Vol. 10 | No. 2 | 2022

International Journal of Information Systems and Project Management

ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X

Available online at ijispm.sciencesphere.org

IJISPM

UMinho Editora

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Mission

The mission of the IJISPM - International Journal of Information Systems and Project Management - is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

The IJISPM publishes leading scholarly and practical research articles that aim to advance the information systems management and project management fields of knowledge, featuring state-of-the-art research, theories, approaches, methodologies, techniques, and applications.

The journal serves academics, practitioners, chief information officers, project managers, consultants, and senior executives of organizations, establishing an effective communication channel between them.

Description

The IJISPM offers wide-ranging and comprehensive coverage of all aspects of information systems management and project management, seeking contributions that build on established lines of work, as well as on new research streams. Particularly pursuing multidisciplinary and interdisciplinary perspectives, and focusing on currently emerging issues, the journal welcomes both pure and applied research that impacts theory and practice.

The journal content provides relevant information to researchers, practitioners, and organizations, and includes original qualitative or qualitative articles, as well as purely conceptual or theoretical articles. Due to the integrative and interdisciplinary nature of information systems and project management, the journal may publish articles from a number of other disciplines, including strategic management, psychology, organizational behavior, sociology, economics, among others. Articles are selected for publication based on their relevance, rigor, clarity, novelty, and contribution to further development and research.

Authors are encouraged to submit articles on information technology governance, information systems planning, information systems design and implementation, information technology outsourcing, project environment, project management life-cycle, project management knowledge areas, criteria and factors for success, social aspects, chief information officer role, chief information officer skills, project manager role, project manager skills, among others.

Topics covered

The journal offers comprehensive coverage of information systems management and project management.

The topics include, but are not limited to:

- information technology governance
- information systems planning
- information systems design and implementation
- information technology outsourcing
- enterprise architecture
- information systems governance
- information systems department
- chief information officer role
- information technology leadership role
- chief information officer skills
- information systems management tools
- management of complex projects
- audits
- innovation
- ethics
- project environment
- project management life-cycle
- project initiation
- project planning
- project execution
- project control and monitoring
- project closing
- success criteria and success factors
- project manager role
- project manager skills
- portfolio management
- program management
- managing organization - structure
- tools and techniques
- project evaluation
- project management knowledge areas
- scope management
- time management
- cost management
- quality management
- procurement management
- risk management
- communication management
- human resources management
- performance teams
- social aspects
- conflict management
- managing organization - responsibilities
- project management office
- contracts

Special issues devoted to important specific topics will be evaluated for publication.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Submissions

Researchers and practitioners are encouraged to submit their manuscripts to the IJISPM. The guidelines for submission can be found at the journal's home page: ijispm.sciencesphere.org

Correspondence and questions

All correspondence and questions should be directed to João Varajão (Editor-in-Chief). E-mail: editor.ijispm@sciencesphere.org

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Table of contents

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

IJISPM

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Editorial

The mission of the *IJISPM* **-** *International Journal of Information Systems and Project Management* is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

It is our great pleasure to bring you the second number of the tenth volume of IJISPM. In this issue, readers will find important contributions on agile projects, portfolio management, hybrid project management, and IS development risks.

The first article, “Tensions and ambidexterity: a case study of an agile project at a government agency”, is authored by Carin Lindskog. According to the author, today’s dynamic business environment must continuously adapt its software development methods to changing technologies and new requirements on the part of customers. Therefore, agile methods are being used more and more because they emphasize both flexibility and the ability to change. However, at the same time, the business-driven need for predictability and control remains. The purpose of this case study is to explore and theorize on paradoxical tensions and ambidexterity during an agile software development project at a government agency. The study empirically examines how tensions and the ambidextrous responses to these tensions are related to agile values. Data was collected by conducting interviews and studying internal project documents. Four categories of tensions (learning, organizing, performing, and belonging) were used for analytical purposes. The findings suggest that most of the tensions perceived were in the categories of learning and performing. There are, furthermore, several connections between the ambidextrous responses to these tensions and agile principles. A deeper understanding of agile values and principles is required in order to make projects successful. The contribution made by the study, therefore, is of great importance because agile methods are for leading projects, not only in agile software development but also in other industries and sectors.

The title of the second article is “Can product modularization approaches help address challenges in technical project portfolio management? – Laying the foundations for a methodology transfer”, which is authored by Thorsten Lammers, Matthias Guertler, and Henning Skirde. Formalized Project Portfolio Management (PPM) models struggle to provide comprehensive solutions to project selection, resource allocation and adaptability to dynamic technology project environments. In this article, the authors introduce a vision for a novel Modular Project Portfolio Management (MPPM) approach by drawing on well-established engineering methods for designing modular product architectures. The authors show how systems theory can be used to enable a transfer of methods from the area of engineering design and manufacturing to the area of PPM and how the concept of product modularity could help address the challenges of existing PPM approaches. This lays the groundwork for the possible development of MPPM as a new and innovative methodology for managing complex technology and engineering project landscapes.

The third article, authored by Janine Reiff and Dennis Schlegel, is entitled “Hybrid project management – a systematic literature review”. Hybrid project management is an approach that combines traditional and agile project management techniques. The goal is to benefit from the strengths of each approach, and, at the same time avoid the weaknesses. However, due to the variety of hybrid methodologies that have been presented in the meantime, it is not easy to understand the differences or similarities of the methodologies, as well as the advantages or disadvantages of the hybrid approach in general. Additionally, there is only fragmented knowledge about prerequisites and success factors for successfully implementing hybrid project management in organizations. Hence, the aim of this study is to provide a structured overview of the current state of research regarding the topic. To address this aim, the authors have conducted a systematic literature review focusing on a set of specific research questions. As a result, four different hybrid methodologies are discussed, as well as the definition, benefits, challenges, suitability, and prerequisites of hybrid project management. The study contributes to knowledge by synthesizing and structuring prior work in this growing area of research, which serves as a basis for purposeful and targeted research in the future.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

“Risks associated with the development process of in-house information system projects” is the fourth article and is authored by Chia-Ping Yu and Wan-Ying Lin. To provide a risk management perspective for managers responsible for in-house project development, the authors investigated how the risks associated with an in-house information system project evolve during the software development process. They conducted interviews and content analysis to examine the risks that affect project delivery quality. Three companies participated in this research. The results of this study indicate that risks related to organizational structure persist throughout the software development process. Content analysis indicated that in the conducted interviews, sentences regarding task- and actor-related risks characterized the first two phases of this process, and sentences regarding technology-related risks characterized the last two (third and fourth) phases. The results also suggest that different types of risks exert pressure on in-house project teams to reassess the weaknesses and resource allocation in a project and the possible solutions to any potential problems. This research explains risk dynamics throughout the life cycle of in-house information systems development. Moreover, the findings of this study can help project managers identify the risks associated with the project development process that directly affect the project outcome.

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board, for their commitment and for sharing their knowledge and experience in supporting the IJISPM.

Finally, we would like to express our gratitude to all the authors who submitted their work, for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Editor-in-Chief,

João Varajão

University of Minho

Portugal

João Varajão is currently a professor of information systems and project management at the *University of Minho*. He is also a researcher at the *ALGORITMI Research Center* at the *University of Minho*. Born and raised in Portugal, he attended the *University of Minho*, earning his Undergraduate (1995), Masters (1997), and Doctorate (2003) degrees in Technologies and Information Systems. In 2012, he received his Habilitation degree from the *University of Trás-os-Montes e Alto Douro*. His current main research interests are related to Information Systems and Information Systems Project Management success. Before joining academia, he worked as an IT/IS consultant, project manager, information systems analyst and software developer, for private companies and public institutions. He has supervised more than 100 Masters and Doctoral dissertations in the Information Systems field. He has published over 300 works, including refereed publications, authored books, edited books, as well as book chapters and communications at international conferences. He serves as editor-in-chief, associate editor and member of the editorial board for international journals and has served on numerous committees of international conferences and workshops. He is the co-founder of CENTERIS – Conference on ENTERprise Information Systems and ProjMAN – International Conference on Project MANagement.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Tensions and ambidexterity: a case study of an agile project at a government agency

Carin Lindskog
Karlstad University
Universitetsgatan 2, SE-651 88, Karlstad
Sweden
carin.lindskog@kau.se

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

C. Lindskog, "Tensions and ambidexterity: a case study of an agile project at a government agency", *International Journal of Information Systems and Project Management*, vol. 10, no. 2, pp. 5-23, 2022.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Tensions and ambidexterity: a case study of an agile project at a government agency

Carin Lindskog
Karlstad University
Universitetsgatan 2, SE-651 88, Karlstad
Sweden
carin.lindskog@kau.se

Abstract:
Today's dynamic business environment must continuously adapt its software development methods to changing technologies and new requirements on the part of customers. Therefore, Agile methods are being used more and more used because they emphasize both flexibility and the ability to change. However, at the same time, the business-driven need for predictability and control remains. The purpose of this case study is to explore and theorize on paradoxical tensions and ambidexterity during an Agile software development project at a government agency. The study empirically examines how tensions and the ambidextrous responses to these tensions are related to Agile values. Data was collected by conducting interviews and studying internal project documents. Four categories of tensions (learning, organizing, performing, and belonging) were used for analytical purposes. The findings suggest that most of the tensions perceived were in the categories of learning and performing. There are, furthermore, several connections between the ambidextrous responses to these tensions and Agile principles. A deeper understanding of Agile values and principles is required in order to make projects successful. The contribution made by the study, therefore, is of great importance because Agile methods are for leading projects, not only in Agile software development, but also in other industries and sectors.

Keywords:
agile software development; paradoxical tensions; ambidexterity; government agency.

DOI: 10.12821/ijispm100201

Manuscript received: 10 October 2021
Manuscript accepted: 15 February 2022

1. Introduction

There is an ever-increasing demand for organizational agility and flexibility in order to gain competitive advantage [1], [2]. At the same time, underlying business models and institutional and regulatory environments in the public sector are primarily designed for robustness and stability [3]. Organizations and teams need to follow standardized procedures to complete tasks effectively (i.e., exploitation). But at the same time, the development of new ideas for adapting to changing situations (i.e., exploration) is also being encouraged. It is then understandable that it can be experienced as tensions when: "the essence of exploitation is the refinement and extension of existing competencies, technologies, and paradigms" and "the essence of exploration is experimentation with new alternatives" [4]. This indicates the importance of a comprehensive ability to deal with (i.e., ambidexterity) these paradoxical tensions [5].

Inherently conflicting goals are typical of the activities of all public organizations [6]. For example, the public sector has been associated with less flexibility but also greater public scrutiny, goals for social improvement, and a lack of profit as a measure of performance (ibid.). Choi and Chandler [7] point out the lack of competition, the impact of policies, and the diversity of stakeholders' interests as the main differences in terms of characteristics between public organizations and private organizations. In addition, software projects at government agencies are designed and built to last a long time. However, planning and implementation have often taken so long that software is frequently obsolete on finally being released [8].

The origins of the Agile concept lie in software development [9], where greater flexibility and changeability have traditionally been requested [10], being seen as a reaction to traditional or planned software methods [11]. Agile methods allow project teams to work in smaller steps, to review their work often, and to include feedback directly in order to prevent costly mistakes [8]. Weber & Tarba [12] state that: "Agile organizations have the ability to initiate continuous renewal that includes adapting existing competencies to an everchanging environment and simultaneously reconfiguring themselves in order to survive and thrive for the long term". However, Horlach and Drechsler [13] are of the opinion that embracing the Agile way of working can produce a number of paradoxical tensions at the team and organizational levels. The team members' experiences can come from traditional project environments with stable processes and predefined requirements based on detailed planning. In the Agile way of working, there is a radical change in the way of working because this attitude strives for flexibility. Preserved experiences can thus lead to inertia when it comes to these changes [13]. The ability of a project team to meet changes and overcome problems plays a critical role in the organization's reliability and success [14]. Managers must also be ready to give up their traditional sources of power, and new skills must be developed throughout the organization [15]. A successful transition to the Agile approach, therefore, requires a deeper understanding of the important Agile values, principles, and the specific way of thinking [16].

This study responds to the call by Werder and Heckmann [17] that future research should be about "investigating ambidexterity that thrives as a result of tension". The lens of paradoxical tensions has developed in organizational theory but has received too little attention in past research on software development [18] and project management [19]. A recent study by Iivari [19] introduces a framework of eleven paradoxical tensions concerning the priority, structure, and execution of projects, wishing to encourage future research on the paradoxical tensions of project management.

Ambidexterity has also been a hot topic in organizational research for a long time, but there is still a lack of understanding of "how" ambidexterity can be concretely supported by different types of organizations [20],[23]. For instance, relatively few empirical studies have studied ambidexterity in the public sector context [24]. In addition, Turner et al. [25] state that the project context is ideal for examining ambidexterity. The reason for this is that, in the project work form, frameworks and tools are already available (i.e., exploitation), but projects also require knowledge generation (i.e., exploration) (ibid.). Werder and Heckmann [17] argue, in turn, that more research on ambidexterity is needed for projects, teams, and individuals (i.e., contextual ambidexterity) because projects and their teams help organizations to solve complex problems and to handle complex tasks.

Based on the arguments made above and the growing use of Agile methods, this study examines how underlying paradoxical tensions are linked to Agile values. In addition, the study also examines what ambidextrous responses consist of. The question posed in this paper is: *How do the concepts of tensions and ambidexterity relate to Agile values?* To answer this question, data from a project (referred to as the Alpha Project) was used at a government agency conducting software development with a project setup (in-house and together with an external partner) that utilizes the Agile way of working. To the best of our knowledge, this was the first time that the four Agile values [9], the four categories of tensions highlighted by Smith and Lewis [26], and ambidextrous responses to these tensions, were combined in order to investigate Agile software development.

The paper is structured as follows: Section 2 provides the theoretical background. Section 3 describes the research methodology. Section 4 reports on the results of the study. Section 5 discusses these results, the limitations of the study, and future work. Finally, Section 6 concludes the paper.

2. Theoretical background

This section aims to provide the initial theoretical understanding necessary in order to understand the analytical lens used in this study. First, there is a brief introduction to the Agile way of working. Then, the focus is on the concepts of paradoxical tensions and ambidexterity.

2.1 The Agile way of working

Agile methods dominate, with their ability to respond and adapt quickly in a changing environment, software development [27]. Scrum [28] is currently the most widely used Agile method [27]. The Agile methods originate from a set of values and associated principles outlined in a declaration, the so-called Agile Manifesto, aimed at providing better ways of developing software [9], [29] using self-management and step-by-step development and delivery [30]. The four central values and the twelve principles formulated in the Agile Manifesto are listed in Table 1.

Table 1. The Agile values and principles from the Agile Manifesto [9]

Agile values	Agile principles		
1: Individuals and interactions over processes and tools.	1. Our highest priority is to **satisfy the customer** through early and continuous delivery of valuable software.	5. Build projects around **motivated individuals**. Give them the environment and support they need, and trust them to get the job done.	9. Continuous attention to **technical excellence** and **good design** enhances agility.
2: Working software over comprehensive documentation.	2. **Welcome changing** requirements, even late in development. Agile processes harness change for the customer's competitive advantage.	6. The most efficient and effective method of conveying information to and within a development team is **face-to-face conversation**.	10. **Simplicity** – the art of maximizing the amount of work not done – is essential.
3: Customer collaboration over contract negotiation.	3. **Deliver working software frequently**, from a couple of weeks to a couple of months, with a preference to the shorter timescale.	7. **Working software** is the primary measure of progress.	11. The best architectures, requirements, and designs emerge from **self-organizing teams**.
4: Responding to change over following a plan.	4. Business people and developers must **work together daily** throughout the project.	8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain **a constant pace** indefinitely.	12. At regular intervals, the team reflects on how to become more effective, **then tunes and adjusts** its behavior accordingly.

Given the growing interest in the Agile way of working, it is invaluable to understand the Agile values and the principles, as well as the factors that facilitate or hinder the acceptance and use of the Agile way of working at organizations [31]. The understanding is needed that embracing the Agile way of working can produce a number of tensions at the organizational and team levels [13]. Agile is described as "people-oriented" [32] rather than "process-oriented" [33], and this can lead to tensions. For example, research conducted by the Scrum Alliance, an independent non-profit organization with 400,000 members, showed that more than 70% of Agile practitioners report tensions between their teams and the rest of their organizations due to a lack of knowledge about the Agile way of working [34]. Introducing Agile into an organization means changing the organizational culture, strategy, and structure, something which is not always easy [35]. Therefore, it is important that the Agile way of working is accepted and supported by the whole organization and all stakeholders at both the management and operational levels [36].

According to the Agile Manifesto [9], "the best architectures, requirements, and designs emerge from a self-organizing team". However, software developers working on the Agile team should not have specialized roles: Instead, decisions are made jointly about "how" development work should be conducted [37]. This can cause problems given the lack of basic domain knowledge of software developers. Conboy et al. [38] call this issue "masters of all and masters of none".

"Being Agile", according to Denning [16] and Prange [39], is about embracing the mindset, culture, values, and principles. In contrast, "Doing Agile" refers to the adoption of either Agile methodology or a limited set of Agile practices and tools (ibid.). Horlach and Drechsler [13] believe that in order to have a successful transition to the Agile way of working, a deeper understanding of the important Agile values and principles is required. That is, the particular mindset that characterizes "Being Agile" [16].

