem review

This section discusses similar problems, the specific problem at hand, and the objectives of the solution (Stange et al., 2022). As highlighted above, NPD projects are often characterized by high task interdependence and uncertainty: Specifications of the product to be developed are unclear before development begins and frequently change during the development process (Cooper, 2019; Cooper & Sommer, 2016a). Processes related to NPD projects must align with these contingencies. The process directly linked to NPD projects is the NPD process itself, which can be adapted to these contingencies by making it agile (Beck et al., 2001; Cooper, 2019; Cooper & Sommer, 2016b). The key idea of the agile NPD process is to divide the development scope into sprints – iterative, short development cycles. At the beginning of each sprint, the specifications for the product to be developed during that sprint are defined. This short-term planning approach enables flexible changes, which are essential for managing high task interdependence and uncertainty, thereby enhancing customer value. Reviews conducted after each sprint allow for continuous performance and progress evaluation. The process aims to start development as quickly as possible and is executed by a self-organized, cross-functional team with a high level of responsibility (Beck et al., 2001; Cooper, 2021). Procurement plays a critical role in NPD projects when external value creation from suppliers is involved. Thus, the procurement process must align with both the agile NPD process (Beck et al., 2001; Cooper & Sommer, 2016a) and the contingencies of the NPD project.

First, the "traditional" procurement process described by Van Weele (2001) is misaligned with the agile NPD process. While the latter includes iterative short development cycles, the traditional procurement process is a linear process that needs to be finished before development starts. Further, specifications are defined and incorporated into detailed contract designs before development begins. In contrast, in the agile NPD process, specifications are defined at the start of each sprint. Discrepancies between sprint-specific specifications in the NPD process and pre-defined specifications in the procurement process necessitate change requests, for which suppliers charge substantial extra costs. This issue arises because the buying company is locked into a contract and, therefore, cannot replace the supplier during the project (Handfield et al., 1999; Schmitz et al., 2016; Wynstra et al., 2003). Additionally, while performance is reviewed after each sprint in the agile NPD process, performance reviews in the traditional procurement process typically occur only after the project is completed. Moreover, the agile NPD process is carried out by a cross-functional team, whereas the procurement process is solely managed by the procurement department. These discrepancies result in numerous points of friction between the agile NPD process and the traditional procurement process (cf. Table 1).

Second, the traditional procurement process is also misaligned with the contingencies of the NPD process. Because specifications are determined early, the traditional process cannot accommodate unclear specifications (task uncertainty) or adapt to changing specifications (task interdependence) during development. Table 1 lists the specific misalignment issues between the traditional procurement process, the agile NPD process, and the contingencies of high task interdependence and high task uncertainty.

These misalignments result in higher costs, longer time-to-market, and lower quality, as summarized in Table 1. Higher costs result from changing specifications during development (Cooper & Sommer, 2016a) and frictions between procurement, R&D, and the supplier (Petersen et al., 2005). Longer time-to-market occurs due to the need to identify the best supplier, negotiate, and finalize a detailed contract for the entire development scope before starting the NPD process, as well as delays caused by change requests during development (Cooper & Sommer, 2016a). Lower quality results from selecting a single supplier (Wynstra et al., 2003) who must have broad capabilities to be able to deliver the full development scope implement the late feedback provided (Cooper & Sommer, 2016a). Aligning the procurement process is essential to mitigate these inefficiencies and reduce costs, shorten time-to-market, and improve quality.

Table 1
Misalignment of the traditional procurement process with the agile NPD process and the NPD contingencies, and its negative effect on NPD goals.

Misalignment		NPD goals affected negatively
Traditional procurement process	Agile NPD process	
Linear process to be finished before agile NPD process starts	Iterative short development cycles during development	Time-to-market
Specifications are determined before development starts	Specifications are determined during development at the beginning of a sprint for the scope of this sprint	Cost, time-to-market, quality
Performance review after NPD project is finished	Performance reviews after each sprint for ongoing performance and progress evaluation	Quality
Procurement team	Cross-functional team	Cost
Traditional procurement process	**Contingency: High task uncertainty**	
Specifications are determined before development starts	Specifications can only be determined during development	Cost, time-to-market, quality
Traditional procurement process	**Contingency: High task interdependence**	
Specifications are determined before development starts	Specifications change during development	Cost, time-to-market, quality

3. Solution space review

The solution space review examines solutions to similar problems and identifies the gaps in these solutions for addressing the problem at hand (Stange et al., 2022). The review is divided into two categories: Solutions that inform the alignment of the procurement process with the agile NPD process, and solutions that inform the alignment of the procurement process with the contingencies of high task interdependence and uncertainty.

Regarding the former, prior literature highlights the general need to align related processes with one another (Flynn et al., 2010). For example, Dyer and Singh (1998) emphasized that the decision processes of buying companies and suppliers need to be aligned to maximize joint performance. Similarly, Fawcett and Magnan (2002) found that cross-functional process integration enhances customer satisfaction in supply chain initiatives. Wynstra et al. (2003) specifically highlighted the need to align the procurement process with the NPD process. While they directly address the misalignment of the processes in the focus of this research, they noted a limitation in their research: Their suggested approach required "some specific 'tailoring'" (Wynstra et al., 2003, p. 82) before implementation. This research aims to overcome this limitation by designing a procurement process that is fully aligned with the agile NPD process and is ready for implementation.

With regard to the latter, the notion that processes must align with their contingencies lies at the core of contingency theory. According to this theory, both organizational design and applied processes must match an organization's contingencies (Van Echtelt et al., 2008; vom Brocke et al., 2016). These contingencies include task interdependence, task uncertainty, and size (Donaldson, 2001). While size can be viewed as part of uncertainty, it is often excluded in more recent literature (Ward & Chapman, 2003), as it is in this research. To address the high levels of task interdependence and uncertainty present in NPD projects, the NPD process has transitioned to agility (Cooper, 2021). However, this transition has largely neglected the procurement process, which has remained a linear process. Given the critical role that the procurement process plays in achieving NPD goals (Sjoerdsma & van Weele, 2015), it is surprising that no procurement process has yet been designed that addresses these issues, while also being ready to implement.

4. Methodology

To develop an agile procurement process, we used a design science approach which is particularly suitable as it aims to "design and implement […] processes […] to achieve desired outcomes in practice" (Van Aken et al., 2016, p. 1). It is especially relevant for developing procurement processes to overcome performance inefficiencies in inter-organizational collaborations (Stange et al., 2022). Given that the goal of this research was to propose an agile procurement process that aligns with the agile NPD process and the contingencies of high task interdependence and uncertainty, and thereby better achieves the NPD goals – lower costs, shorter time-to-market, and higher quality – than to the traditional procurement process (Prat et al., 2015; Sjoerdsma & van Weele, 2015), conducting a design science approach was very appropriate.

The research procedure followed the six-step framework proposed by Peffers et al. (2007), organized into three design phases – solution incubation, solution refinement, and explanation – as shown in Fig. 1. The first design phase, *solution incubation*, serves to identify the problem, define the objectives of the solution, and design and develop an initial solution for implementation at a case company (Holmström et al., 2009). As suggested by Österle et al. (2011), semi-structured interviews were conducted during this phase to gather in-depth exploratory insights from experts familiar with the misalignment between traditional procurement processes, agile NPD processes, and the contingencies of high task interdependence and uncertainty. These interviews were designed to better understand the challenges faced by these experts. Potential interviewees were selected based on their experience in NPD projects that employed agile NPD processes and were characterized by high task interdependence and uncertainty, either from the procurement or supplier perspective. Additionally, participants were required to have been with their organizations for at least one year to ensure sufficient familiarity with relevant processes and challenges. Candidates were contacted via email and professional social networks, and, as an incentive for participation, they were offered an exclusive summary of the results upon the completion of data collection. Using the theoretical saturation criterion (Strauss & Corbin, 1998), data collection for the solution incubation phase was concluded after conducting 13 interviews (Table 2), as the final interview did not yield any new insights. Each interview lasted approximately 60 min on average.

The interview guidelines for the solution incubation phase consisted of three sections: (1) agile procurement in general, (2) challenges of using the traditional procurement process, and (3) use cases for agility. Questions in the first section included: "What does agility mean to you?" In the second section, regarding challenges of the traditional procurement process, the following questions were asked for each step of the process: "What are the main challenges in this step of the procurement process?" and "How do you think agile concepts could help address these issues?" The third section focused on use cases for agility, with questions such as: "Why and when should agile concepts and methods be implemented in the (software) procurement process?" and "Why and when should agile concepts and methods not be implemented in the (software) procurement process?" Synthesizing the results of these interviews led to the design of the initial agile procurement process.

The second design phase, *solution refinement*, aimed to further improve the proposed solution and confirm its effectiveness in addressing the identified problem and achieving the solution objectives (Holmström et al., 2009). First, as suggested by Österle et al. (2011), a case study was conducted to analyze the implementation of the solution, followed by a series of validation interviews in line with Van Aken et al. (2016). This two-step approach was adopted to gain an in-depth understanding of the process's applicability, goal achievement, and potential refinements by implementing it in a case company and interviewing involved stakeholders. Subsequently, external validity was

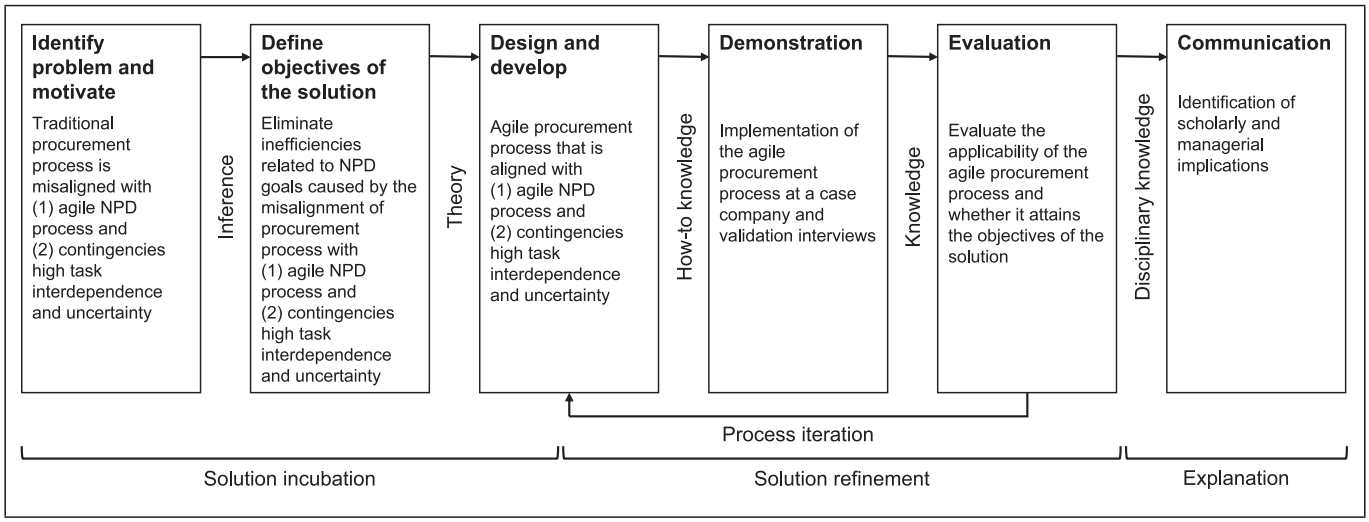

Fig. 1. Research procedure adapted from Holmström et al. (2009) and Peffers et al. (2007).
Note. NPD refers to new product development.