In the public sector, Agile studies are lacking because the adoption of Agile methods has been slower than in the private sector [40]. An example here, however, is the study by Nuottila et al. [40], which identifies and categorizes the challenges that may impede the effective use of Agile methods in public IT projects that embrace private software vendors. The identified challenges related to documentation, staff training, experience and commitment, stakeholder communication and involvement, Agile roles, the locations of Agile teams, legislation, and the complexity of software architecture and system integration.

This subsection touches on the tensions that can arise when working Agile. The next subsection digs deeper into the concept of paradoxical tensions.

2.2 Paradoxical tensions

The concept of the "paradox" provokes, confuses, and raises questions [41]. Perhaps we think of logical paradoxes that are thoughtful contrasts or contradictions, or any problematic situation [42] that can never be resolved [17]. Therefore, Poole and Van de Ven [43] suggest a difference between logical and social paradoxes. Socially constructed paradoxes are created by actors and can be handled through acceptance, confrontation, and transcendence [44]. In addition, in this study, the term paradoxical tensions is preferred to paradoxes. These paradoxical tensions are seen as two sides of the same coin (ibid.). Dealing with paradoxical tensions is not always about compromises between flexibility and control, but about an awareness of their contemporaneity [44]. In other words, managing paradoxes needs a creative both / and approach that utilizes the advantages of each side separately, while utilizing their synergistic potential [45].

In the rest of the paper, the concept of tensions is thus used to denote socially constructed paradoxical tensions defined as "conflicting but still interrelated elements that exist simultaneously and persist over time" [26]. The concepts of tensions and ambidexterity are closely linked and should be seen in combination [46]. In the growing body of literature on these concepts, different tensions are often described as exploitation versus exploration. This study follows the advice of Pertusa-Ortega et al. [47], who claim that other types of tensions must also be emphasized. Examples of other types of tensions are highlighted by Smith and Lewis [26], who propose an organizing framework in order to explore rising plurality in research into paradoxes and who categorize tensions into four categories (with potential combinations). Each category represents an organization's core activities; i.e. learning (knowledge-related), organizing (process-related), performing (goal-related), and belonging (identity/interpersonal relationship-related) (ibid.).

The most common category in the paradoxical tensions research field is **learning tensions**, which are tensions that arise when dynamic systems change and renew [48]. "Learning requires using, critiquing, and often destroying past understandings and practices to construct new and complicated frames of reference" [44]. A key source of learning tensions is precisely the tensions between old and new. Lewis [44] calls it: “A struggle between the comfort of the past and the uncertainty of the future”. Limited resources or time pressure can increase learning tensions if employees are required to learn new things (exploration) while maintaining a high level of performance (exploitation) [49]. A noteworthy challenge facing organizations is the balance between exploitation and exploration [4].

From a paradoxical perspective, **organizing** itself is filled with different **tensions**, such as tensions between control and flexibility [44] and routine and change [26]. The organizing tensions exists because organizations consist of several subsystems which must act independently and which are nevertheless part of a mutually dependent overall organizational system [50]. Organizing tensions often manifest themselves during periods of organizational restructuring or change [51]. It is mainly in processes, routines, and collaborations that such tensions are experienced (ibid.). For example, to compare contrasting forces that encourage commitment and trust, while at the same time providing productivity and discipline [44]. As mentioned before, organizations and teams typically need to develop new ideas in order to adapt to changing situations, but they also need to follow standardized procedures to complete tasks effectively [5].

Tensions that arise between different stakeholders’ often conflicting demands, or conflicting expectations [52], can be categorized as **performing tensions** [26]. These tensions can result in conflicting strategies and goals [51], [53]. Tensions can manifest themselves at the individual level as actors struggle to respond to either the conflicting demands embodied in their roles or the conflicting demands that arise from the roles of others that they share everyday tasks with [44], [50]. These tensions can arise especially during a change development process, when new goals are being set, roles changed, and relations between actors redefined [50]. In the study by Lüscher and Lewis [54], it turned out to be the case that performing tensions arose when managers’ roles became more blurred and multiplied in response to conflicting demands during major organizational changes. According to Iivari [18], the paradoxical lens has not been explicitly used to understand software development and therefore the references mentioned have been taken from the organizational research field. However, when implementing the Agile way of working as a replacement for a plan-driven way, roles and responsibilities will change, something that affects everyone. For instance, compared to plan-driven software development, the boundaries between the developer roles were less well defined in the Agile way of working [38]. If the developers are expected to have a broad knowledge of all aspects of software development, this can affect the balance between being “a generalist” and “a specialist” (ibid.).

Belonging tensions arise because people in organizations want to belong to a group but they also want to be independent [51]. It is mainly in the areas of organizational culture, values, roles, and membership that such tensions are experienced [26], [51]. Belonging tensions often arouse the emotions of the actors, and can also intensify conflicts and polarization. This kind of tensions can arise when actors try to express their differences while still remaining valued members of a group [44]. An example of a combination of belonging and performing tensions arises when role identification and the goals of different stakeholders conflict [53].

It is worth noting that tensions can overlap organizational levels because the experience creates new challenges on one level [53]. Tensions can also be combined (ibid.). A big change results if organizations that previously worked in a more traditional or plan-driven way switch to the Agile way of working [55]. Inherent and latent tensions can be made prominent through this process of change [26], [56]. Cooper and Sommer [57], Farjoun [58], and Pellegrinelli et al. [20] report that more and more organizations are struggling to address rapidly changing environments, and that change can result in “chaos” for the individual team members.

In the next subsection, the ability to handle these tensions is discussed.

2.3 Ambidexterity

An organization’s diversity in terms of its ways of handling tensions by doing two different things simultaneously is captured in the concept of organizational ambidexterity [59], [60], [61]. The concepts of paradox, tensions, and ambidexterity are closely connected [19], [46], but the ambidexterity literature often focuses on a single tension between exploitation and exploration [18].

The ever-increasing interest in studying ambidexterity is because ambidexterity has long been considered an important driver of long-term results [7], [21], [62], leading not only to profitability but also to the survival of an organization [4]. Ambidexterity is also positively associated with performance when it comes to capacity utilization and employee motivation [63]. An ambidextrous perspective is especially favorable when it comes to providing insight into how organizations explore new opportunities while continuing to exploit their existing markets and resources [64]. Scholars and practitioners have tried to identify different ways or strategies for striking an appropriate balance between tensions [7]. In recent research, Luger et al. [65] reconceptualize the concept of ambidexterity as the ability to *dynamically* balance exploration and exploitation. Most previous ambidexterity studies focus on organizational and static mechanisms that enable organizations to build an ambidextrous capability (ibid.).

The most common forms of ambidexterity are structural (separation of units), sequential (time-based), and contextual (behavior-based) [66]. Ambidexterity can be examined at different levels of analysis; i.e. the organizational, group/team, and individual levels. Previous research on ambidexterity has mainly focused on the organizational level because it has been shown that successful organizations have had the unique ability to balance both their current business and market needs, and adapt to change [67]. A recent conceptual study in the context of Agile software development identified and categorized ambidextrous factors as time-related, team-related, task-related, and transition-related [68]. Another study, by Sailer [21], theorizes how project management methods affect ambidexterity on the project level. This study shows that planning activities are more exploratory and that project implementation activities are instead more exploitative in their nature (ibid.). But it is worth pointing out that ambidexterity is a “nested” concept; i.e. it takes place on several levels within the organization at the same time [61].

3. Research methodology

Using a case study approach allowed us to capture rich details of the Agile way of working, as well as the tensions, capabilities, and supporting factors associated with organizational ambidexterity in a “real-world” project setting. This kind of project was chosen as public sector projects in themselves have conflicting objectives typical of this type of organization [6]. In addition, there is also a lack of empirical studies of ambidexterity in the public sector context [24]. The interviews, together with the content analysis of the project documentation, functioned as a method of data triangulation [69] aimed at improving the internal validity of the study.

The project under study, referred to as the Alpha Project, was conducted by a major Swedish government agency that focuses on infrastructure. This government agency has thousands of employees and is split into several business divisions and key functions. Just over 45 billion SEK is financed by government subsidies, while certain activities are also financed using fees and income from commissioned work. The Alpha Project lasted from September 2015 to January 2018. The Alpha Project’s main aim was to build and introduce a new IT system to replace three older IT systems, but also contribute towards clarifying the division of responsibilities between two government agencies in that particular field of activity. The project goal was broken down into ten sub-goals and nine impact goals. The project members came from three departments at two different organizations. Two of these departments were at the government agency, while the third was a partner, an IT company.

The Alpha Project was arranged into two teams, i.e. the lead and control team and the development team. People from both teams were interviewed, and all the interviews were audio-recorded and transcribed. Data generation and analysis took place in parallel. The respondents were anonymized. First, the main project manager was interviewed (alias PM in quotations). The PM also gave a guest lecture on a university course and had a meeting about the current project. From the PM, we received the names of potential respondents/team members from the lead and control team (i.e., snowball sampling), including the product owner (alias TM1, TM2, PO, in quotations). TM2 was hired from an IT company as a resource consultant. Finally, the sub-project manager from the development team (alias SPM in quotations), was contacted and interviewed. The project group containing the two groups was geographically spread across five Swedish cities. The overall planning of the project used the waterfall model, with an Agile approach during the actual implementation. During the project’s realization phase, the Agile method Scrum [28] was used. Figure 1 shows the overall schedule for the Alpha Project.

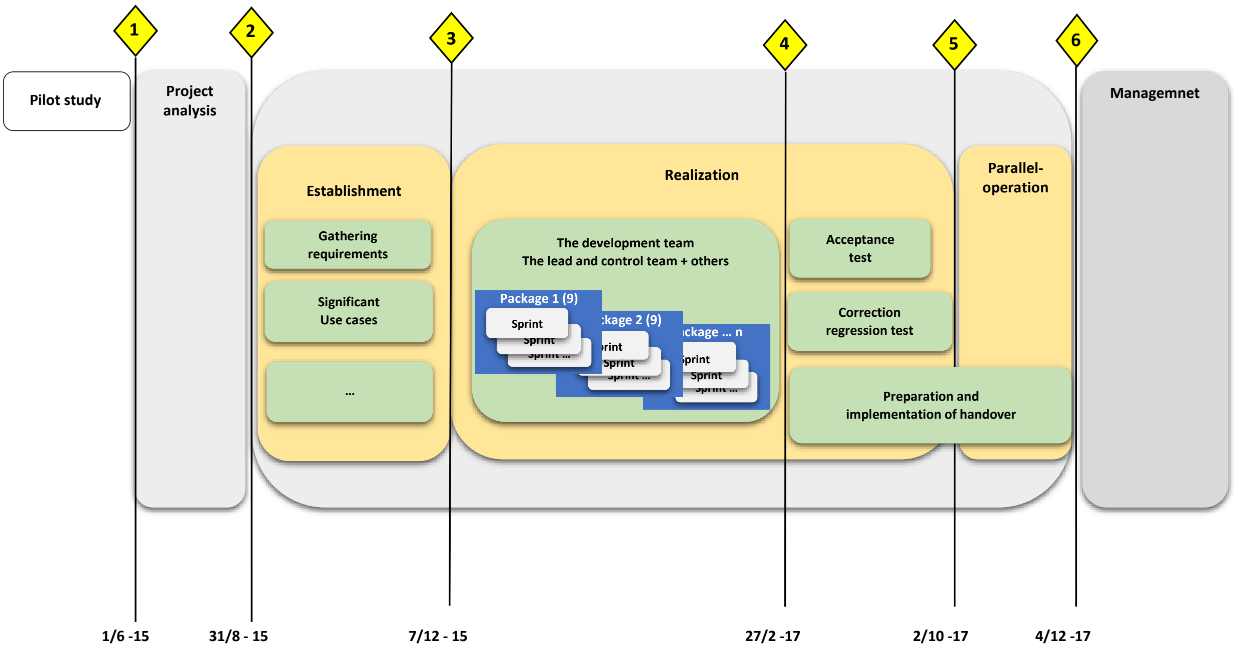


Fig. 1. The overall schedule for the Alpha Project (from a PowerPoint slide, translated into English)

Semi-structured interviews were conducted via Zoom due to the COVID-19 restrictions. In addition to predetermined questions, the interview was supplemented with follow-up questions, and the respondents were asked to express themselves openly and freely to define the world from their own perspectives [70]. An interview guide was designed, with these tensions and responses to them in mind, but it did not include the specific concept of "ambidexterity". The reason for this was that the concept of ambidexterity is an academic construct [61] and could create confusion among the participants. The interview consisted of questions about the respondents' Agile experience and their perceptions of the Agile mindset, culture, values, principles, and practices. The guide by Hancock and Algozzine [70] was followed in order to break down the research question into interview topics. For instance, the following questions were asked: What do Agile values mean to you? Are there any contradictions, tensions, or difficulties in following these values? How were these tensions handled by the team/project? Also asked were questions about how the respondents remembered the Alpha Project and how a typical working day during the project looked. The interviews took place between November 2020 and January 2021, lasting between 50 and 60 minutes. The interviews were conducted in Swedish, and thus the quotes and texts presented in the paper have been translated. The secondary data consisted of internal project documents of different kinds, see Table 2.

Table 2. Overview of dataset

Data Source	Description	Number
In-depth interviews	Semi-structured	5
Additional meetings	Web-meeting, guest lecture	2
Documents	Project documents; project presentations, stakeholder analysis, project financing, project planning, handover, review report, architecture report, final report, requirements modeling report, annual reports, test strategy, quality plan, follow-up, weekly diary, description of development work, description of working methods, PowerPoint slides	22

The coding activity was based on the research question: *How do the concepts of tensions and ambidexterity relate to the Agile values?* Furthermore, coding was arranged into three steps: First, the tensions emerging from the interviews and secondary data were identified, interpreted, and linked to the Agile values. Then, the Smith and Lewis framework [26] was used to categorize the identified tensions into four tension codes (learning, organizing, performing, and belonging). Each interview transcript and piece of project documentation was examined sentence by sentence and linked both to the different Agile value codes and to the different types of tension codes. Last, the ambidextrous responses to the different tensions were interpreted, coded, and linked to the Agile values. The qualitative research tool NVivo was used for the data extraction process, as well as for the linking and coding. Figure 2 shows two examples from steps one and two.

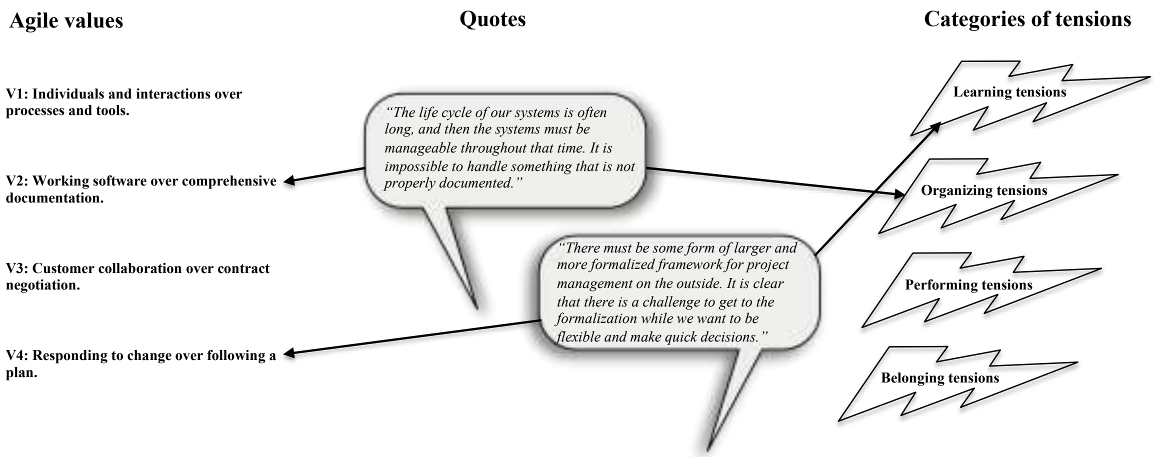


Fig. 2. Examples from steps one and two of the data analysis.

4. Results and analysis

This section provides an overview of the results with the aim of answering the stated research question: *How do the concepts of tensions and ambidexterity relate to the Agile values.* Under each subheading (which is an Agile value), both the tensions and the contextual (behavior-based) ambidextrous responses to them are present together with quotations from the Alpha Project. The section ends with a summary and analysis of the results explaining the differences and similarities between theory and practice.

4.1 Agile value 1 - Individuals and interactions over processes and tools

The focus in this value is on the individual's talents, skills, processes, and tools that should suit the people [38]. However, working in self-organized teams can also lead to developers experiencing fear caused by a lack of competence (ibid.). Tensions are categorized as **belonging tensions** because they relate to the complex relationships between the self and others' demands, concerning priorities, values and beliefs [26]. The PM of the Alpha Project explains:

"Working Agile means an opportunity to be effective and make things happen, but it can also mean a "scary" feeling for the team members who may not be so active. On an Agile team, there's nowhere you can hide or "flatten the curves", because everything will be visible."

Although all the respondents had experience of working Agile, there was still an underlying **learning tension** between old and new ways of working. The PO says: *"We as human beings might not be the most likely ones to want to change; traditionally, we always want to keep track of the next step."*

Another quote illustrates this (PO): *"I usually say that there's no system that's as good as the previous one. Because, in the old system, you know your way around, and when there's something new, you have to change, and then you think it's a bit scary."*

During the Alpha Project, **organizing tensions** were both predicted and aroused. This type of project organization, with several departments and a geographical spread, can make interactions more difficult to handle. In one of the project documents (the architecture report), the following can be seen: *"The fact that construction took place entirely using an external partner who is also a fairly large geographical distance away from the rest of the project, has entailed certain challenges of course."*

<u>Ambidextrous responses to Agile value 1</u>

In response to the tensions relating to this value, several respondents emphasized the importance of Agile experiences, commitment, and a common understanding of the different goals and needs. They allocated their time and resources to finding motivated and committed team members. Creating a "project culture" was something that the PM emphasized: *"With the different cultures of the companies, it's important to be able to build a common culture and framework within the project regarding how we should work Agile."*

It was essential for the PM to negotiate extra time to create or build this "project culture". The PM said: *"From the beginning, we had a preparation phase that was two months long, but I negotiated for another month."*

The importance of team building can be gleaned from the final document: *"At the beginning of the project, a workshop was held with the project participants to set a game plan regarding how we want ourselves to relate to each other, and how we contribute to a good working climate and results. All the project participants had a positive attitude toward contributing and were committed to the project work, to fulfill their own roles and areas of responsibility, and to help the project forward. A solid investment in creating two teams, where the project members have been given clear roles and frameworks for their areas of responsibility, has given all the project participants challenging and interesting tasks. Staff turnover has been low, based on resource planning for the project."*

The development team consisted of a team from the external IT company, who were also on a quest to find the right resource composition. The SPM, acting in the role of sub-project manager, said: *"We're dependent on the result, both as a customer and a supplier, because if we as a supplier are unable to achieve the result the customer has requested, then we won't get the references allowing us to sell more consultancy services to other agencies and companies. We always want to provide good craftsmanship because it's extremely important for us as a supplier to have satisfied customers because the whole industry relies on trust. As a team member, you must be both technically and professionally proficient. We also try to reuse the teams that we've seen to be working well."*

Despite the geographical spread of the project participants, interactions and continuous meetings were maintained in order to provide constant interaction. In one of the project documents (final report), the following can be seen: *"Physical meetings with the entire project group have been conducted twice a year — meetings in a smaller part of the project every quarter. Weekly web conference meetings have worked when it comes to keeping the project together."*

Another response to managing tensions, according to the document (test strategy), was testing as an activity occurring early on in the project: *"This led to a good opportunity to set up a common test strategy where clear roles and communication paths were described. This test strategy enabled good bridging between the two organizations. Early involvement in the project also enabled the test practice to both influence and be included in the project requirements process."*

4.2 Agile value 2 - Working software over comprehensive documentation

This value is interpreted thus: Choosing to spend less time documenting tasks and functions should make deliveries faster. During the Alpha Project, the TM1 described the value thus: *"You can say that it's a trade-off; you do less paperwork and administration and then you'll be able experiment more."*

Less documentation means that communication and decision-making can be more difficult to achieve satisfactorily [37], potentially leading to **organizing tensions**. One member of the lead and control team said: *"The lifecycle of our systems is often long, and then they must be manageable throughout that period. It's impossible to handle something that hasn't been properly documented."*

The project document (working method) also said: *"One challenge was being able to predict the scope of the new system without any clear system specifications, and also welcoming changes, improvements, and innovations within the scope of the project's financial framework."*

This value is also linked to a **performing tension** between the different stakeholders' goals and requirements. The PO said: *"We're also a government agency bound by laws and regulations, and if there's a change in the law, or in an ordinance, or a change, then we always have to look at it."*

For stakeholders unaccustomed to the Agile approach, this value also leads to **learning tensions**. TM1 explained: *"Many of our stakeholders have an expectation regarding, so to speak, classic reporting of time, cost, and content and they aren't used to the content not being fixed."*

Another team member (TM2) added: *"They knew how much the system would cost but not what they'd get in the end."*

<u>Ambidextrous responses to Agile value 2</u>

A shared understanding between the two organizations and three departments is needed to deal with the tensions relating to this value. A shared understanding can be created, for example, via continuous meetings. The SPM stated that: *"Understanding the business and relating to the customer's major IT guidelines puts great demands on the team. At the same time, it's also important to have technical learning. In this project, we brought in senior developers with great knowledge who would simultaneously be able to understand the similarities between industry-wide and other solutions."*

An understanding is needed of what it really means to work Agile (i.e., to adopt a new way of thinking) in order to balance the tension between an old way of working and a new one. Agile practices can also be used for a structure that is necessary. Using sprints can, for instance, help to create a structure. TM2 described the purpose of the sprints: *"Something useful will come from the sprints; we build the functionality the whole time."*

4.3 Agile value 3 - Customer collaboration over contract negotiation

This value also emphasizes people in the successful adoption of Agile methodologies, being characterized by communication and collaboration between people who trust each other [71]. During the Alpha Project, one respondent experienced **performing tensions** that had arisen between the various stakeholders' often conflicting goals and strategies due to the project being conducted at a major government agency with an array of stakeholders. For government organizations, all system development must comply with laws and regulations. TM2 described it thus: *"The project was conducted at a Swedish government agency, and when you build something at this type of organization, it becomes part of something much larger, and there must be a more formalized project management framework outside of the project itself."*

The context also implies that: "traditional contracting processes are oriented toward waterfall, which focuses on the delivery of specified products in a stepwise fashion" [8]. In contrast, the Agile way of working requires a contract management approach that is flexible and stretches beyond a fixed-price, one-time project (ibid.). Since the context of this study is a government agency, that is largely funded by government subsidies, TM1 points out: *"Those who distribute the money for the project must be aware that the Agile method is quite expensive because many of the alternatives that aren't used are discarded."*

The Agile way of working assumes failure, with public sector managers being forced to abandon a zero-error culture so that employees are allowed to make mistakes [8]. This changed approach to mistakes is described thus by the PO: *"We as a government agency are afraid of making mistakes, but if we dared to experiment a little bit more within the framework we have, then we'd move forward. Our mission is to produce a system that brings the greatest benefit to* *both the customer and the business. In addition, the system must also be legally secure. My role as a product owner is to make this system work, and to follow both the business process and technological development."*

<u>Ambidextrous responses to Agile value 3</u>

At the beginning of the Alpha Project, the PM negotiated for extra time to build trust and what was called a special "project culture". Despite, or thanks to, this extra time, the PM emphasized the fact that: *"The project came in under budget and definitely managed to keep to schedule, delivering significantly more than was originally intended."* During the project, the framework was set as regards how the teams wanted the work environment to be for this project. The teams worked with documents and PowerPoint presentations that clarified communication so they could read what was expected of each role. This documentation was addressed both externally to the stakeholders and internally to the project, and had dialogs about the teams. Furthermore, the project culture was developed to create trust and facilitate collaboration. This is especially important because the two organizations have different goals and strategies. The SPM, acting in the role of sub-project manager during *development*, said: *"In the IT industry, you have to win a procurement and, to be able to do that, you have to have a low price. So, we must always be aware of what we have promised the customer."*

Another way to respond to tensions between different goals and strategies is by clarifying roles. McHugh et al. [72] emphasize that the product owner must trust the developers to do what they say they will do, and that the developers must trust the product owner not to burden them with work. Drury-Grogan et al. [37] argue that the project manager's role, as a decision-maker, is greatly reduced and resembles that of a facilitator or coordinator. The SPM of the development team claimed that one of the success factors of the project is an ever-present, knowledgeable and active PO. The PO him-/herself also saw the importance of participating in all the meetings so that the developers would be able to ask questions and discuss problems. The PO said: *"In the role of product owner, you have to dare to relinquish power and control to the organization, where the experts sit. Rather, you have to spend a lot of time continuously following up."*

Continuous meetings in response to perceived tensions were described by several respondents. The SPM from the development team had daily stand-up meetings with his/her team where they tried to capture both the big picture but also what was important on the day, identifying the different roles and their different dialogues. The SPM continued: *"You have to have a motivated group that thinks this is fun. They have to want to build something together and to make the customer feel like a hero. It's no longer possible to just put together a project consisting of random people, you need to create a team with the right players, players who want to become an innovative and welcome change, and who want to deliver a bit extra and shine a bit for their own sake, but also for the customer's. We also have to ask the customer the corresponding question, that is, are you prepared for this? Do you understand this? Do you understand the power, and do you understand the risks attached to everything we do in the event of this happening? It's very important that we agree on that. A success factor of this project was the development team being hired as an entire development team; not as individual consultants paid on an hourly basis."*

4.4 Agile value 4 - Responding to change over following a plan

The fourth value of adapting to change entails the action's iterative and incremental nature, with frequent product releases, allowing teams to adapt and respond quickly. It was identified, however, that there are **learning tensions** when changing working methods and mindsets. For instance, the document (working methods) emphasizes that: *"a challenge facing the project was being Agile while maintaining full control."*

In order to deal with the uncertainty of not being able to predict the scope of the new system (from working methods), one respondent's (TM2) wish is as follows: *"There must be some form of larger and more formalized framework for project management on the outside. It's clear that there's a challenge in getting to the formalization while wanting to be flexible and to make quick decisions."*

An example of a combined (**belonging-performing) tension** from TM2 is: *"On the development team, there were some rather young system developers who could get a bit frustrated and impatient when it took time to decide that things had to be dealt with formally."*

Ambidextrous responses to Agile value 4

To manage and balance the learning tensions identified in this assessment, the PO constantly asked him-/herself questions such as: *"Where are we today? Are there any new technologies we can use? Are there any new requirements on the part of the customers or the business?"*

The fact that the Agile way of working is a mindset was testified to by the PM thus: *"Change is our main focus because we know that we don't know everything right from the start. We put a lot of time into goals and goal breakdowns to gain an understanding of the project, but also to gain a shared understanding within the project team."*

All three departments involved were documented in a weekly diary throughout the project. The document (follow-up) describes the purpose: *"Writing a weekly diary enables reflection, and it also provides a very good brief summary of the project's progress on a weekly basis. Deviations from the plan are captured proactively. We see staffing of the project on a weekly basis. This weekly diary facilitates the work of going back and seeing the reasons for deviations and actions in a simple and clear way. Each resource responsible for a specific area writes briefly about its work for the week."*

Since the project used Scrum, the retrospective practice is also included, whereby, after each sprint, the team members asked themselves the following questions: What went well? What went less well? What can we do differently next time? TM2 described the benefits as follows: *"It's an extremely important part of working Agile practicing that reflection so that you don't repeat the same mistakes during the next sprint. The idea is for the team to be more efficient during the project. If you neglect to do follow-up, there's a risk that you'll continue working in the same way during the next sprint."*

4.5 Analysis of the results

To help analyze the results, and explain the differences and similarities between theory and practice, Table 3 shows a summary of the results.

Table 3. Summary of the results

Agile values	Identified tensions	Ambidextrous responses
V1: Individuals and interactions over processes and tools.	Belonging tension; relationships between the self and others' demands. Learning tension between old and new ways of working. Organizing tension caused by several geographically-spread departments.	Creating a "project culture". Team building. Interaction and continuous meetings. Test occurring early on in the project.
V2: Working software over comprehensive documentation.	Organizing tension caused by less documentation. Performing tension between the different stakeholders' goals and requirements. Learning tension between old and new ways of working.	Continuous meetings. A common understanding of the different organizations. Adopting the Agile way of thinking/working.
V3: Customer collaboration over contract negotiation.	Performing tensions between the different stakeholders' goals and requirements. All development must comply with laws and regulations. Furthermore, the government agency is largely funded by government subsidies.	Creating a "project culture". Team building. Clarifying roles and responsibilities. Continuous meetings.
V4: Responding to change over following a plan.	Learning tension when changing working methods and mindsets. A combined belonging-performing tension when individuals experience frustration due to different goals and strategies.	An active and ever-present PO. Understanding the Agile way of working as a mindset. Using the retrospective practice.

The aim of the first part of the results is to answer how the concept of tensions relates to the Agile values (the second column in Table 3). The results from the project show that there are perceived tensions in the various Agile values. This may be because the Agile values have been written on an overarching level and can thus be interpreted in different ways. Wang et al. [73] also point out that tensions exist because the existing Agile literature mainly adopts an "either / or" perspective on these values. For example, in the Agile manifesto, Beck et al. [9] state: "While there is value in the items on the right, we value the items on the left more". Wang et al. [73] are also of the opinion that those tensions exist in particular in values 1 and 4, i.e. people vs. processes, as well as in responding to change vs. following a plan. The current study shows that tensions are experienced within each Agile value, and not just between numbers 1 and 4.

Tensions are hard to define and observe directly, and thus they can be difficult to recognize empirically [74]. This study has gone a step further in explaining the different types of tensions that are perceived. This has been done with the help of the theoretical lens highlighted by organizational researchers Smith and Lewis [26]. The current study confirms that Agile is described as "people-oriented" rather than "process-oriented" [32], because most of the tensions are experienced due to people changing their way of working and / or having different goals and strategies.

The aim of the second part of the results is to answer how the concept of ambidexterity relates to the Agile values (the third column in Table 3). The study contributes by identifying ambidextrous responses to the identified tensions: It is equally important here to both identify and make the ambidextrous responses visible. In contrast to previous ambidextrous research, focusing on "what" ambidexterity is [68], this study has instead focused on "how" ambidextrous responses can be expressed concretely. From this study, it may be concluded that ambidexterity is not realized through behavior alone, but through a combination of creating both common goals and an understanding of the Agile approach, together with the department's prerequisites and the need for continuous meetings.

5. Discussion

This study aims to explore and theorize paradoxical tensions and ambidexterity during an Agile software development project at a government agency. To fulfill this aim*;* a case study was conducted as a research strategy. The study clearly shows that tensions exist which are related to the Agile values: An initial step towards being able to handle or balance tensions is identifying and investigating them.

5.1 Tensions identified during the Alpha Project

One empirical observation made was that most of the tensions perceived were in the categories of learning and performing. Even though all the project members had experience of working Agile, it was not always so easy to completely switch to a new way of working. An Agile approach permeates not only the project team itself, but also all the project's stakeholders and the entire organization. Performing tensions arose because this major government agency, with its multiplicity of stakeholders, is used to working on the basis of processes, laws, and regulations. Resetting the course of a "large ship" takes time, and requires understanding and patience.

Given these tensions, we can ask ourselves the big question: Does the Agile way of working suit such a major government agency? According to a recent study of Swedish government agencies, 87.8% (65 of the 73 government agencies that responded) of these reported that their software development is more Agile than plan-driven [75]. The results of the current study are in line with the fact that the Agile approach also suits government agencies because both the interviews and the documentation testified to the project being successful, and not just on the basis of the three sides of the project triangle; i.e. cost, quality, time [76]. Most of the identified success factors of the project can be categorized as "people-focused". This is in line with the study by Tam et al. [77], which states that personal characteristics and societal culture are, directly or indirectly, the reason for Agile software development projects being successful. Perhaps it is because of this "people-focus" that a number of tensions *were also identified during the Alpha Project.*

To further follow the call by Werder and Heckmann [17] to investigate the ambidexterity thriving as a result of tensions, the ambidextrous responses found during the Alpha Project are discussed below.

5.2 Ambidextrous responses identified during the Alpha Project

As a further explanation of the values of the Agile Manifesto, it was also accompanied by twelve principles (see Table 1). An interesting pattern found during the Alpha Project was that there are several connections between the ambidextrous responses and the Agile principles. For example, the first principle is: "Our highest priority is to satisfy the customer through the early and continuous delivery of valuable software" [9]. During the Alpha Project, the SPM, in his/her role as a developer who came from a supplier, described the importance of having satisfied customers thus: "Because the whole industry is about trust". Another example is the fifth principle: "Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done" (ibid.). During the Alpha Project, a lot of time and resources went into creating the special "project culture". The third example is the twelfth principle: "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly" (ibid.). This principle is about reflection, and it was found that the project members of the Alpha Project wrote down their reflections in a weekly diary throughout the project. Even when it comes to the ambidextrous responses in the study, there is a clear link that they are "people-focused".

5.3 Limitations and future research

In case study research, the validity of the design concerns how well the narrative of the case represents reality. In the current study, the team members actively involved in a completed project were interviewed. There are always risks attached to what the respondents remember, as well as to personal opinions or social pressures. The empirical material could have involved all the team members and the steering group in generating richer data. The validity of the design of the study can be increased by triangulating data sources [69]. In the study, interviews and the project documentation were both used as a method of data triangulation.

Although any generalizations based on this study should be made with caution, given its limitations, case studies are particularly good when it comes to gaining a rich picture and an analytical understanding of the object of study [78]. However, in addition to the fact that use case studies can contribute rich insights, there is also a kind of generalization whereby empirical statements can be generalized to concepts and / or to theory [79],[80]. Lee and Baskerville explain that case studies are lacking *in "particularizability" rather than in generalizability [79].*

Four categories of tensions (learning, organizing, performing, and belonging) were used for analytical purposes. We should be aware that there is a risk of using these four categories as a typology, or as a full-scale roadmap for the paradoxical landscape [41]. It is worth noting that tensions are multifaceted and go beyond organizational levels, and/or are made up of one or more of the four categories in unique ways (ibid.).