Table 2
Interviewees per design phase.

Design phase		Perspective	Number of companies	Number of interviewees
Solution incubation		Procurement	5	8
		Supplier	3	5
Solution refinement	Case study	Procurement	1	4
		R&D	1	4
	Validation interviews	Procurement	2	2
		Supplier	1	1

established by determining whether external experts also found the process applicable, capable of achieving the NPD goals, and if they had suggestions for further refinement.

In the case study, the initial solution was implemented at a German automotive company with an annual turnover of approximately €30 billion and a procurement spend of approximately €20 billion. The company's mature and well-developed procurement processes made it a suitable candidate for implementation. The selected NPD project involved the development of custom software and was chosen because agile NPD processes are widely used in software development, and because this project was characterized by high task interdependence and uncertainty. High task interdependence arose from multiple departments within the company sharing responsibility for interlinked submodules. Task uncertainty was high due to the long development timeframe of three to five years and the rapid technological advancements during this period, which made it impossible to define product specifications fully in advance. These contingencies suggest the use of an agile NPD process rather than a waterfall approach, making the project an ideal candidate for complementing the agile NPD process with an agile procurement process. Further details about this NPD project are provided in Appendix A.

After implementation, eight semi-structured interviews were conducted with procurement and R&D practitioners from the case company (Table 2) to evaluate the applicability of the agile procurement process, determine whether it achieved NPD goals more effectively than the traditional procurement process, and suggest refinements. R&D practitioners were included because they are deeply involved in the overall NPD project, of which the supplier's custom software development project was a subproject. Their insights were particularly valuable for assessing alignment with the project's contingencies. The interviews were conducted six months after the initial implementation of the agile procurement process, while development was still ongoing. After conducting eight interviews, each lasting approximately 60 min, theoretical saturation was reached (Strauss & Corbin, 1998).

The interview guideline for the solution refinement phase was structured around the steps of the initial agile procurement process. For each process step, questions such as "What went well in [insert process step]?" and "How could [insert process step] be further improved?" were asked. Additional questions focused on the applicability and achievement of the solution objectives: "Were there any problems with the applicability of the process?" and "Does the application of this process reduce costs, reduce time-to-market, or increase quality?" In addition to a qualitative assessment of whether the agile procurement process achieved the solution objectives, changes in *costs* and *time-to-market* were quantitatively assessed. Therefore, the project that used the agile procurement process was benchmarked against similar custom software development projects that used the traditional procurement process. However, exact assessments were not feasible because a perfect benchmark was unavailable: The same custom software development project cannot be procured a second time using a traditional procurement process without learning effects by the supplier and R&D teams skewing the results. *Quality* was intentionally excluded from benchmarking because it is highly sensitive to variations in development scope and project complexity, making comparisons with similar projects unreliable. Therefore, quality improvements were assessed only qualitatively.

Due to the minimal process refinements proposed by interviewees from the case company and the long development timeframe (three to five years), further implementations were not conducted. Instead, validation interviews (Table 2) were used to assess the applicability and goal attainment of the refined process. According to Van Aken et al. (2016, p. 7), validation interviews "can be very informative and lead to better and more relevant management implications" than additional implementations. Potential interviewees for the validation phase included consulting and industry experts who met the same criteria as those in the solution incubation phase. They were contacted via email and professional social networks. During the validation interviews, the refined solution was demonstrated and explained to the interviewees, who were then asked to evaluate the applicability of the process, assess whether it would achieve NPD goals more effectively than the traditional procurement process, and propose further refinements. After each interview, the solution was refined. The iteration of validation interviews and refinements ended when theoretical saturation was reached, and no further design improvements were suggested (Strauss & Corbin, 1998; Van Aken et al., 2016). This point was reached after three validation

interviews, as shown in Table 2. The interview guideline used with the case company was slightly adapted for the validation interviews, but the overall structure remained the same. For instance, instead of asking, "Were there any problems with the applicability of the process?" the question was reframed as, "Do you have any concerns regarding the applicability of the process?"

In the final step of the solution refinement phase, the refined solution was presented to the eight interviewees from the case company who had assessed the implementation of the initial solution. They were asked for a final evaluation of its applicability and whether it would achieve NPD goals more effectively than the initial implemented solution, thereby confirming its improvement.

The final design phase, *explanation*, focusses on outlining the implications of this research for both scholars and practitioners. These implications are discussed in the contributions section.