Looking at future research, there is a lack of empirical studies of ambidexterity in the public sector [24]. For future research, further Agile case studies at government agencies are also proposed, given that research in this type of organization is limited. Studying the Agile way of working seems to be very relevant to the major government agencies that are "in the starting blocks" as regards changing their way of working to Agile. Achieving a successful transition to the Agile way of working requires a deeper understanding of Agile values and principles [13]. In other words, the special mindset that characterizes "Being Agile" is needed [16]. Our study also links success with "Being Agile" i.e., embracing its mindset, culture, values, and principles.

6. Conclusion

As more and more organizations have begun adopting Agile methods, this study examines how underlying paradoxical tensions are linked to Agile values. In addition, the study also concretely examines what ambidextrous responses consist of. The question posed in this paper is: *How do the concepts of tensions and ambidexterity relate to the Agile values?* The use case featured in this study was a project conducted by a major Swedish government agency, lasting from September 2015 to January 2018. Data was collected by conducting interviews and analyzing internal project documents. Four categories of tensions (learning, organizing, performing, and belonging), using the Smith and Lewis framework [26], were used for analytical purposes. One empirical observation was that most of the perceived tensions were in the categories of learning and performing. Even if all the project members had experience of working Agile, it was not always so easy to switch completely to a new way of working. It was also found, during the Alpha Project, that there are several connections between *ambidextrous responses and Agile principles.*

The theoretical contribution made by this paper lies in how the analytical lens, consisting of four categories of tensions, can be used for identifying, analyzing, and categorizing several of the tensions occurring during an Agile software development project. In addition, the study also brings concepts together: From academic domains of knowledge (organizational theory of paradoxical tensions and ambidexterity), and ambidextrous responses from practitioners' domains of knowledge, to fresh insight into the complexity of system development. Thus, it can further develop knowledge of which types of tensions exist and how ambidexterity can be related to the Agile values. Due to the fact that the Agile values have been written on an overarching level, and can therefore easily be misunderstood, the practical contribution made lies in identifying the different types of tensions that may exist within each value. This knowledge can help organizations to deal with the competing demands that arise when Agile values are applied. The study also helps in identifying ambidextrous responses to the identified tensions. In contrast to previous research into organizational ambidexterity, which focuses on "what" ambidexterity is, this study has instead focused on "how" ambidextrous responses can be expressed concretely. Studying the Agile way of working seems to be very relevant to major government agencies that are "in the starting blocks" as regards changing their way of working to Agile. Achieving a successful transition to the Agile way of working requires a deeper understanding of the Agile values and principles. The contribution made will be of great importance to practice since Agile methods are a popular method of managing projects, not only in Agile software development, but also in other industries and sectors.

References

[1] S. Clegg, C. P. Killen, C. Biesenthal, and S. Sankaran, "Practices, projects and portfolios: Current research trends and new directions," *International Journal of Project Management,* vol. 36, no. 5, pp. 762-772, 2018.

[2] B. Ramesh, K. Mohan, and L. Cao, "Ambidexterity in agile distributed development: An empirical investigation," *Information Systems Research,* Article vol. 23, no. 2, pp. 323-339, 2012.

[3] J. Magnusson, J. Khisro, M. Björses, and A. Ivarsson, "Closeness and distance: configurational practices for digital ambidexterity in the public sector," *Transforming Government: People, Process and Policy,* Ahead of print, 2020.

[4] J. G. March, "Exploration and exploitation in organizational learning," *Organization science,* vol. 2, no. 1, pp. 71-87, 1991.

[5] K. Zhao, B. Zong, and L. Zhang, "Explorative and Exploitative Learning in Teams: Unpacking the Antecedents and Consequences," *Frontiers in Psychology,* vol. 11, Article 2041, 2020.

[6] M. Parikh and D. Bhatnagar, "A system of contradictory goals and realization of ambidexterity: a case study of a municipal corporation," *International Journal of Public Administration,* vol. 41, no. 2, pp. 95-109, 2018.

[7] T. Choi and S. M. Chandler, "Exploration, exploitation, and public sector innovation: An organizational learning perspective for the public sector," *Human Service Organizations: Management, Leadership & Governance,* vol. 39, no. 2, pp. 139-151, 2015.

[8] I. Mergel, S. Ganapati, and A. B. Whitford, "Agile: A new way of governing," *Public Administration Review,* vol. 81, no. 1, pp. 161-165, 2020.

[9] K. Beck *et al.* "Manifesto for agile software development." https://agilemanifesto.org/ (accessed 09/29/2021).

[10] N. Abbas, A. M. Gravell, and G. B. Wills, "Historical roots of agile methods: Where did "Agile thinking" come from?," in *International Conference on Agile Processes and Extreme Programming in Software Engineering*, 2008, pp. 94-103.

[11] T. Dybå and T. Dingsøyr, "Empirical studies of agile software development: A systematic review," *Information and software technology*, vol. 50, no. 9, pp. 833-859, 2008.

[12] Y. Weber and S. Y. Tarba, "Strategic agility: A state of the art introduction to the special section on strategic agility," *California Management Review,* vol. 56, no. 3, pp. 5-12, 2014.

[13] B. Horlach and A. Drechsler, "It's Not Easy Being Agile: Unpacking Paradoxes in Agile Environments," in *International Conference on Agile Software Development*, 2020, pp. 182-189.

[14] J. Varajao, G. Fernandes, A. Amaral, and A. M. Gonçalves, "Team Resilience Model: An Empirical Examination of Information Systems Projects," *Reliability Engineering & System Safety,* vol. 206, Article 107303, 2021.

[15] J. Birkinshaw and J. Ridderstråle, *Fast/Forward: Make Your Company Fit for the Future,* Redwood City: Stanford University Press, 2017.

[16] S. Denning, "How to make the whole organization "Agile"," *Strategy & Leadership,* vol. 43, no. 6, pp. 10-17, 2015.

[17] K. Werder and C. S. Heckmann, "Ambidexterity in Information Systems Research: Overview of Conceptualizations, Antecedents, and Outcomes," *Journal of Information Technology Theory and Application,* vol. 20, no. 1, 2019.

[18] J. Iivari, "A Paradox lens to Systems Development projects: The Case of the Agile Software Development," *Communications of the Association for Information Systems* vol. 49, Article 4, 2021.

[19] J. Iivari, "A framework for paradoxical tensions of project management," *International Journal of Information Systems and Project Management,* vol. 9, no. 1, Article 2, 2021.

[20] S. Pellegrinelli, R. Murray-Webster, and N. Turner, "Facilitating organizational ambidexterity through the complementary use of projects and programs," *International Journal of Project Management,* vol. 33, no. 1, pp. 153-164, 2015.

[21] P. Sailer, "Project management methods as a way to ambidexterity," *International Journal of Managing Projects in Business,* Article vol. 12, no. 4, pp. 1061-1078, 2019.

[22] N. Turner and L. Lee-Kelley, "Unpacking the theory on ambidexterity: An illustrative case on the managerial architectures, mechanisms and dynamics," *Management Learning,* vol. 44, no. 2, pp. 179-196, 2013.

[23] C. A. O'Reilly and M. L. Tushman, "Organizational ambidexterity in action: How managers explore and exploit," *California Management Review,* vol. 53, no. 4, pp. 5-22, 2011.

[24] J. Magnusson, D. Koutsikouri, and T. Päivärinta, "Efficiency creep and shadow innovation: enacting ambidextrous IT Governance in the public sector," *European Journal of Information Systems,* vol. 29, no. 4, pp. 329-349, 2020.

[25] N. Turner, H. Maylor, and J. Swart, "Ambidexterity in projects: an intellectual capital perspective," *International Journal of Project Management,* vol. 33, no. 1, pp. 177-188, 2015.

[26] W. K. Smith and M. W. Lewis, "Toward a theory of paradox: A dynamic equilibrium model of organizing," *Academy of management Review,* vol. 36, no. 2, pp. 381-403, 2011.

[27] C. VersionOne. "14th State of Agile survey." https://stateofagile.com/?_ga=2.132299718.935942205.1605613380-506223216.1605613380#ufh-i-615706098-14th-annual-state-of-agile-report/7027494 (accessed 09/22/2021).

[28] K. Schwaber and M. Beedle, *Agile software development with Scrum*. Prentice Hall Upper Saddle River, 2002.

[29] A. Zaitsev, U. Gal, and B. Tan, "Reviewing the Role of the Agile Manifesto and Agile Methods in Literature," in *Americas Conference on Information Systems (AMCIS*), New Orleans, LA, 2018, pp. 2613-2622.

[30] C. Prange and L. Heracleous, *Agility. X: How organizations thrive in unpredictable times*. Cambridge: Cambridge, UK: University Press, 2018.

[31] G. Mangalaraj, R. Mahapatra, and S. Nerur, "Acceptance of software process innovations–the case of extreme programming," *European Journal of Information Systems,* vol. 18, no. 4, pp. 344-354, 2009.

[32] A. Cockburn and J. Highsmith, "Agile software development, the people factor," *Computer,* vol. 34, no. 11, pp. 131-133, 2001.

[33] S. Syed-Abdullah, M. Holcombe, and M. Gheorge, "The impact of an agile methodology on the well being of development teams," *Empirical Software Engineering,* vol. 11, no. 1, pp. 143-167, 2006.

[34] D. K. Rigby, J. Sutherland, and H. Takeuchi, "The secret history of agile innovation," *Harvard Business Review,* pp. 2-5, April, 2016.

[35] T. J. Gandomani, H. Zulzalil, A. A. Ghani, A. B. M. Sultan, and K. Y. Sharif, "How human aspects impress Agile software development transition and adoption," *International Journal of Software Engineering and its Applications,* vol. 8, no. 1, pp. 129-148, 2014.

[36] N. B. Moe, A. Aurum, and T. Dybå, "Challenges of shared decision-making: a multiple case study of agile software development," *Information and Software Technology*, vol. 54, no. 8, pp. 853-865, 2012.

[37] M. L. Drury-Grogan, K. Conboy, and T. Acton, "Examining decision characteristics & challenges for agile software development," *Journal of Systems and Software,* vol. 131, pp. 248-265, 2017.

[38] K. Conboy, S. Coyle, X. Wang, and M. Pikkarainen, "People over process: key people challenges in agile development," *IEEE Software,* vol. 28, no. 4, pp. 48-57, 2011.

[39] C. Prange, "Agility as the Discovery of Slowness," *California Management Review,* vol. 63. no. 4, pp. pp. 27-51, 2021.

[40] J. Nuottila, K. Aaltonen, and J. Kujala, "Challenges of adopting agile methods in a public organization," *International Journal of Information Systems and Project Management,* vol. 4, no. 3, pp. 65-85, 2016.

[41] M. P. e. Cunha and L. L. Putnam, "Paradox theory and the paradox of success," *Strategic organization,* vol. 17, no. 1, pp. 95-106, 2019.

[42] E. J. Carlson, M. S. Poole, N. J. Lambert, and J. C. Lammers, "A study of organizational reponses to dilemmas in interorganizational emergency management," *Communication Research,* vol. 44, no. 2, pp. 287-315, 2017.

[43] M. S. Poole and A. H. Van de Ven, "Using paradox to build management and organization theories," *Academy of management review,* vol. 14, no. 4, pp. 562-578, 1989.

[44] M. W. Lewis, "Exploring paradox: Toward a more comprehensive guide," *Academy of Management review,* vol. 25, no. 4, pp. 760-776, 2000.

[45] M. W. Lewis, C. Andriopoulos, and W. K. Smith, "Paradoxical leadership to enable strategic agility," *California management review,* vol. 56, no. 3, pp. 58-77, 2014.

[46] R. W. Gregory, M. Keil, J. Muntermann, and M. Mähring, "Paradoxes and the nature of ambidexterity in IT transformation programs," *Information Systems Research,* vol. 26, no. 1, pp. 57-80, 2015.

[47] E. M. Pertusa-Ortega, J. F. Molina-Azorín, J. J. Tarí, J. Pereira-Moliner, and M. D. López-Gamero, "The microfoundations of organizational ambidexterity: A systematic review of individual ambidexterity through a multilevel framework," *BRQ Business Research Quarterly,* p. 2340944420929711, 2020.

[48] J. Schad, M. W. Lewis, S. Raisch, and W. K. Smith, "Paradox research in management science: Looking back to move forward," *The Academy of Management Annals,* vol. 10, no. 1, pp. 5-64, 2016.

[49] E. Miron-Spektor, A. Ingram, J. Keller, W. K. Smith, and M. W. Lewis, "Microfoundations of organizational paradox: The problem is how we think about the problem," *Academy of Management Journal,* vol. 61, no. 1, pp. 26-45, 2018.

[50] P. Jarzabkowski, J. K. Lê, and A. H. Van de Ven, "Responding to competing strategic demands: how organizing, belonging, and performing paradoxes coevolve," *Strategic Organization,* vol. 11, no. 3, pp. 245-280, 2013.

[51] W. K. Smith, M. Gonin, and M. L. Besharov, "Managing social-business tensions: A review and research agenda for social enterprise," *Business Ethics Quarterly,* vol. 23, no. 3, pp. 407-442, 2013.

[52] F. Maon, J. Vanhamme, K. De Roeck, A. Lindgreen, and V. Swaen, "The dark side of stakeholder reactions to corporate social responsibility: tensions and micro-level undesirable outcomes," *International Journal of Management Reviews,* vol. 21, no. 2, pp. 209-230, 2019.

[53] D. C. Smith, M. Bruyns, and S. Evans, "A project manager's optimism and stress management and IT project success," *International Journal of Managing Projects in Business,* Article vol. 4, no. 1, pp. 10-27, 2011.

[54] L. S. Lüscher and M. W. Lewis, "Organizational change and managerial sensemaking: Working through paradox," *Academy of Management Journal,* vol. 51, no. 2, pp. 221-240, 2008.

[55] S. Thangasamy, "Lessons learned in transforming from traditional to agile development," *Journal of Computer Science,* vol. 8, no. 3, pp. 389-392, 2012.

[56] G. T. Fairhurst, W. K. Smith, S. G. Banghart, M. W. Lewis, L. L. Putnam, S. Raisch, and J. Schad, "Diverging and converging: integrative insights on a paradox meta-perspective," *Academy of Management Annals,* vol. 10, no. 1, pp. 173-182, 2016.

[57] R. G. Cooper and A. F. Sommer, "The Agile–Stage-Gate hybrid model: a promising new approach and a new research opportunity," *Journal of Product Innovation Management,* vol. 33, no. 5, pp. 513-526, 2016.

[58] M. Farjoun, "Contradictions, Dialectics, and paradoxes," in *The Sage handbook of process organization studies*, A. T. Langley, H. Ed. Londo, UK: Sage, 2016, pp. 87-109.

[59] C. Andriopoulos and M. W. Lewis, "Exploitation-exploration tensions and organizational ambidexterity: Managing paradoxes of innovation," *Organization science,* vol. 20, no. 4, pp. 696-717, 2009.

[60] R. B. Duncan, "The ambidextrous organization: Designing dual structures for innovation," *The management of organization,* vol. 1, no. 1, pp. 167-188, 1976.

[61] J. Birkinshaw and K. Gupta, "Clarifying the distinctive contribution of ambidexterity to the field of organization studies," *Academy of Management Perspectives,* vol. 27, no. 4, pp. 287-298, 2013.

[62] S. Raisch and J. Birkinshaw, "Organizational ambidexterity: antecedents, outcomes, and moderators," *Journal of management,* vol. 34, no. 3, pp. 375-409, 2008.

[63] D. Lavie, U. Stettner, and M. L. Tushman, "Exploration and exploitation within and across organizations," *The Academy of Management Annals,* vol. 4, no. 1, pp. 109-155, 2010.

[64] J. Birkinshaw, A. Zimmermann, and S. Raisch, "How do firms adapt to discontinuous change? Bridging the dynamic capabilities and ambidexterity perspectives," *California Management Review,* vol. 58, no. 4, pp. 36-58, 2016.

[65] J. Luger, S. Raisch, and M. Schimmer, "Dynamic balancing of exploration and exploitation: The contingent benefits of ambidexterity," *Organization Science,* vol. 29, no. 3, pp. 449-470, 2018.

[66] M. Hughes, "Organisational ambidexterity and firm performance: burning research questions for marketing scholars," *Journal of Marketing Management,* vol. 34, no. 1-2, pp. 178-229, 2018.

[67] C. B. Gibson and J. Birkinshaw, "The antecedents, consequences, and mediating role of organizational ambidexterity," *Academy of management Journal,* vol. 47, no. 2, pp. 209-226, 2004.

[68] C. Lindskog and M. Magnusson, "Ambidexterity in Agile software development: a conceptual paper," *Journal of Organizational Effectiveness: People and Performance,* vol. 8, no. 1, pp. 16-43, 2021.

[69] R. K. Yin, *Case study research and applications: Design and methods*, 6th ed. Thousand Oaks, CA: Sage publications, 2017.

[70] D. R. Hancock and B. Algozzine, *Doing case study research: A practical guide for beginning researchers*. New York, NY: Teachers College Press, 2017.

[71] S. Nerur, R. Mahapatra, and G. Mangalaraj, "Challenges of migrating to agile methodologies," *Communications of the ACM,* vol. 48, no. 5, pp. 72-78, 2005.