5. Creative leap

The purpose of the creative leap is to propose an initial design of the agile procurement process, developed during the *solution incubation* phase (Stange et al., 2022). The initial solution, illustrated in Fig. 2, consists of two distinctive phases, the (1) *pre-development phase* and the (2) *during development phase*. The objective of the (1) *pre-development phase* is to quickly establish a pool of potential suppliers for the NPD project, enabling the product development to start promptly. In the (2) *during development phase*, short development iterations are planned, executed, and reviewed. Note that, since the (2.3) *development* step consists of a set of agile NPD sprints, the during development phase includes fewer iterations than the NPD process itself. The agile procurement process involves procurement and R&D of the buying company as well as the supplier.

The first step of the (1) *pre-development phase* is (1.1) *product portfolio definition and supply analysis*. A cross-functional internal team, comprising procurement and R&D, defines the product portfolio by describing its broad functionalities. Concurrently, procurement conducts a supply market analysis to identify potential suppliers capable of developing the required functionalities. In the next step, procurement (1.2) *prepares and runs tender and negotiations* based on the product portfolio defined in the previous step. Suppliers are invited to participate in a hackathon designed to evaluate their performance and standardize task complexity. To foster competition and rigorously assess supplier capabilities, the hackathon is intentionally designed so that the actual task complexity exceeds the standardized complexity within the given time. This ensures that no supplier can fully complete the task, allowing R&D to evaluate supplier performance using two performance indicators: Efficiency and quality. Evaluations are conducted using a standardized assessment sheet prepared jointly by procurement and R&D. By informing the suppliers about the actual complexity of the task, every supplier has the same understanding of task complexity and thus complexity is standardized. If a supplier's hackathon performance meets expectations, procurement negotiates a frame contract with that supplier. This contract is independent of specific product specifications and includes provisions for a price per standardized complexity and some minimal demand commitments, providing suppliers with a degree of planning certainty. Supplier capacities can be drawn from this contract later in the development phase. The final step of this phase is (1.3) *nomination and contracting*. Procurement nominates suppliers based on efficiency and quality as evaluated in the hackathon, and the negotiated price per complexity. Ideally, multiple suppliers with diverse capabilities are nominated to maintain healthy competition during development. Suppliers may be categorized into different pools based on specific criteria, such as the deviation of the negotiated price per complexity from the target price per complexity. Additional approval procedures may be required when selecting suppliers from higher-cost pools. Framework contracts are then signed with the nominated supplier(s), formalizing the previously negotiated terms.

The first step of the (2) *during development phase* is to (2.1) *determine specifications and demand* for a set of sprints in the NPD process. R&D defines the specifications for the product components to be developed in the upcoming set of development sprints. The complexity of the associated tasks is assessed, and criteria for functionality and quality are established to evaluate whether specifications have been met upon completion. Finally, the demand for supplier capabilities needed for the upcoming development sprints is determined. In the next step, (2.2) *supplier selection and ordering*, R&D analyzes the capabilities of the supplier(s) in the supplier pool(s) and selects one or more supplier(s) best suited to meet the specifications for the upcoming sprints at the lowest cost. If a selected supplier belongs to a higher-cost pool, additional approval procedures may be required. Procurement then orders the set of development sprints by calling up the required capacity from the frame contract based on the complexity of the sprints. Next, (2.3) *development* sprints are executed. R&D and the supplier(s) determine the scope of each development sprint, the supplier(s) develop(s) the determined scope, and R&D and the supplier(s) review performance and progress after each development sprint. Procurement is involved only in the event of critical organizational issues that require immediate resolution to avoid jeopardizing sprint success. The final step of the during-development phase is the (2.4) *development review* for a set of development sprints. R&D and the supplier(s) assess whether the fulfillment criteria established in step (2.1) have been met. If the defined

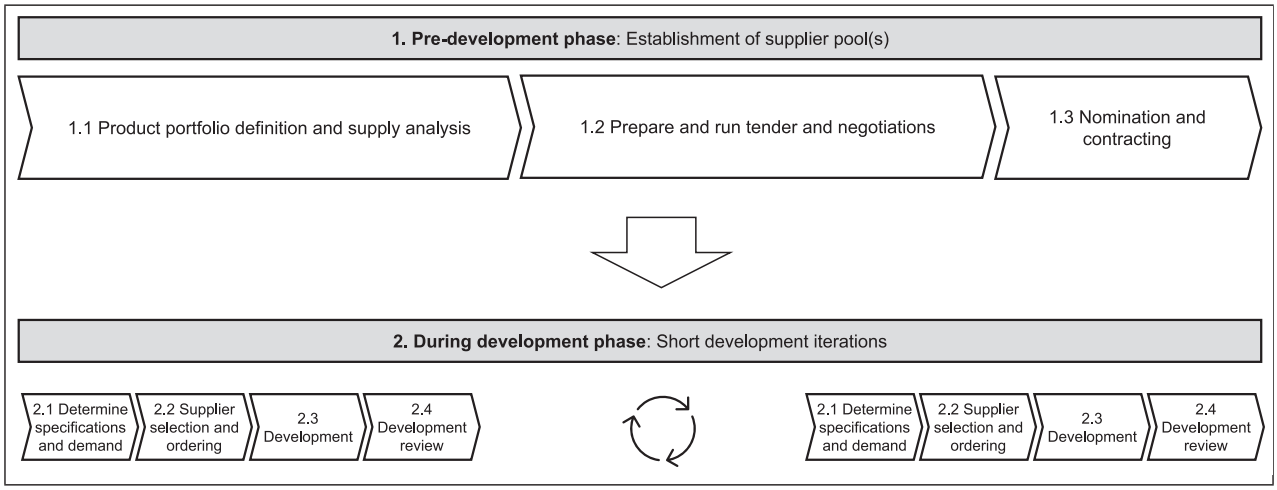

Fig. 2. Initial design of the agile procurement process.

functionality and quality criteria are achieved, the supplier(s) is(are) remunerated based on the complexity of the demanded tasks. If the criteria are not met, remuneration is adjusted based on the delivered complexity. Additionally, the reasons for non-fulfillment and potential improvement options are discussed collaboratively by procurement, R&D, and the supplier(s). If a supplier repeatedly fails to meet criteria without providing acceptable justification, procurement may exclude that supplier from the pool.