[72] O. McHugh, K. Conboy, and M. Lang, "Agile practices: the impact on trust in software project teams," *IEEE Software,* vol. 29, no. 3, pp. 71-76, 2011.

[73] X. Wang, E. Ó Conchúir, and R. Vidgen, "A paradoxical perspective on contradictions in agile software development," in *16th European Conference on Information Systems (ECIS),*Galway, Ireland, 2008, pp. 1-13.

[74] V. Michaud, "Words fly away, writings remain–paradoxes in and around documents," *Qualitative Research in Organizations and Management: An International Journal*, vol. 12, no. 1, pp. 33-52, 2017.

[75] M. Borg, T. Olsson, U. Franke, and S. Assar, "Digitalization of Swedish government agencies-a perspective through the lens of a software development census," in *2018 IEEE/ACM 40th International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS),* pp. 37-46.

[76] R. Atkinson, "Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria," *International Journal of Project Management*, vol. 17, no. 6, pp. 337-342, 1999.

[77] C. Tam, E. J. da Costa Moura, T. Oliveira, and J. Varajão, "The factors influencing the success of on-going agile software development projects," *International Journal of Project Management,* vol. 38, no. 3, pp. 165-176, 2020.

[78] G. Thomas and K. Myers, *The anatomy of the case study*. Thousand Oaks, CA: Sage, 2015.

[79] A. S. Lee and R. L. Baskerville, "Generalizing generalizability in information systems research," *Information systems research*, vol. 14, no. 3, pp. 221-243, 2003.

[80] H. Wimelius, L. Mathiassen, J. Holmström, and M. Keil, "A paradoxical perspective on technology renewal in digital transformation," *Information Systems Journal*, vol. 31, no. 1, pp. 198-225, 2021.

Biographical notes

Carin Lindskog

Carin Lindskog is interested in exploring the expanding Agile way of developing software by using the lenses of paradoxical tensions and organizational ambidexterity. She has been employed as a lecturer in information systems and project management at Karlstad University, in Sweden, since 2001 and has been teaching students on both the Bachelor’s and Master’s levels. Currently, she is a PhD student at Karlstad University, and her dissertation is planned for the end of 2022.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Can product modularization approaches help address challenges in technical project portfolio management? – Laying the foundations for a methodology transfer

Thorsten Lammers
Centre for Advanced Manufacturing, University of Technology Sydney
Broadway, Ultimo NSW 2007, Australia
thorsten.lammers@uts.edu.au

Matthias Guertler
Centre for Advanced Manufacturing, University of Technology Sydney
Broadway, Ultimo NSW 2007, Australia
matthias.guertler@uts.edu.au

Henning Skirde
ID-Consult GmbH
Rupert-Mayer-Strasse 46, 81379 Munich, Germany
henning.skirde@tuhh.de

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

T. Lammers, M. Guertler, H. Skirde, "Can product modularization approaches help address challenges in technical project portfolio management? – Laying the foundations for a methodology transfer", *International Journal of Information Systems and Project Management*, vol. 10, no. 2, pp. 26-42, 2022.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Can product modularization approaches help address challenges in technical project portfolio management? – Laying the foundations for a methodology transfer

Thorsten Lammers
Centre for Advanced Manufacturing, University of Technology Sydney
Broadway, Ultimo NSW 2007, Australia
thorsten.lammers@uts.edu.au

Matthias Guertler
Centre for Advanced Manufacturing, University of Technology Sydney
Broadway, Ultimo NSW 2007, Australia
matthias.guertler@uts.edu.au

Henning Skirde
ID-Consult GmbH
Rupert-Mayer-Strasse 46, 81379 Munich, Germany
henning.skirde@tuhh.de

Abstract:
Formalized Project Portfolio Management (PPM) models struggle to provide comprehensive solutions to project selection, resource allocation and adaptability to dynamic technology project environments. In this article, we introduce a vision for a novel Modular Project Portfolio Management (MPPM) approach by drawing on well-established engineering methods for designing modular product architectures. We show how systems theory can be used to enable a transfer of methods from the area of engineering design and manufacturing to the area of PPM and how the concept of product modularity could help address challenges of existing PPM approaches. This lays the groundwork for the possible development of MPPM as a new and innovative methodology for managing complex technology and engineering project landscapes.

Keywords:
project portfolio management; technology projects; modular product architecture; systems theory; method transfer; project selection.

DOI: 10.12821/ijispm100202

Manuscript received: 30 June 2021
Manuscript accepted: 29 April 2022

1. Introduction

Technology organizations operate in highly dynamic, volatile and uncertain environments. Those environments can trigger changes to their strategy and performance, and they can affect how projects are designed and executed. In this respect, VUCA (volatility, uncertainty, complexity and ambiguity) has become a common phrase in different domains such as industry and military [1]. It can be caused by external changes (e.g. politics, market), internal changes (e.g. technologies, strategies) as well as project-specific changes (e.g. customer needs, project delays) [2, 3]. The result is a high level of project uncertainty that requires flexibility, fast-paced responses and frequent adaptations of projects and project portfolios [1].

Traditional linear and rigid project and process management approaches are increasingly struggling to sufficiently address these uncertainties and the need for frequent adaptations. This has led to the ongoing rise of agile approaches like "Scrum" or "lean start-ups", which are "able to change, or to be changed, rapidly and cost effectively" [4, 5]. Their step-wise and iterative process structure, including an inherent reflection and learning process, allows for continuous project evaluation and course adaptations [6]. In the context of continuous planning, more recent approaches have even looked at evolving baselines for performance estimation to overcome shortcomings of traditional rigid methods [7]. However, lean, agile or "leagile" approaches also present their own challenges for companies and have a strong focus on software projects [8]. Although they allow for the sufficient management of changes within projects, they are a challenge for overarching programs because project outcomes, timelines and progress are less deterministic compared to linear approaches.

In general, existing linear and agile program and portfolio management approaches tend to consider projects as the smallest unit and focus on the strategic selection of suitable projects [2, 3, 9]. Besides these strategic considerations, some companies use project portfolio management (PPM) on a tactical level with the aim of managing short-term resource capacity as well as project dependencies and sequences [10, 11]. Challenges of PPM include efficiency gains through standardisation of work packages within and reuseability across the project boundaries [12]. Risks to the success of project portfolios have been studied and consolidated extensively in recent literature (for example [13, 14]).

We aim to contribute to the discussion on how to address those shortcomings by exploring new contributions to the strategic and tactical dimensions of PPM, considering links between project activities, and supporting the derivation of logical project modules and the reuse of interim outcomes [8, 15].

In the field of technology and engineering management, product modularization and platform approaches could be well-placed to address these shortcomings. These approaches are well-established in fields such as the automotive industry, where they are used to structure complex systems into more manageable subsystems, modules and components [16, 17, 18, 19]. Besides having modules with defined dependencies and interfaces, this enables for standardization across platforms, which in turn allows for the cost-efficient use and re-use of components and modules [20, 21].

In the past, first attempts have been made to use the idea of modularity in order to describe projects in a conceptual way [22]. More recently, the role of project modularity has been explored in the context of information systems development [23]. Nevertheless, while product modularization theories and approaches have proven to be highly successful and transferable to other contexts [24], they have not been fully adopted in a project portfolio management context to date, despite a promising degree of similarities.

Therefore, in this article, we ask how concepts for designing flexible modular product architectures in engineering design can be transferred to the realm of PPM and if they can help address current challenges.

In the next section, we provide brief backgrounds on both the management of project landscapes and product modularization as focal fields of research. This is followed by a description of the applied conceptual research methodology to explore the feasibility of a new Modular Project Portfolio Management (MPPM) approach in section three. Then, we present the findings: In section four, we introduce a taxonomy based on systems theory to analyze the characteristics of products and projects and to derive transfer criteria for modularization methods. In section five, we develop an overview of current challenges for PPM approaches and subsequently discuss how modularization could help. For this assessment, we introduce an established product modularization methodology, called METUS, as an example. In section six, we conclude with a discussion of our findings and their significance and outline potential next steps and considerations for the development of an MPPM methodology.

2. Background

2.1 Strategic and tactical PPM

In organizational planning and management, PPM is defined as "the management of a multi-project organization and its projects in a manner that enables the linking of the projects to business objectives" [25]. Program management refers to "the integration and management of a group of related projects with the intent of achieving benefits that would not be realized if they were managed independently". In contrast, PPM – on a more aggregated level – does not only include related projects, but also deals with the challenges of achieving strategic advantage by coordinating and aligning several projects that draw from the same resources [26]. Therefore, program management focusses on "doing projects right", while project portfolio management focusses on "doing the right projects" [27]. Different key elements are [27]:

- Interdependencies: the identification and reduction of competition for resources among projects (also [28]);
- Prioritization, alignment and selection: the composition of a project portfolio, its scope and importance in line with business strategic goals (also [29]); and
- Dynamic re-assessment of the portfolio: the possibility to abandon projects after initiation (also [30]).

In recent years, many efforts have been made to formalize programs and portfolios by generating standards, frameworks, formal evaluation criteria and guidelines [31]. Integration of methods into technology and product development have shown to be able to align business and technology innovation goals [32]. However, formalized models are still struggling to provide comprehensive solutions for project selection, resource allocation and dealing with dynamic project environments [33]. In this context, coaction and dynamics are key complexity drivers in the configuration of projects.

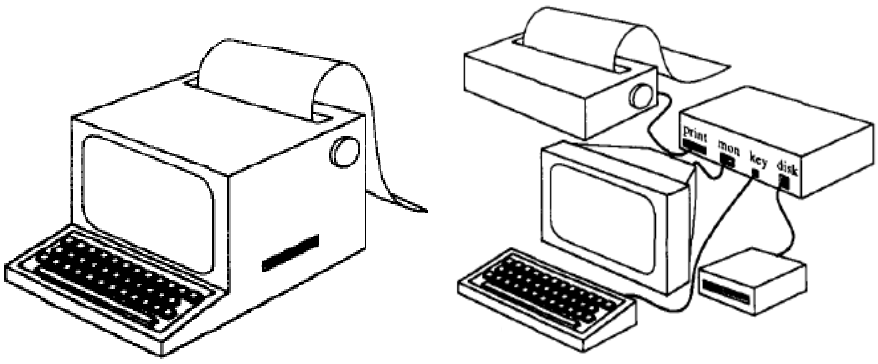
Besides the focus of strategic PPM on aligning projects with the strategic objectives of the organization and determining whether the organization should invest in the project, tactical PPM focusses on efficient product selection and implementation [34]. On this level, areas of concern are a loss of interim results when projects are stopped, negative side effects for other projects when focal projects are changed or stopped due to dependencies between projects, and the neglect of synergy and learning effects when planning new projects [15]. Recent investigations have produced comprehensive sets of risks to the success of a project portfolio, including sharing resources across and interdependencies between projects, affecting smooth communication flow as well as portfolio fragmentation [14, 13, 11]. These sources of complexity and interdependency present a particular challenge in tactical PPM. Managing project interdependencies in technical project portfolios tends to be a complex task [11]. Hence, there is a need for improved methods to understand and manage project interdependencies since they form the foundation of project identification and scoping [35]. We will build on this initial overview by creating a more detailed set of PPM challenges and requirements as part of our analysis in section 5.1.

2.2 Product modularization – a source of inspiration to tackle PPM challenges?

In the field of engineering design and manufacturing, the challenge of managing complexity and interdependency of physical modules has been successfully addressed by the introduction of modular product architectures [36]. In 1999, Volkswagen saved US$1.7 billion on costs for product development and manufacturing using modular product architectures [37].

Product modularization and platform approaches analyze dependencies between components and group them into suitable modules, considering different module drivers across the entire product lifecycle [38]. Reducing dependencies between modules and the standardization of components and interfaces decreases uncontrolled side effects and allows for flexible architectural changes. The use of standardized components across product platforms also allows the use and/or reuse of existing component kits, which leads to cost savings through economies of scale and the division of labour, an effective coordination of processes and the avoidance of bottlenecks [20, 21].

In order to address the specific demands of customers, product variants need to become increasingly individual. However, this is in conflict with increased cost pressures in a globalized competitive environment [39]. Modular product architectures address this conflict by allowing the creation of a broad variety of products (so called external variance) using a limited number of interchangeable modules with standardized interfaces (so called internal variance) as shown in Figure 1 [40].



INTEGRAL **MODULAR**

Fig. 1. Integral and modular product architectures [36]

In this context, an important characteristic of a system is its degree of modularity. The degree of modularity is located within the gradual spectrum between a completely integral and a completely modular architecture [19, 41, 42, 43, 44, 45]. Modularization refers to the activity of rearranging a system in a way that an optimal (not maximal) level of modularity for a certain purpose is achieved. In the modularization process, subsystems are created that are relatively independent from each other [16]. By creating modules with standardized interfaces, manifold benefits in development and production can be realized [36]. A degree of modularity that is too high, can however lead to numerous interfaces between individual building blocks. The alignment among these building blocks becomes conspicuous and thus would increase transaction costs.

The process of modularization generally follows a common workflow [46]:

- Decomposition of existing product structure and identification of product components as smallest unit of analysis – depending on the desired granularity, a component could be a single part (e.g. a screw) or an assembly group (e.g. a gear box);
- Analysis of components and their interdependencies (e.g. mechanical links, electrical links or information exchange);
- Arrangement of components into modules as new smallest unit of analysis considering specific module drivers (e.g. better functional alignment, improved mechanical interfaces etc.).

There is a range of different modularization methodologies that is used in engineering design and manufacturing (e.g. [18, 41]). Several of those methodologies have been developed and implemented with the aim of identifying and shaping modules according to specific purposes and to assess the related costs. While following the broadly similar workflow outlined above, different methodologies put emphasis on different aspects, such as functions, suppliers and logistics [47], the strength of the coupling between components [48], and heuristic methods [40]. Mathematical models to assess the level of modularity have also been developed [49]. More recent research initiatives are further investigating the cost and complexity effects of modular product architectures and their impact on the design of effective supply chains, and are creating a common language around the manifold approaches [20, 44, 50].

Product modularization approaches have already been used to successfully enhance management in other fields such as logistics [51], supply chains and production systems [52], business modelling [53] and business services [54].

3. Method

Before transferring a methodology into a new research context, it makes sense to gather directional input on its potential success [55, 56]. In order to gain this directional input and to provide a basis for eventually initiating the development of an MPPM theory, we follow a conceptual approach in this article [57]. To enable the theory building, we aim to create a theoretical framework that enables relationships between two distinct areas of research – product modularization and the management of project portfolios [58]. To connect those two areas, we will first develop a taxonomy for the transfer of parameters from modular product architectures to modular project portfolios, systematically arranging those parameters in relevant categories [59]. For this, systems theory is introduced as the bridging theory. From a methodological standpoint, systems theory will serve as a nomological network to enable the identification of linkages and to explore new connections between the two constructs of modular products and PPM [60, 61]. This builds the foundation for transferring a modularization methodology from the domain of engineering design to the domain of project management.

Next, we will review challenges of existing project management approaches from literature. Then, we refer back to them and use the example of the "Management Engineering Tool for Unified Systems" (METUS) as an established methodology for product modularization, to conceptualize the merit of a potential MPPM methodology towards addressing those challenges [59]. Methodologically speaking, the set of challenges will help us to determine to what extent, a new MPPM approach can provide supplementary value by bridging the observed gaps of the focal theory [58]. Figure 2 provides an overview of the applied research method.

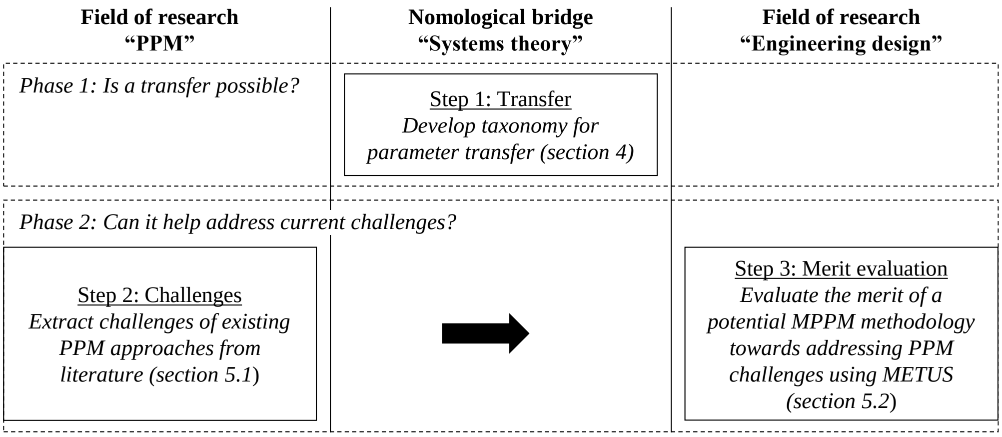


Fig. 2. Research design

4. Developing a taxonomy for parameter transfer

In this section, we identify key parameters used in methodologies for product modularization and demonstrate how they can be linked to equivalent parameters in the context of PPM. On a high level, product and project landscapes show a certain degree of structural similarity, such as a high number of different elements (e.g. components and modules vs. tasks and work packages) and a high number of different interdependencies (e.g. physical interfaces vs. information flows), which form a complex and dynamic system. However, a direct adoption of existing modularization approaches from products or technical systems to projects is not feasible due to the different nature of time dependencies and the increased role of human interaction in project environments [62].

To establish such a link, systems theory is identified as a theoretical bridge between the two domains. To establish these links, four aggregation levels are introduced to cluster the parameters. In systems theory, a system is made up of elements, which are linked via connections and system boundaries, which separate the system from its environment [63]. Systems consist of different modules, which are a kind of subsystem. They are defined by strong connections between its comprised elements, but only few and often standardized connections to external elements and modules. Systems are often part of overarching systems of systems [64].

Applying this systems theory lens to both product architectures and PPM, we see some general similarities between both domains (Figure 3).

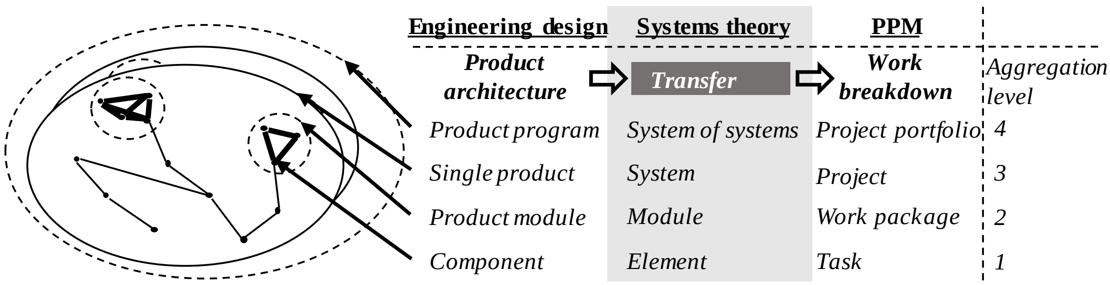


Fig. 3. Transfer of modularization approach to PPM

These are explored in more detail below. Using this neutral systems theory layer allows us to identify key characteristics of each domain and map them onto their equivalents in the other domain.

Aggregation level 1 – "Element":

The element, as a component or constituent of a whole, is the lowest building block of a system and is not further sub-divided [65]. In the context of this research, the element is represented by a physical component in engineering design and manufacturing (e.g. a screw). In the context of PPM, we consider a single task/activity within a project as an element.

Aggregation level 2 – "Module":

The module is a set of standardized or independent elements, which can be used to build a more complex structure [66]. It ideally contains elements with strong interactions between them. To the outside, there are only few and standardized interactions. In engineering design and manufacturing, components are merged into product modules based on their individual contributions towards fulfilling the same functionality (e.g. the keyboard as a module of the system "computer" fulfilling the function of a user interface). From a PPM perspective, a work package is the equivalent of a module comprising different tasks that attribute to the same objective.

Aggregation level 3 – "System":

A system consists of interrelated and interdependent elements and modules, which are systematically organized and structured [65]. In engineering design and manufacturing, this is represented by a single product consisting of elements and/or product modules. The PPM equivalent is a single project.

Aggregation level 4 – "System of systems":

The highest aggregation level considered in this research is the system of systems, defined as "an interoperating collection of component systems that produce results unachievable by the individual systems alone", including resources and capabilities of the component systems [64]. This level allows for modules with standardized interfaces and clearly defined functionalities to be replaced and/or shared across different systems. In engineering design and manufacturing, this is represented by a product program comprising a set of related products. For PM, system of systems corresponds to project portfolios consisting of individual projects.

The structure of corresponding system layers is the basis for a detailed analysis and mapping of system characteristics on all four levels. In addition to the structure of four system layers, the identification of parameters was guided by the definition of systemic properties (see Figure 3). In systems theory, systemic properties (such as complexity, flexibility and robustness) can be described by types and number of elements and connections and their development over time [67]. This structure allows us to search for context-specific representations of elements, connections and dynamics in the areas of both engineering design and PM.

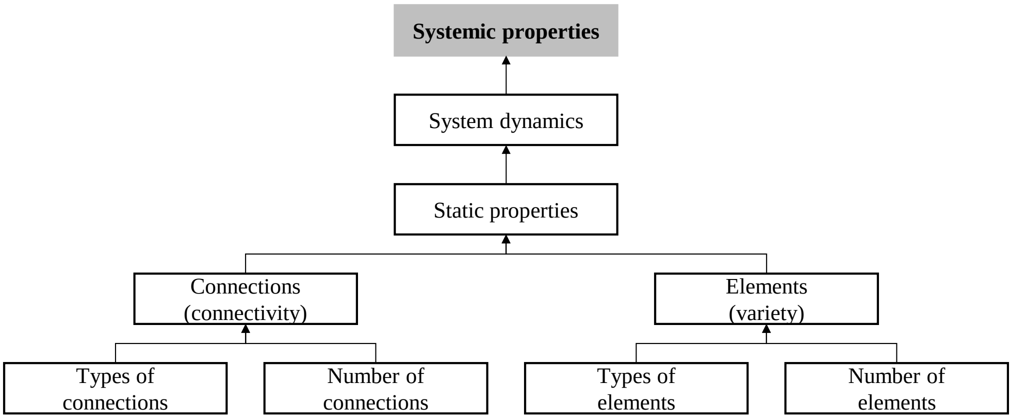


Fig. 3. Description of system properties (based on: [68, 69]])

The results and insights are consolidated in the Systems Transfer Taxonomy, illustrated in Table 1. Using the system properties and building blocks as a framework, we can identify contextual specifications in both areas and on all four aggregation levels, supporting a general transferability of methods based on the underlying structure and terminology. Some of those specifications are very similar in both areas (such as the simple number of products vs projects in a portfolio) and therefore might allow for a direct transfer of unchanged modularization methods. Others are different in that they represent physical properties (such as product dimensions or material interfaces between components) in engineering and intangible properties (such as project scope or information flows between tasks/work packages) in the realm of PPM. These differences, together with the heightened importance of the human factor in PPM environments, will necessitate a close examination of methods and appropriate changes in the process of adapting to the new context of PPM [62].

Table 1. Systems Transfer Taxonomy

	Engineering design ***(Contextual specification)***	**Systems theory layer** ***(General characteristic)***	**PM** ***(Contextual specification)***
Aggregation Level 4 **(strategic)**	***"Product program"***	***"System of systems"***	***"Program"***
	Number of products	*Number of systems*	*Number of projects*
	Usability of modules across products in product program	*Degree of system standardisation*	*Usability of work packages across projects in portfolio*
	Criteria for product modularisation (e.g. functional, supplier/department involvement, ability for concurrent engineering)	*Criteria for modularisation*	*Criteria for project modularisation (e.g. alignment of responsibilities, project objectives, resources, timeframes)*
	Contribution of products to business objectives	*Contribution to overarching objectives*	*Contribution of projects to strategic objectives*
	E.g. adaptivity, complexity, maintainability	*Emergent system properties*	*E.g. agility, complexity, flexibility*
Aggregation Level 3 **(tactical)**	***"Product"***	***"System"***	***"Project"***
	Number of product modules	*Number of modules*	*Number of work packages*
	Types of product modules	*Types of modules*	*Types of work packages*
	Number of connections between product modules	*Number of connections between modules*	*Number of work package dependencies*
	Types of connections between product modules	*Types of connections between modules*	*Types of work package dependencies*
	Product innovation cycles	*System dynamics*	*Evolving project scopes and priorities*
	Value-oriented alignment of customer priorities with module costs (target costing)	*Importance of modules*	*Prioritisation of work packages according to their contribution to project success*
	Definition of product dimensions	*Definition of system boundaries*	*Definition of project scope, objectives and timeframes*
	Degree of product modularity	*Degree of modularity*	*Degree of project modularity*
Aggregation Level 2 **(operational)**	***"Product module"***	***"Module"***	***"Work package"***
	Number of components	*Number of elements (extent)*	*Number of tasks*
	Types of components	*Types of elements (diversity)*	*Types of tasks*
	Number of connections (e.g. interfaces)	*Number of connections (density)*	*Number of task dependencies*
	Types of connections (e.g. energy, data, material)	*Types of connections (content)*	*Types of task dependencies (e.g. reporting structures, prerequisites*
	Product module innovation cycles	*Module dynamics (change of above system properties over time)*	*Evolving work package scopes and priorities*
Aggregation Level 1 **(fundamental)**	***"Component"***	***"Element"***	***"Task"***
	Physical properties (e.g. size, weight)	*Inherent system properties*	*Required labour (e.g. man-hours)*
	Functionality	*Justification of existence*	*Scope/objective*
	Number and type of interfaces: Capability to interact with other components	*Number and type of interfaces: Capability to interact with other elements (information, material, energy, spatial) (what can generally be exchanged?)*	*Type and number of interfaces (especially communication interfaces): Capability to interact with other tasks*
	Development, manufacturing efforts	*Resource requirements*	*Planning, execution efforts*

5. Can a new MPPM approach address challenges of existing PPM approaches?

5.1 An overview of PPM challenges

Resolving paradoxical tensions (such as between rigid or flexible approaches, control and autonomy, or individual and team-based rewarding) has been identified as a crucial factor for success on a project level [70]. However, due to the interplay of different projects with individual and interdependent uncertainties, dynamics and complexity, PPM cannot rely on upscaled project management approaches [35]. It requires specific and structured approaches that can be tailored to the specific application context [5, 35, 71]. It remains to be seen to what extent those challenges remain critical for success. Traditional PPM approaches tend to focus on selecting projects on a strategic level to optimize the value of the entire project portfolio [9]. However, this might not be sufficient for a more agile PPM [72]. There is a necessity for a more detailed consideration of projects based on activity level, even though that means greater effort required as a result [15]. A PPM approach should combine a strategic and an operational perspective. The strategic perspective includes the alignment of portfolios with company strategies, adaptability to internal and external changes, and the insurance of value proposition. The operational perspective includes project visibility to stakeholders, transparency in decision-making and predictability of outcomes [73]. It is important to align PPM with organizational structures and processes along with the company strategy [72]. From a decision-making perspective, multiple factors need to be considered for a systematic ranking of projects such as project costs, timelines and necessary resources [35, 71, 72].

A key requirement of a successful agile PPM is the consideration of project dependencies [35, 74, 75]. This is specifically true for high tech R&D environments [76]. Dependencies can be clustered into financial dependencies (shared funding sources), resource dependencies (shared infrastructure and resources), market or benefit dependencies (complementary or competitive effects), outcome dependencies (projects' use of other project outputs), and learning dependencies (projects' use of the learnings from other projects) [35, 76]. These dependencies and interactions need to be monitored in all phases of a project's lifecycle to allow for performance to be controlled and risks to be managed [5, 71]. Along with dependencies between ongoing projects, it is also crucial to consider dependencies between ongoing and potential projects in the project pipeline [71, 75]. For technology projects, a quantification of those interdependencies can help to optimize project selection and evaluate changes to the portfolio [77]. In addition, it is important to consider and involve different key stakeholders, such as project managers and middle and senior management sponsors [78].

Table 2 takes into consideration the project portfolio risks (component, structural and general) shown in Hofman and Grela [13] as a basis and consolidates them into a set of high-level challenges, clustered along different perspectives, in order to initiate the assessment of a potential MPPM method.

Table 2. Challenges of PPM approaches

Perspective	**Challenge**	**Additional source**
Agility	*Tailorable approach concerning different application contexts*	[35]
	Adaptability to internal and external changes	[72, 73]
	Continuous consideration of all project phases across the entire project lifecycle	[5, 71]
	Involvement of different key stakeholders	[78]
Complexity	*Size of portfolio and consideration of multiple project criteria, such as costs, timeframes and necessary resources*	[71, 72]
	Consideration of project dependencies (financial, resources, market/benefit, outcomes, learnings)	[35, 74, 76]
	Consideration of dependencies between ongoing projects and potential ones in the project pipeline	[71, 75, 77]
Structural alignment	*Hierarchical structure of portfolio*	[5, 71]
	Alignment to company strategy and value proposition	[72, 73]
	Alignment with organisational structures and processes	[72]
Transparency	*Consideration of project activities and methodical standards for portfolio element management*	[15]
	Project visibility to key stakeholders and transparent decision-making process and information flow	[73]
	Predictability of project deliverables and information transfer between portfolio elements	[73]

5.2 Assessing the merit of a modularization approach in addressing the PPM requirements

We now introduce an existing product modularization methodology as an example and assess its potential to address those current challenges of PPM. This allows us to determine whether an MPPM method could be used as a desirable alternative to fill the gap in current PPM approaches.

METUS is an established modularization tool that uses a solution-neutral modelling approach, is available as a software for data handling and visualization, and is adaptable to different use cases. METUS originates from the German automotive industry [79]. It structures and systematically enhances system development processes with a focus on creating modules based on their functional alignment. Figure 4 illustrates the underlying principle.

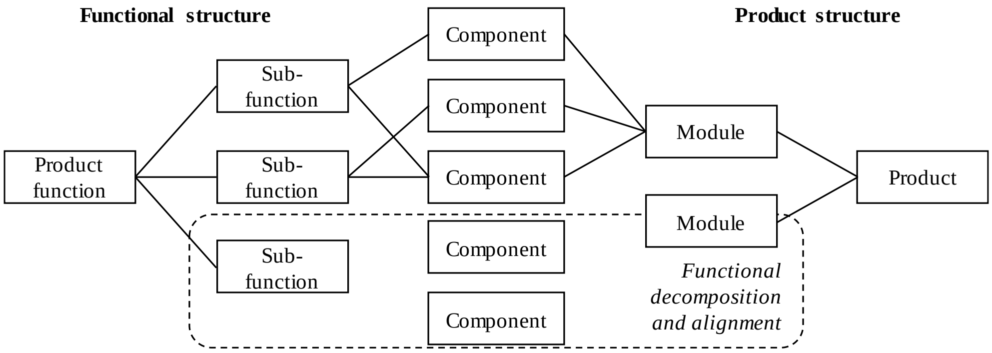


Fig. 4. Product architecture for METUS [79]

Due to the modular and adaptable structure of the METUS methodology and software, they can be easily tailored to different application contexts, companies, user needs and products. The ability to replace product structures with project portfolios makes METUS a promising candidate for exploring its applicability in a PPM context.

METUS substantiates the generic modularization workflow for product modularization outlined earlier [80]. Table 3 summarizes this workflow and shows, how it could be translated to the PPM context.

Table 3. High-level workflow of METUS-based MPPM

Step	METUS	METUS-based MPPM
1	*Clarify objectives of a modularization project and identify the product requirements that reflect customer needs and market dynamics*	*Clarify objectives of technology project portfolio and identify the project requirements that reflect stakeholder needs and alignment with company strategy*
2	*Create a solution-neutral functional structure that hierarchically decomposes the main function of the product into sub-functions (without mental constraints of an existing physical system)*	*Create a functional structure, free from organizational limitations, that decomposes the overall strategic goal of the technology portfolio into appropriate sub-goals based on previously identified requirements*
3	*Create an existing product structure by identifying components, interfaces and assembly groups of the product (only if existing product is modularized; can be skipped if new product is being developed)*	*Create an existing project structure by identifying tasks, activities, organizational dependencies and information flows of the projects (only if current project landscape exists; can be skipped if new portfolio is being developed)*
4	*Map sub-functions to components and create new modules that group components based on their functional alignment*	*Map sub-objectives to tasks and create new modules that group tasks based on their strategic alignment*
5	*Optimize new product architecture based on product-specific variant drivers and alignment with company objectives (e. g. optimise for supplier network, logistics, packaging, re-useability of modules etc.)*	*Optimize new project structure based on project-specific variant drivers and alignment with company objectives (e. g. optimise for resource allocation, budget constraints,project independence, re-useability of project results etc.)*

We can now assess METUS and its high-level workflow against the previously established challenge perspectives of agility, complexity, structural alignment and transparency in the following sections.

Agility perspective

A METUS-based MPPM approach could be tailored to different contexts. It offers the freedom to adjust the structure of the model and the Key Performance Indicators (KPIs) and is very flexible in terms of which data are fed into it. The tool is built in a modular way and consists of solution modules that allow flexible adaption to different application scenarios, such as project portfolios. Variant drivers define alternative customer-relevant product characteristics to address the needs of different customers (such as different colors, engine performances or bodyworks of a car). In combination with the product structure, the variant drivers help identify structural standard or platform elements (common in every product variant), variant elements (different for each product variant) and optional elements (not in every product variant, these elements may be standard or variant). Similar to modules and products, requirements are different between projects and portfolios and depend on the needs of stakeholders. These changing requirements can be mapped into variant drivers in METUS. Stakeholder alignment is also a core concept of METUS. A potential loss of agility can arise however from the fact that METUS is often used sequentially in a project’s context. However, the methodology allows for parallel processing, which would benefit overall agility.

Complexity perspective

A key weakness of METUS is its ability to consider dependencies between ongoing and upcoming projects. However, the tool generally allows for mapping of inter-project dependencies. It also allows for the consideration of multiple project success criteria such as cost, quality and time, which are widely similar to criteria from product modularization. Addressing complexity requirements such as cost and effect relationships is a core feature of METUS, but successful implementation requires a software to ensure correct application and visibility of dependencies. The new product architecture concept is then assessed on its interface optimization, make-or-buy analysis and an enhancement of the supplier structure, which would also become a step in the MPPM workflow (see Table 3). Overall, the METUS approach comprises 18 steps, so called “solution modules”, which form a generic workflow that guides product developers through the modularization process.