6. Application

This section focuses on the *solution refinement* design phase, where the initial agile procurement process is enhanced (Stange et al., 2022). It assesses the implementation of the initial solution at the case company in terms of applicability and achievement of the solution objectives. Finally, refinements to the initial solution are described.

First, the implementation of the initial agile procurement process at the case company showed that the process is applicable. Second, the subsequent interviews provided qualitative empirical evidence that the agile procurement process achieves the NPD goals of lower costs, shorter time-to-market, and higher quality more effectively than the traditional procurement process. Benchmarking against similar NPD projects conducted using the traditional procurement process supports these findings, as shown in Table 3. In terms of *costs*, the proposed agile procurement process achieved cost savings of 34 % against the initial offer, compared to an average of 27 % for traditional procurement processes applied to agilely developed products characterized by high task interdependence and uncertainty. This represents a 26 % improvement in costs. In terms of *time-to-market*, the *(1) pre-development phase* of the agile procurement process had a cycle time of 12 weeks, compared to 16 weeks for the traditional procurement process at the case company. This constitutes a 25 % reduction in time-to-market. While the impact of the agile procurement process on product *quality* could not be quantitatively supported, the qualitative feedback from the respondents aligns with findings from prior research (Cooper & Sommer, 2016a; Haeufler et al., 2021):

- The possibility of nominating multiple suppliers for development allows individual development sprints to be assigned to suppliers with specialized capabilities.
- The definition of specifications later in the development process leads to higher-quality specifications.
- Frequent feedback loops allow the cross-functional team to quickly address quality issues, such as assigning additional suppliers to subsequent sets of sprints.

The validation interviewees raised no concerns regarding the applicability of the agile procurement process or its ability to achieve NPD goals more effectively than the traditional process. However, despite the notable improvements achieved, interviewees from the case company and the validation interviews suggested a few minor refinements to the initial solution, summarized in Table 4.

The first refinement in the (1) *pre-development phase* involves establishing supplier pool(s) across similar NPD projects. This approach fosters long-term relationships when quality, efficiency, and price are satisfactory. Moreover, if (a) supplier pool(s) is(are) already established when a new project begins, only the product portfolio definition step is required before development, which further reduces time-to-market.

In the process step (1.2) *prepare and run tender and negotiations*, one interviewee highlighted the importance of ensuring that the product portfolio described in the tender is not overly specific, which would contradict the agile NPD process, where specifications are iteratively defined during development. Another interviewee suggested that the buying company could account for learning effects based on the called-up capacity to enhance efficiency during development. To achieve this, different prices could be negotiated depending on the called-up capacity, starting with a higher price per complexity that decreases as capacity increases. Lastly, an interviewee from the case company proposed standardizing complexity across similar NPD projects to enhance comparability and ensure consistency.

For the (1.3) *nomination and contracting* process step, it was proposed to assign suppliers to pools based on the negotiated price per complexity compared to the average *negotiated* price per complexity instead of the *target* price per complexity to create supplier pools of similar sizes. The implementation showed that assigning suppliers based on the target price per complexity resulted in most suppliers being categorized into expensive pools, necessitating additional approval procedures for most orders and increasing time-to-market. Another interviewee suggested incorporating not only price but also quality and efficiency into the description of suppliers in the pools. Suppliers delivering higher quality or operating more efficiently can justifiably charge higher prices, and

Table 3
Improvements in costs and time-to-market of the agile procurement process at the case company.

New product development goal	Agile procurement process	Traditional procurement process	Improvement
Costs (savings against initial offer)	34 %	27 %	26 %
Time-to-market	12 weeks	16 weeks	25 %

Note. Quality is assessed only qualitatively due to the lack of an appropriate benchmark.

Table 4
Refinements to the initial design of the agile procurement process.

Process step	Refinement	Source
1. Pre-development phase	Establish supplier pool(s) across similar NPD projects	Case study
1.1 Product portfolio definition and supply analysis	–	–
1.2 Prepare and run tender and negotiations	• Reduce specificity of tender	• Case study
	• Account for learning effects	• Validation interview
	• Standardization of complexity across similar NPDs	• Case study
1.3 Nomination and contracting	• Assignment to supplier pools based on average prices, not target prices	• Case study
	• Supplier pool(s) provide(s) information on quality and speed in addition to price	• Case study
	• Suppliers can be assigned to different supplier pools based on different contract conditions	• Case study
	• Non-disclosure agreements between suppliers in supplier pool(s)	• Validation interview
2. During development phase	–	–
2.1 Determine specifications and demand	Include procurement	Case study
2.2 Supplier selection and ordering	Include procurement	Case study
2.3 Development	–	–
2.4 Development review	Include procurement	Case study

this additional information can support selecting more expensive suppliers when quality or efficiency is critical. This interviewee further suggested that one supplier can be assigned to different supplier pools based on different contract conditions. For instance, a supplier could handle tasks on short notice at a higher price or with more advanced notice at a lower price. Lastly, the importance of non-disclosure agreements between suppliers within pools was highlighted to facilitate easier information sharing among collaborating suppliers.