Structural alignment perspective

METUS has the ability to address requirements related to structural alignment of project portfolios. It can easily be aligned with organizational structures and processes as projects need to fulfil a structure’s set of functions like products. Instead of mapping this functional structure to a product structure, METUS can be adapted to PPM to map functional structures onto project structures instead. Alignment to strategy and processes is possible as well in that way.

Transparency perspective

Visibility to key stakeholders is enforced within the tool, which has the effect of increased transparency. This requirement also reiterates the necessity of using a software tool to provide transparency and highlights the need to communicate deliverables clearly as this is not an integral part of the METUS workflow. METUS is generally implemented through a dedicated software to allow for good usability, easy data manipulation and handling, testing of different settings, transparency and the visualization of complex structures and dependencies. The software also enables interdisciplinary experts to collaborate and consolidate their knowledge in one data model as well as capture the lessons learnt.

6. Conclusion and outlook

Efficient PPM will be highly relevant to prepare new and existing industries in an era of digital transformation and ever-increasing complexity for the challenges of increasing global competition and limited resources. In this article, we explore the possibility and merit of transferring established modularization methodologies from the context of engineering design and manufacturing to the context of PPM. To demonstrate that a transfer is possible, we develop a taxonomy based on systems theory to establish correlations between the central parameters of products and project. After that, an exploratory analysis of an established product modularization methodology (in this case METUS) is performed in order to assess its capacity to address PPM requirements for technology projects.

This research contributes to closing an open research gap around agile PPM approaches, which goes beyond approaches focusing on single projects like Scrum. The Systems Transfer Taxonomy provides new insights into a systematic transfer of approaches and methods between different disciplines and domains, which can also inform other research fields such as cross-industry innovations. Therefore, MPPM also contributes to a better understanding of transdisciplinary research initiatives.

The practical implications of a newly developed MPPM approach would be that companies could react more flexibly and quickly to project changes and changing boundary conditions. This could support companies in better dealing with known and unknown project uncertainties. In addition, the modular and standardized project setup with self-contained work packages would increase the reusability of intermediate outcomes. In the medium-term, this allows for a better exploitation of experience and knowledge and enhances the value from limited resources across multiple portfolios.

However, certain limitations have to be considered and can inform future studies on this topic. We have used one well-established product modularization methodology (METUS) as an example to show how the concept of modularity can help address PPM challenges. Other methodologies might be just as or even more appropriate for future works on developing an MPPM methodology. Other approaches that could be considered include Modular Function Deployment (MFD) [81] and Modular Engineering [82]. Further modularization methods (without a corresponding software tool) to be taken into consideration are the ones by Baldwin and Clark [16], Pimmler and Eppinger [83] or Ulrich [36].

The next step will be to develop an executable MPPM methodology that effectively and efficiently addresses current PPM challenges. In the process of developing this methodology, a set of empirical data should be collected to ensure it includes and correctly prioritizes all relevant (potentially industry-specific) steps towards designing modular project portfolios. In the context of developing the methodology, its viability will have to be considered to create a sustainable business model for implementation and produce positive financial outcomes. Therefore, direct evaluations in different organizations are suggested to ensure the applicability and benefits of this new MPPM methodology.

References

[1] A. Sarkar, "We live in a VUCA World: The importance of responsible leadership," *Development and Learning in Organizations,* vol. 30, no. 3, pp. 9-12, 2016.

[2] M. Martinsuo, T. Korhonen and T. Laine, "Identifying, framing and managing uncertainties in project portfolios," *International Journal of Project Management,* vol. 32, no. 5, pp. 732-746, 2014.

[3] M. Martinsuo and C. P. Killen, "Value Management in Project Portfolios: Identifying and Assessing Strategic Value," *Project Management Journal,* vol. 45, no. 5, pp. 56-70, 2014.

[4] M. A. G. Darrin and W. S. Devereux, "The Agile Manifesto, design thinking and systems engineering," in *Annual IEEE International Systems Conference (SysCon),* Montreal, 2017.

[5] K. Parvan, H. Rahmandad and A. Haghani, "Inter-phase feedbacks in construction projects," *Journal of Operations Management,* Vols. 39-40, pp. 48-62, 2015.

[6] E. C. Conforto, D. C. Amaral, S. L. da Silva, A. Di Felippo and D. S. L. Kamikawachi, "The agility construct on project management theory," *International Journal of Project Management,* vol. 34, no. 4, pp. 606-674, 2016.

[7] S. Chhetri and D. Du, "Continual learning with a Bayesian approach for evolving the baselines of a leagile project portfolio," *International Journal of Information Systems and Project Management,* vol. 8, no. 4, pp. 46-65, 2020.

[8] C. J. Stettina and J. Hörz, "Agile portfolio management: An empirical perspective on the practice in use," *International Journal of Project Management,* vol. 33, no. 1, pp. 140-152, 2015.

[9] N. P. Archer and F. Ghasemzadeh, "An integrated framework for project portfolio selection," *International Journal of Project Management*, vol. 17, no. 4, pp. 207-216, 1999.

[10] T. Washington, "Tactical or Strategic PPM," CloudBYZ, 25 10 2017. [Online]. Available: https://www.cloudbyz.com/blog/project-portfolio-management/tactical-or-strategic-ppm/. [Accessed 11 06 2021].

[11] S. Bathallath, A. Smedberg and H. Kjellin, "Managing project interdependencies in IT/IS project portfolios: a review of managerial issues," *International Journal of Information Systems and Project Management,* vol. 4, no. 1, pp. 67-82, 2016.

[12] D. J. Wessels and C. Wilson, "From tactical project management to strategic project leadership," in *PMI® Global Congress 2009—North America*, Orlando, 2009.

[13] M. Hofman and G. Grela, "Project portfolio risk categorisation –factor analysis results," *International Journal of Information Systems and Project Management,* vol. 6, no. 4, pp. 39-58, 2018.

[14] C. Micán, G. Fernandes and M. Araújo, "Project portfolio risk management: a structured literature review with future directions for research," *International Journal of Information Systems and Project Management* , vol. 8, no. 3, 2020.

[15] B. S. Blichfeldt and P. Eskerod, "Project portfolio management – There's more to it than what management enacts," *International Journal of Project Management,* vol. 26, no. 4, pp. 357-365, 2008.

[16] C. Y. Baldwin and K. B. Clark, Design rules, Cambridge, Mass: MIT Press, 2000.

[17] D. Doran and M. K. Starr, "Modular production – a 45-year-old concept," *International Journal of Operations & Production Management,* vol. 30, no. 1, pp. 7-19, 2010.

[18] S. K. Fixson, "Modularity and Commonality Research: Past Developments and Future Opportunities," *Concurrent Engineering,* vol. 15, no. 2, pp. 85-111, 2016.

[19] K. T. Ulrich and S. D. Eppinger, Product design and development, Boston: McGraw-Hill Higher Education, 2008.

[20] H. Skirde, W. Kersten and M. Schröder, "Measuring the Cost Effects of Modular Product Architectures — A Conceptual Approach," *International Journal of Innovation and Technology Management,* vol. 13, no. 4, p. 1650017, 2016.

[21] R. N. Langlois and P. L. Robertson, "Networks and innovation in a modular system: Lessons from the microcomputer and stereo component industries," *Research Policy,* vol. 21, no. 4, pp. 297-313, 1992.

[22] J. B. Phillips and A. Phillips, "Management of Modular Projects: A Templating Approach," *Project Management Journal,* vol. 30, no. 4, pp. 33-41, 1999.

[23] Y. N. Yeo and J. Hahn, "The Role of Project Modularity in Information Systems Development," in *Thirty Fifth International Conference on Information Systems*, Auckland, 2014.

[24] S. A. Brax and F. Visintin, "Meta-model of servitization: The integrative profiling approach," *Industrial Marketing Management,* vol. 60, pp. 17-32, 2017.

[25] K. A. Artto, P. H. Dietrich and T. Ikonen, "Industry models of project portfolio management and their development," in *PMI Research Conference 2002*, Newtown Square, 2002.

[26] M. Lycett, A. Rassau and J. Danson, "Programme management: A critical review," *International Journal of Project Management,* vol. 22, no. 4, pp. 289-299, 2004.

[27] B. D. Reyck, Y. Grushka-Cockayne, M. Lockett, S. R. Calderi, M. Moura and A. Sloper, "The impact of project portfolio management on information technology projects," *International Journal of Project Management,* vol. 23, no. 7, pp. 524-537, 2005.

[28] J. Thorp, The information paradox: Realizing the business benefits of information technology, Toronto, London: McGraw-Hill, 1998.

[29] C. Goldman, "Align drive – expert advice," *CIO Magazine*, 1999.

[30] M. Jeffery and I. Leliveld, "Best Practices in IT Portfolio Management," *MIT Sloan Management Review,* pp. 41-49, 2004.

[31] B. N. Unger, H. Gemünden and M. Aubry, "The three roles of a project portfolio management office: Their impact on portfolio management execution and success," *International Journal of Project Management,* vol. 30, no. 5, pp. 608-620, 2012.

[32] M. G. Oliveira and H. Rozenfeld, "Integrating technology roadmapping and portfolio management at the front-end of new product development," *Technological Forecasting and Social Change,* vol. 77, no. 8, pp. 1339-1354, 2010.

[33] M. Martinsuo, "Project portfolio management in practice and in context," *International Journal of Project Management,* vol. 31, no. 6, pp. 794-803, 2013.

[34] S. J. Edgett, "Portfolio Management," in *Wiley International Encyclopedia of Marketing*, Wiley, 2010.

[35] C. P. Killen and C. Kjaer, "Understanding project interdependencies: The role of visual representation, culture and process," *International Journal of Project Management,* vol. 30, no. 5, pp. 554-566, 2012.

[36] K. Ulrich, "The role of product architecture in the manufacturing firm," *Research policy,* vol. 24, no. 3, pp. 419-440, 1995.

[37] R. Bremner, "Cutting edge platforms. Financial Times Automotive World," *Financial Times Automotive World,* pp. 30-38, 1999.

[38] C. Blees, H. Jonas and D. Krause, "Development of modular product families," in *DRUID-DIME Academy Winter Conference 2010: Innovation, Knowledge and Entrepreneurship*, Aalborg, 2010.

[39] G. Schuh, Produktkomplexität managen: Strategien, Methoden, Tools, Muenchen: Hanser, 2005.

[40] R. B. Stone, K. L. Wood and R. H. Crawford, "A heuristic method for identifying modules for product architectures," *Design Studies,* vol. 21, no. 1, pp. 5-31, 2000.

[41] J. K. Gershenson, G. J. Prasad and Y. Zhang, "Product modularity: Measures and design methods," *Journal of Engineering Design,* vol. 15, no. 1, pp. 33-51, 2004.

[42] K. Hölttä-Otto and O. de Weck, "Degree of Modularity in Engineering Systems and Products with Technical and Business Constraints," *Concurrent Engineering,* vol. 15, no. 2, pp. 113-126, 2016.

[43] J. H. Mikkola, "Capturing the Degree of Modularity Embedded in Product Architectures," *Journal of Product Innovation Management,* vol. 23, no. 2, pp. 128-146, 2006.

[44] S. Pashaei and J. Olhager, "Product architecture and supply chain design: A systematic review and research agenda," *Supply Chain Management,* vol. 20, no. 1, pp. 98-112, 2015.

[45] M. A. Schilling, "Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity," *Academy of Management Review,* vol. 25, no. 2, p. 312, 2000.

[46] N. Gebhart, M. Kruse and D. Krause, "Gleichteile-, Modul- und Plattformstrategie," in *Handbuch Produktentwicklung,* Muenchen, Carl Hanser, 2016, pp. 111-149.

[47] J. Golfmann and T. Lammers, "Modular Product Design: reducing complexity, increasing efficacy," *EY Performance Journal,* vol. 7, no. 1, pp. 56-63, 2015.

[48] B. Koeppen, Modularisierung komplexer Produkte anhand technischer und betriebswirtschaftlicher Komponentenkopplungen, Aachen: Shaker, 2008.

[49] J. H. Mikkola and O. Gassmann, "Managing modularity of product architectures: Toward an integrated theory," *IEEE Transactions on Engineering Management,* vol. 50, no. 2, pp. 204-218, 2003.

[50] J. Bonvoisin, F. Halstenberg, T. Buchert and R. Stark, "A systematic literature review on modular product design," *Journal of Engineering Design,* vol. 27, no. 7, pp. 488-514, 2016.

[51] A. Mayer, Modularisierung der Logistik: Ein Gestaltungsmodell zum Management von Komplexität in der industriellen Logistik, Berlin: Univ.-Verl. der TU, Univ.-Bibliothek, 2007.

[52] F. Rossi, F. Maneti and G. Reklaitis, "A general modular framework for the integrated optimal management of an industrial gases supply-chain and its production systems," *Computers & Chemical Engineering*, vol. 82, pp. 84-104, 2015.

[53] A. Bask, M. Lipponen, M. Rajahonke and M. Tinnilä, "Modularity in logistics services: A business model and process view," *International Journal of Services and Operations Management,* vol. 10, no. 4, p. 379, 2011.

[54] S. Pekkarinen and P. Ulkuniemi, "Modularity in developing business services by platform approach," *The International Journal of Logistics Management,* vol. 19, no. 1, pp. 84-103, 2008.

[55] T. L. Greenbaum, The handbook for focus group research, Thousand Oaks: Sage, 2002.

[56] R. Busch, W. Fuchs and F. Unger, Integriertes Marketing: Strategie, Organisation, Instrumente, Wiesbaden: Gabler, 2008.

[57] M. S. Yadav, "The decline of conceptual articles and implications for knowledge development," *Journal of Marketing,* vol. 74, no. 5, pp. 1-19, 2010.

[58] E. Jaakkola, "Designing conceptual articles: four approaches," *AMS Review,* vol. 10, pp. 18-26, 2020.

[59] S. McGregor, "Conceptual frameworks, theories, and models," in *Understanding and evaluating research*, Thousand Oaks, Sage, 2018, pp. 51-91.

[60] J. Cornelissen, "Editor's comments: Developing propositions, a process model, or a typology? Addressing the challenges of writing theory without a boilerplate," *Academy of Management Review,* vol. 42, no. 1, pp. 1-9, 2017.

[61] R. Delbridge and P. C. Fiss, "Editors' comments: Styles of theorizing and the social organization of knowledge," *Academy of Management Review,* vol. 38, no. 3, pp. 325-331, 2013.

[62] K. Cicotti, "The human factor in project management," in *PMI® Global Congress 2014—North America*, Phoenix, 2014.

[63] K. D. Sedlacek, Emergenz: Strukturen der Selbstorganisation in Natur und Technik : Arbeits- und Handbuch, Norderstedt: Books on Demand, 2010.

[64] C. Haskins, Systems Engineering handbook, Wiley, 2006.

[65] U. Lindemann, M. Maurer and T. Braun, Structural Complexity Management, Berlin, Heidelberg: Springer, 2009.

[66] M. Persson and P. Åhlström, "Product modularisation and organisational coordination," *International Journal of Automotive Technology and Management,* vol. 13, no. 1, p. 55, 2013.

[67] A. Stephan, "Eine kurze Einführung in die Vielfalt und Geschichte emergentistischen Denkens," in *Blinde Emergenz?: Interdisziplinäre Beiträge zu Fragen kultureller Evolution*, Heidelberg, Synchron, 2000, pp. 33-48.

[68] G. Budin, Wissensorganisation und Terminologie: Die Komplexität und Dynamik wissenschaftlicher Informations- und Kommunikationsprozesse, Tübingen: Narr, 1996.

[69] C. M. Meyer, Integration des Komplexitätsmanagements in den strategischen Führungsprozess der Logistik, Bern: Haupt, 2007.

[70] J. Iivari, "A framework for paradoxical tensions of project," *International Journal of Information Systems and Project Management,* vol. 9, no. 1, pp. 5-35, 2021.

[71] A. H. Levine, Project portfolio management: A practical guide to selecting projects, managing portfolios, and maximizing benefits, Chichester: Jossey-Bass, 2005.

[72] M. G. Kaiser, F. El Arbi and F. Ahlemann, "Successful project portfolio management beyond project selection techniques: Understanding the role of structural alignment," *International Journal of Project Management,* vol. 33, no. 1, pp. 126-139, 2015.

[73] P. Patankul, "Key attributes of effectiveness in managing project portfolio," *International Journal of Project Management*, vol. 33, no. 5, pp. 1084-1097, 2015.

[74] G. Bilgin, G. Eken, B. Ozyurt, I. Dikmen, M. T. Birgonul and B. Ozorhon, "Handling project dependencies in portfolio management," *Procedia Computer Science*, vol. 121, pp. 356-363, 2017.

[75] M. Rungi, "Success rate and resource consumption from project interdependencies," *Industr Mngmnt & Data Systems*, vol. 110, no. 1, pp. 93-110, 2010.

[76] D. Verma and K. K. Sinha, "Toward a theory of project interdependencies in high tech R&D environments," *Journal of Operations Management*, vol. 20, no. 5, pp. 451-468, 2002.