In the (2) *during development phase*, stronger integration of procurement was suggested. Procurement should be involved in the (2.1) *determination of specifications and demand* to monitor the costs associated with including specifications and challenge their value relative to cost. Additionally, procurement should participate in (2.2) *supplier selection and ordering* to ensure cost-optimal suppliers are chosen and spare capacities are utilized effectively. Finally, procurement should contribute to the (2.4) *development review* to compare performance across projects and assist R&D and the supplier in the commercial assessment of the developed scope, especially if fulfillment criteria are unmet. These minor refinements further enhance the agile procurement process and support the achievement of NPD goals.

7. Assessment

7.1. Efficacy

The efficacy of the designed solution in achieving the stated objectives is explained by its underlying mechanisms (Van Aken et al., 2016). Specifically, the agile procurement process outperforms the traditional procurement process in achieving the NPD goals of low costs, short time-to-market, and high quality by leveraging three mechanisms – the *costs mechanism*, *time-to-market mechanism*, and *quality mechanism* – as summarized in Table 5.

Costs are reduced through the integration of a cross-functional team, as cross-functionality enhances the effectiveness of decision-making (Petersen et al., 2005). This is particularly impactful in contexts with high task interdependence and uncertainty, where involving multiple functions enables a more holistic evaluation of uncertainties and a deeper understanding of interdependencies, resulting in cost savings. Additionally, costs are reduced by accommodating changing specifications. In NPD projects, specifications are often undefined at the outset and evolve during development. Under the traditional procurement process, specifications are fixed before development begins, and a single supplier is contracted for the entire scope. This rigidity allows suppliers to impose substantial costs for change requests during development, as the buying company is bound by the contract and cannot switch suppliers. The agile procurement process addresses this issue by defining only broad functionalities and negotiating frame contract conditions upfront, leaving exact specifications to be finalized iteratively during development. This flexibility eliminates the cost premiums associated with change requests. However, achieving this cost reduction depends on standardizing complexity prior to the development phase, ensuring consistent benchmarks for evaluating and managing tasks.

The reduction in *time-to-market* is driven by dividing the procurement process into two distinct phases: The *pre-development phase* and the *during development phase*. Since only the pre-development phase must be completed before development begins – unlike the traditional procurement process, which requires the entire process to be finalized upfront – time-to-market is significantly shortened. It is further reduced by focusing on a fundamental level of detail in broad product portfolio description prior to the start of development. In the traditional procurement process, demand and supply must be thoroughly analyzed, the ideal supplier must be identified, and a comprehensive contract covering the entire development scope must be negotiated and finalized before development can commence. Given the high task interdependence and uncertainty inherent in NPD projects, this traditional approach is time-intensive and clunky. Also, less task interdependence and uncertainty must be considered when negotiating the contract conditions for a frame contract. During development, the short planning horizons reduce both uncertainty and the number of interdependencies that need to be considered when determining specifications, demand, and suppliers. This, in turn, reduces the time required for decision-making. Moreover, the time typically spent on managing change requests during development is eliminated, as only fundamental details are fixed upfront, and these foundational elements remain unchanged throughout the development process.

Higher *quality* is achieved by accommodating changing specifications, which helps to effectively address and manage the high task interdependence and uncertainty present at the outset of NPD projects. By initially defining only a product portfolio with broad functionalities, the process allows for exact specifications to be determined during development with greater precision and quality. Furthermore, the agile procurement process facilitates the selection of the most suitable supplier for the specific requirements of each development sprint, rather than relying on a supplier chosen based on pre-defined specifications established before development begins. This adaptability ensures that supplier capabilities are optimally matched to the evolving needs of the project. Additionally, the process introduces opportunities to exchange suppliers between sprints, allowing the selection of a supplier whose capabilities best align with the requirements of each sprint. This approach is significantly more effective than depending on a single supplier with generalized capabilities to oversee the entire development scope. Finally, integrating frequent performance reviews increases transparency on supplier performance and development progress. This allows for early feedback and supplier exchanges, when necessary, which further increases quality (Haeufler et al., 2021).

The objective of this research was to design an agile procurement process that aligns with both the agile NPD process and the contingencies of high task interdependence and uncertainty, thereby

Table 5
Drivers of the costs mechanism, the time-to-market mechanism, and the quality mechanism.

Process step	Costs mechanism	Time-to-market mechanism	Quality mechanism
1. Pre-development phase	Cross-functional team	Split into two phases	–
1.1 Product portfolio definition and supply analysis	Support of changing specifications	Fundamental level of details	Support of changing specifications
1.2 Prepare and run tender and negotiations	Support of changing specifications	Fundamental level of details	–
1.3 Nomination and contracting	–	–	–
2. During development phase	Cross-functional team	Split into two phases	–
2.1 Determine specifications and demand	Support of changing specifications	Short planning horizon	Support of changing specifications
2.2 Supplier selection and ordering	Support of changing specifications	Short planning horizon	• Support of changing specifications • Selection of the best supplier for each development sprint
2.3 Development	–	–	–
2.4 Development review	–	–	Frequent performance reviews

enhancing the attainment of NPD goals. The Context-Intervention-Mechanism-Outcome (CIMO) logic provides a framework to state the relationship between objectives and mechanisms: "In this class of problematic Contexts, use this Intervention type [design] to invoke these generative Mechanism(s), to deliver these Outcome(s)" (Denyer et al., 2008, pp. 395–396). Applying this framework to the present research yields the following: When a new product is developed by external suppliers employing an agile NPD process and the project is characterized by high task interdependence and uncertainty (Context), implement the agile procurement process that aligns with both the NPD process and these contingencies (Intervention) to activate the costs, time-to-market, and quality mechanisms (Mechanisms). These mechanisms enable the agile procurement process to achieve the NPD goals of lower costs, shorter time-to-market, and higher quality more effectively than the traditional procurement process (Outcomes). Thus, these mechanisms establish a clear link between improved NPD outcomes and the designed agile procurement process, specifically through the created alignment (Table 6).

7.2. Pragmatic validity

Pragmatic validity is evaluated by addressing the question: "How strong is the evidence that the design will produce the desired result?" (Van Aken et al., 2016, p. 1), which is answered by comparing the proposed design with the existing alternative (Prat et al., 2015). To provide empirical evidence that the designed agile procurement process outperforms the traditional procurement process for NPD projects characterized by high task interdependence and uncertainty, the agile procurement process was implemented in a case company. Post-implementation feedback from the case company's interviewees coupled with benchmarking against similar NPD projects demonstrates that the agile process surpasses the traditional process in terms of cost efficiency, time-to-market, and quality. Additionally, experts from other companies and industries confirmed the process's positive impact on NPD goals after being presented with an explanation of the agile procurement process, thereby establishing external validity. The rationale behind these improvements is explained through the costs, time-to-market, and quality mechanisms.

The minor adaptations to the initial solution, that were suggested by the interviewees, have been incorporated into the refined solution to further enhance the process design and its effectiveness in achieving NPD goals. To confirm that the refined agile procurement process is better than the initial agile procurement process, the refined process was presented to the interviewees from the case company. They unanimously agreed that the refined process better addresses the NPD goals than the initial design. Altogether, this robust evidence provides a compelling case that the designed agile procurement process effectively eliminates the inefficiencies associated with NPD goals that arise from the misalignments inherent in the traditional procurement process.

8. Discussion

8.1. Contributions and implications

This research offers several significant scholarly contributions. Mid-range theory is developed by "the design proposition, with its action/outcome relation and explanatory mechanisms […] with its specified application domain" (Van Aken et al., 2016, p. 4). Specifically, the designed agile procurement process improves NPD outcomes – reducing costs, accelerating time-to-market, and enhancing quality – through the explanation of the costs, time-to-market, and quality mechanisms. These mechanisms are particularly effective in NPD projects characterized by high task interdependence and uncertainty and utilizing an agile NPD process. By addressing these complexities, this research generates novel mid-range theory consistent with the framework outlined by Van Aken et al. (2016).

This research also makes a contribution to the literature by underscoring the importance of aligning the procurement process with related processes, particularly the NPD process. While prior studies have emphasized the need to align internal processes with external suppliers (Patrucco & Kähkönen, 2021), they often present only "rather generic" approaches to integrating procurement into NPD projects, leaving "some specific 'tailoring'" (Wynstra et al., 2003, p. 82) necessary for effective implementation. This study addresses this limitation by proposing a concrete methodology for aligning the procurement process specifically with the agile NPD process.

This research further contributes to the field by emphasizing the critical need to align the procurement process with its contingencies. The findings elaborate theory (Ketokivi & Choi, 2014), specifically contingency theory, by assessing this theory's applicability and effectiveness in addressing the specific problem context (Oliva, 2019). In situations where the traditional procurement process is misaligned with the contingencies of high task interdependence and uncertainty, performance is constrained. However, when the proposed agile procurement process – which is specifically designed to align with these contingencies – is implemented, performance improves. As Oliva highlights, such "contrasting evidence from interventions [designs] with documented statements from the theory renders a [theoretical] contribution unambiguous" (Oliva, 2019, p. 714).

This research also contributes to the discussion on agility in procurement and supply chain management by emphasizing the critical role of procurement within the original context of agility, which is NPD, and particularly in software development. When an NPD project is outsourced to a supplier, procurement is pivotal in managing this external value creation. However, using a traditional procurement process undermines the benefits of employing an agile NPD process, diminishing its

Table 6
Mechanisms underlying the alignment of the agile procurement process with the agile NPD process and NPD contingencies, leading to NPD goal improvement.

Alignment		Mechanisms affecting NPD goals positively
Agile procurement process	Agile NPD process	
Split into two phases, only pre-development phase needs to be finished before the agile NPD process starts	Iterative short development cycles during development	Time-to-market mechanism
Specifications are determined in the during development phase for a set of sprints in the NPD process	Specifications are determined during development at the beginning of a sprint for the scope of this sprint	Costs mechanism, time-to-market mechanism, quality mechanism
Performance review after a set of sprints in the agile NPD process	Performance reviews after each sprint for ongoing performance and progress evaluation	Quality mechanism
Cross-functional team	Cross-functional team	Costs mechanism
Agile procurement process	**Contingency: High task uncertainty**	
Specifications are determined in the during development phase	Specifications can only be determined during development	Costs mechanism, time-to-market mechanism, quality mechanism
Agile procurement process	**Contingency: High task interdependence**	
Specifications are determined in the during development phase	Specifications change during development	Costs mechanism, time-to-market mechanism, quality mechanism

advantages compared to a linear waterfall approach. This study demonstrates that fully realizing the potential of agility requires an agile procurement process that complements the agile NPD process. By designing such a process, this research effectively integrates the original concept of agility into the domains of procurement and supply chain management.

Finally, this study complements the existing body of research on procurement processes. It demonstrates that a procurement process achieves its objectives most effectively when it is aligned with related processes and tailored to match its contingencies. Consequently, a "one size fits all" procurement approach can hinder performance, as a standard process cannot simultaneously address the unique contingencies of all procured products while aligning with all related processes.

In addition to these scholarly contributions, this research provides relevant managerial insights. First, misalignments between the procurement process, related processes, and contingencies can adversely affect goal attainment. Specifically, using a traditional procurement process alongside an agile NPD process in contexts characterized by high task interdependence and uncertainty leads to inefficiencies in costs, time-to-market, and quality.

The developed agile procurement process addresses these inefficiencies, enabling better achievement of NPD goals within the given context compared to the traditional approach. While the agile procurement process incorporates elements of the traditional process, its primary distinctions lie in its division into two phases – the *pre-development phase* and the *during-development phase* – and the iterative nature of the latter.

Three mechanisms driving improved goal achievement were identified. *Costs* are reduced by incorporating a cross-functional team and accommodating changes in specifications. *Time-to-market* is shortened by fixing only broad details prior to development and finalizing specific details iteratively during short planning horizons. *Quality* is enhanced by supporting specification changes, selecting the most suitable supplier for each development sprint, and conducting frequent performance reviews. Selected drivers of these mechanisms could also be implemented in other processes with similar contingencies.

8.2. Limitations and research directions

The results presented above should be interpreted in light of several limitations. First, agility is a multifaceted concept that encompasses not only processes but also critical elements such as the mindset of employees and the nature of collaboration (Beck et al., 2001). However, this study focuses exclusively on the processual dimensions of agility. Achieving a holistic implementation of agility will require addressing these additional factors.

Second, this research does not include a quantitative measurement of the quality improvements resulting from the agile procurement process compared to the traditional approach used in the case study. While cost and time-to-market were benchmarked against similar custom NPD projects employing a traditional procurement process, in addition to the qualitative assessment by the interviewees, quality was not quantitatively assessed. This decision stems from the inherent sensitivity of quality metrics in NPD projects to variations in development scope and project complexity, which renders comparisons across projects with differing scopes and complexities unreliable. In the absence of a robust counterfactual or benchmark, and to avoid inaccurate conclusions, quantitative assessments of quality improvement were excluded. Nevertheless, all interviewees – both from the case company and the validation interviews – unanimously anticipated a positive impact of the agile process on quality. This consistent feedback reinforces the assumption that the positive effect on quality is robust. Accurately quantifying cost and time-to-market improvements also posed challenges because the benchmarks involved comparable but not identical NPD projects. Direct comparisons of identical projects were infeasible, as executing and procuring the same project multiple times would introduce learning effects that could distort the results. However, by triangulating the quantitative findings with unanimous qualitative assessments from both case study and validation interviewees regarding the positive impact of the agile process on cost and time-to-market, the findings are considered robust and reliable.

Future research could extend the findings of this study by exploring several promising areas. First, the impact of implementing an agile procurement process, as opposed to a traditional procurement approach, on other procurement goals such as innovativeness warrants further investigation. Second, future studies could examine whether the agile procurement process enhances key buyer-supplier relationship variables, such as trust and commitment, providing insights into additional advantages of adopting this approach. Third, the impact of single drivers of the mechanisms underlying the agile procurement process could be examined. For instance, studies could assess whether specific drivers, such as short planning horizons, can be integrated into other procurement processes to increase efficiency and address contingencies involving high task interdependence and uncertainty. Lastly, future research could investigate the applicability of the agile procurement process beyond pure outsourcing contexts. Specifically, it would be worthwhile to examine whether this process is advantageous in *joint* NPD projects conducted in collaboration with suppliers (Ma & Ozer, 2024).

9. Conclusion

Traditional procurement processes, as described by Van Weele (2001), are based on a linear workflow designed to promote efficiency in stable environments by providing a straightforward progression from start to finish. However, this linear structure can lead to inefficiencies when misaligned with related processes and the demands of specific contingencies. This is particularly problematic in the context of NPD projects, which are often characterized by high task interdependence and uncertainty and therefore better suited to agile approaches. To address this issue, the present study employed a design science approach to develop an agile procurement process tailored to the challenges of high task interdependence and uncertainty. Following its initial implementation, the solution was refined based on case company interviews and validation interviews with experts from other organizations and industries. The refined solution was subsequently presented to the case company interviewees, who confirmed that the refinements represented meaningful improvements over the initial design. To explain why the agile procurement process outperforms the traditional process in achieving NPD goals, three underlying mechanisms are introduced: The *costs* mechanism, the *time-to-market* mechanism, and the *quality* mechanism. Despite the limitations highlighted above, the outcome successfully addresses the identified problem and makes a relevant contribution to bridging the gap between academic theory and practical application (Stange et al., 2022).

CRediT authorship contribution statement

Ruth Schültken: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Steffen Kokozinski:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Christoph Bode:** Validation, Supervision, Project administration, Conceptualization.

Appendix A. New product development project at the case company

Table A.1
Characteristics of the new product development project at the case company.

Characteristic	New product development project
Development time	3–5 years
Interdependencies with other modules	> 30 other modules
Expected costs	> 150 Mio. €
Share of certain software specifications before development	Approximately 20 %
Number of participating suppliers	19
Number of participating developers	Approximately 160

Data availability

The data that has been used is confidential.

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