[77] M. W. Dickinson, A. C. Thornton and S. Graves, "Technology portfolio management: optimizing interdependent project over multiple time periods," *IEEE Trans Eng Manag*, vol. 48, no. 4, pp. 518-527, 2001.

[78] D. Jonas, "Empowering project portfolio managers: How management involvement impacts project portfolio management performance," *International Journal of Project Management*, vol. 28, no. 8, pp. 818-831, 2010.

[79] J. Göpfert, Modulare Produktentwicklung: Zur gemeinsamen Gestaltung von Technik und Organisation, Norderstedt: Books on Demand, 2009.

[80] J. Göpfert and G. Tretow, "Produktarchitektur," in *Pahl/Beitz Konstruktionslehre*, Berlin/Heidelberg, Springer, 2013, p. 252.

[81] G. Erixon, Modular function deployment: A method for product modularisation, Stockholm: The Royal Inst. of Technology, 1998.

[82] F. Koppenhagen, Systematische Ableitung modularer Produktarchitekturen: Komplexitätsreduzierung in der Konzeptphase, Aachen: Shaker, 2004.

[83] T. U. Pimmler and S. D. Eppinger, Integration Analysis of Product Decompositions, Minneapolis: MIT Sloan, 1994.

[84] J. Pajares and A. López, "New Methodological Approaches to Project Portfolio Management: The Role of Interactions within Projects and Portfolios," *Procedia - Social and Behavioral Sciences*, vol. 119, pp. 645-652, 2014.

[85] R. Maniak and C. Midler, "Multiproject lineage management: Bridging project management and design-based innovation strategy," *International Journal of Project Management*, vol. 32, no. 7, pp. 1146-1156, 2014.

Biographical notes

Thorsten Lammers
Thorsten is a Senior Lecturer for Digital Technology Management at the School of Mechanical and Mechatronic Engineering at the University of Technology Sydney. As Core Member of the Centre for Advanced Manufacturing (CAM) he deals with Smart Operations and Supply Chain Management, such as the application of AI to improve job scheduling in manufacturing or the pilot training process in aviation. Thorsten designs and teaches classes in the areas of Digital and AI Strategy, Smart Operations Management and Complex Systems Modelling. He holds a postgraduate degree in Physics and a doctorate in Strategic Management.

Matthias Guertler
Matthias Guertler is a Senior Lecturer at the Centre for Advanced Manufacturing at the University of Technology Sydney. He holds a PhD in engineering design along with two Master degrees in mechanical engineering and innovation management from the Technical University of Munich, Germany. His applied research in engineering design explores how product development and Industry 4.0 can be combined to support companies in developing the right products in the right way. In addition to engineering design processes and methods, this also includes the effective and efficient management of interdisciplinary product development projects.

Henning Skirde
Henning Skirde is a Senior Principal at the Munich-based company ID-Consult. He is responsible for the methodology development of METUS, a method on modular systems and platforms that has been proven in several industries. He holds a Master degree in industrial engineering and management and a PhD from Hamburg University of Technology (TUHH). His research interests are complexity management and modular product architectures as well as product management and interdisciplinary agile product development processes.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Hybrid project management – a systematic literature review

Janine Reiff
Reutlingen University
Alteburgstr. 150, 72762 Reutlingen
Germany
janine.reiff@student.reutlingen-university.de

Dennis Schlegel
Reutlingen University
Alteburgstr. 150, 72762 Reutlingen
Germany
dennis.schlegel@reutlingen-university.de

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

J. Reiff, D. Schlegel, “Hybrid project management – a systematic literature review”, *International Journal of Information Systems and Project Management*, vol. 10, no. 2, pp. 45-63, 2022.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Hybrid project management – a systematic literature review

Janine Reiff
Reutlingen University
Alteburgstr. 150, 72762 Reutlingen
Germany
janine.reiff@student.reutlingen-university.de

Dennis Schlegel
Reutlingen University
Alteburgstr. 150, 72762 Reutlingen
Germany
dennis.schlegel@reutlingen-university.de

Abstract:
Hybrid project management is an approach that combines traditional and agile project management techniques. The goal is to benefit from the strengths of each approach, and, at the same time avoid the weaknesses. However, due to the variety of hybrid methodologies that have been presented in the meantime, it is not easy to understand the differences or similarities of the methodologies, as well as, the advantages or disadvantages of the hybrid approach in general. Additionally, there is only fragmented knowledge about prerequisites and success factors for successfully implementing hybrid project management in organizations. Hence, the aim of this study is to provide a structured overview of the current state of research regarding the topic. To address this aim, we have conducted a systematic literature review focusing on a set of specific research questions. As a result, four different hybrid methodologies are discussed, as well as, the definition, benefits, challenges, suitability and prerequisites of hybrid project management. Our study contributes to knowledge by synthesizing and structuring prior work in this growing area of research, which serves as a basis for purposeful and targeted research in the future.

Keywords:
hybrid project management; agile project management; traditional project management; project approaches; project management methodologies.

DOI: 10.12821/ijispm100203

Manuscript received: 29 October 2021
Manuscript accepted: 31 May 2022

1. Introduction

A main distinguishing feature of project management approaches is the division between traditional and agile project management, which differ fundamentally in their structures and processes. Due to continued dissatisfaction with the traditional plan-driven (heavyweight) approach, various agile (lightweight) methodologies have been introduced in recent years [1], including Scrum, Kanban, eXtreme Programming (XP) and others [2, 3].

The term project management *approach* is the "highest level of abstraction used when describing how a project will be designed" [4], whereas a project management *methodology* is more granular and provides specific guidance about how to manage a project [4, 5]. In this paper, we use the term approach to distinguish between traditional, agile and hybrid project management, whereas methodology refers to specific models such as Waterfall or Scrum. The terms methods or practices refer to individual tools or techniques that are used within a methodology, such as individual planning methods or specific types of meetings. However, in the literature, there is no uniform use or definition of these terms.

In the traditional project management approach, the project scope, time, and cost are determined in the early phases of the life cycle. Any changes to the scope are carefully managed [6]. One of the key characteristics of traditional project management is that it seeks to minimize changes during the course of the project through requirements gathering, analysis, and design up front to achieve higher quality results [7].

Agile project management has increasingly grown in popularity in recent years, especially driven by the release of the Manifesto for Agile Software Development at the beginning of the 21st century [8–10]. Agile project management attempts to make project execution flexible to changes in the environment and scope of services. Agile requirements tend to be primarily functional and reasonably informal [11]. This is mainly done with the help of short, sequential planning and execution cycles [12, 13], with the aim of providing autonomous project teams, frequent and honest feedback from clients and other stakeholders, as well as, flexibility of the project scope [14]. To complete projects, the agile project management focuses on incremental, iterative development cycles [15]. The agile project management approach is favored in many companies, especially in the IT sector. Agile methodologies are newer and come from software development [16]. The main advantage of all these methodologies is their flexibility [5, 17–19]. The agile approach is ideal for short-time project initiatives that need requirements to be discovered and new technology to be evaluated [20]. On small, stand-alone projects, agile methodologies are less burdensome and more in tune with the software industry's increasing needs for rapid development and coping with continuous change [11].

Despite these advantages, the agile approach has increasingly been criticized in recent years. To make the development process faster, the agile approach enables the software development teams to focus on the final product rather than design and documentation [21, 22]. That can lead to the project documentation being neglected, since the development of the solution can be very time-consuming, and the project documentation is often of lower priority [23]. Another disadvantage of the agile approach can be a certain inaccuracy in time planning and budget scheduling, as the overall overview of the project can become confusing due to the constant re-prioritization of tasks [14, 24]. Moreover, there are numerous barriers and challenges that inhibit the realization of the agile benefits in an organizational context [10, 25]. Especially in large-scale transformation projects, basic agile principles such as team autonomy are hard to maintain [26].

As both, the traditional and agile project management approach have their advantages and disadvantages [5, 7], the hybrid approach has emerged that combines traditional and agile project management methodologies [1, 2, 4–6, 6, 15, 16, 18, 20, 27–29]. The aim of the hybrid project management approach is to bring together the best of the agile and traditional approaches [8, 27]. This is supposed to lead to achieving flexibility without unsettling project planning and to avoid the disadvantages of one approach with the help of positive elements from the opposite approach [19]. There are different methodologies such as the Water-Scrum-Fall model [9], the hybrid V-model [30], the Waterfall-Agile model [15], or the Agile-Stage-Gate model [13, 16]. Due to the variety and heterogeneity of hybrid methodologies that have been presented in the meantime, it is not easy to understand the differences or similarities of the methodologies, as well as, the advantages or disadvantages of the hybrid approach in general. Additionally, there is only fragmented knowledge about the suitability of the hybrid approach depending on firm and project characteristics, as well as, about prerequisites and success factors for successfully implementing hybrid project management in organizations.

Hence, the aim of this study was to provide a structured overview of the current state of research regarding the topic of hybrid project management. To address this aim, we have conducted a systematic literature review (SLR) [31], focusing on a set of specific, pre-determined research questions that are outlined in the research design section of this paper.

In related studies, SLR on hybrid project management were previously conducted as well [32–34]. Calavieri Barbosa et al. [32] develop a hybrid "stage-gate – agile – design thinking" project management model taking into account the results from an SLR. However, due to their focus on the stage-gate methodology, the search is comparably narrow and not suitable for our purpose of providing an overview of the entire field of hybrid project management. Heimicke et al. [34] also focus on a particular context, namely product development. Papadakis and Tsironis [33] have conducted a SLR on hybrid project management in general. However, they define "hybrids" as a combination of "multiple methods, between agile methods or agile and plan-driven" [35]. According to our understanding, the term hybrid means combining the traditional and agile approach, which excludes tailored agile methods that do not integrate traditional, plan-driven elements. Due to these different definitions and aims, our results are not directly comparable.

Our study contributes to knowledge by synthesizing and structuring prior work in this growing area of research, which is a prerequisite of purposeful and targeted research in the future. Moreover, our research helps researchers to use consistent terminology and definitions in future studies. Finally, our research serves to identify important research gap that should be filled by future work.

The rest of the paper is organized as follows. Section 2 explains details of our research design. Subsequently, section 3 outlines the key findings from the literature review, reported along our research questions. After a discussion of the results in section 4, we finally conclude by summarizing our research, as well as, discussing implications, limitations and future research opportunities.

2. Research design

To search and analyze existing literature on hybrid project management, a systematic literature review (SLR) was conducted. Literature reviews are a central part of scientific work and SLR is an established method in the information systems and project management discipline (e.g., [36–38]). A SLR includes a systematic, explicit and reproducible review and analysis of all thematically relevant sources. The available knowledge from the sources is collected, analyzed and critically reviewed [31, 39].

For this research, the Web of Science (WoS) Core Collection database was searched to collect the literature, which is one of the leading bibliometric databases and has a wide coverage of peer-reviewed articles from various publishers and organizations [40], including for instance IEEE, Emerald and Springer. Following Webster and Watson's suggestions that "the major contributions are likely to be in the leading journals" [31], we have deliberately restricted our initial search to the WoS database which has a high quality standard.

In our initial search, suitable literature was identified using a search string. The search string was structured in such way that literature explicitly mentioning the term "hybrid", as well as literature describing a combination of agile and traditional project management was found (Table 1).

Table 1. Search string

Search string
(TS = (hybrid) OR (TS = (traditional) AND TS = (agile))) AND (TS = ("project management") OR TS = ("project approach"))

The search and selection of literature took place in several steps. Firstly, the search with the search string yielded 474 relevant papers (Figure 1). After applying a filter that limited the results to English-language results, 453 papers were left. Of the 453 papers, 4 were duplicates, so 449 papers remained. After analyzing the title and the abstract, 45 of the 449 papers were shortlisted. Of these, 28 were assigned to the category “suitable” and 14 to the category “unsure”. The articles classified as category “suitable” were clearly about hybrid project management, noted in the title, keywords and abstract, and the main theme of the article was relevant for our research questions. Articles classified as category “unsure” were those where the main theme of the article was not about hybrid project management, but according to the first screening the article might have contained some details or short paragraphs about hybrid project management. The next step was to analyze the full text of the suitable and unsure papers.

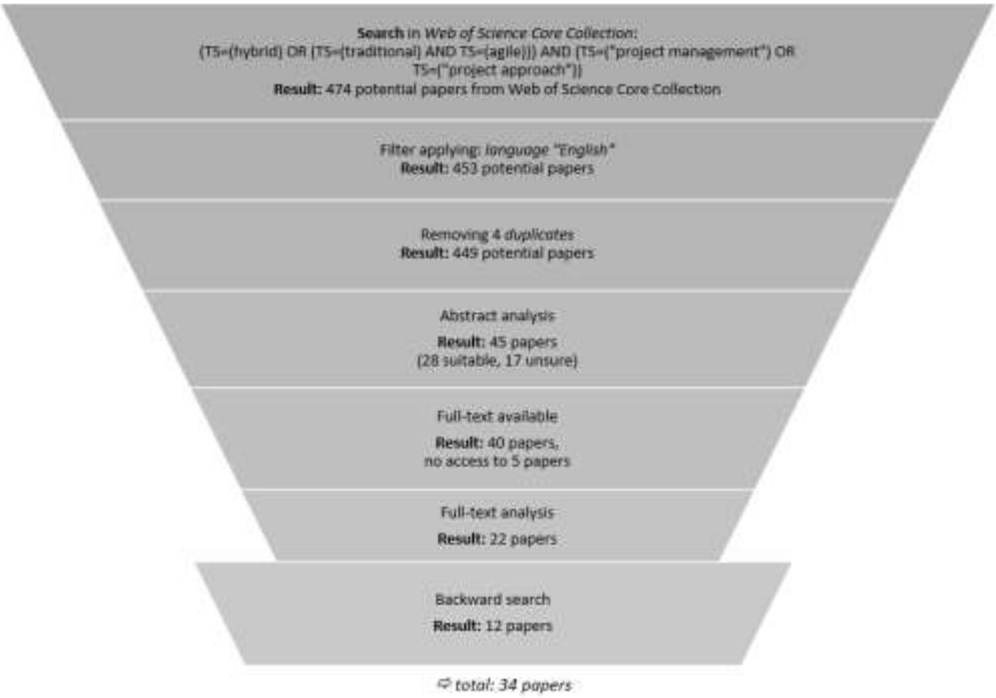


Fig. 1 Systematic literature review

During the analysis of the full texts, the selection of papers was limited to 22 pieces. In the second iteration, backward searching was performed to increase the coverage of the literature and to extend the scope of the literature to include papers that were cited by articles from the first iteration. Through the backward search, 12 articles were added to the literature collection. The final sample of the systematic literature analysis was therefore 22 papers plus 12 papers from the backward search, totaling in 34 papers [1–9, 11–22, 27–30, 32, 41–48].

The selection and analysis of articles was guided by six pre-determined research questions that can be found in Table 2. During the search and analysis of the literature, the individual papers were manually searched for relevant content related to the research questions. The literature was then systematically categorized with regard to the research questions using a spreadsheet to track the selection process and facilitate the subsequent detailed comparison and discussion.

Table 2. Research questions

Research questions	
RQ1:	What is the definition of hybrid project management?
RQ2:	How can traditional and agile methodologies be combined into a hybrid methodology?
RQ3:	What are the advantages and benefits of hybrid project management?
RQ4:	What are the disadvantages and challenges of hybrid project management?
RQ5:	What type of projects or firms is hybrid project management suitable for?
RQ6:	What prerequisites or success factors should be considered to successfully implement hybrid project management?

3. Key findings

3.1 Definition of hybrid project management

When analyzing the literature, it was noticeable that there are two different streams regarding how hybrid project management is defined. 20 out of 34 papers mention a *combination/mix of agile and traditional project management methodologies* [1, 2, 4–6, 9, 15–18, 20, 21, 27–30, 41, 45–47]. By combining an agile approach at the operational level and a traditional approach at the decision-making level, hybrid project management attempts to combine the advantages of both management systems [27].

In contrast, the remaining 14 papers describe hybrid project management as resulting from an *integration of an agile approach into existing traditional project management methodologies* [3, 7, 8, 11–14, 19, 22, 32, 42, 42–44, 48]. Organizations bring together their traditional approach with components of the agile approach for individual parts of the projects. In this way, the project management approach can be individually adapted to the needs, using the best aspects from both worlds [8].

3.2 Hybrid combinations

Based on the analysis of the papers, four different hybrid methodologies could be identified which systematically combine traditional and agile project management phases. In order to systematically compare these methodologies, we have summarized the methodologies in a uniform structure consisting of three generic project phases (Table 3). Besides these systematic methodologies, companies often combine individual methods and practices from the different methodologies. Often times, heavy-weight elements are combined with light-weighted agile elements. If a company applies hybrid project management, then the traditional approach is often supplemented by the agile approach in practice. Individual tasks of a project are then carried out agilely according to Scrum, for example, as firms are "cherry-picking" agile practices into their project management style [30]. Such methodologies are also systematically developed in research projects [6].

Table 3. Hybrid methodologies

Approach	Reference	Phases		
		Initial phase	**Development phase**	**Final phase**
Water-Scrum-Fall	[9], [29]	Waterfall - Requirements analysis - Planning	Scrum - Design - Development - Implementation	Waterfall - Integration - Testing

Approach	Reference	Phases		
		Initial phase	**Development phase**	**Final phase**
Waterfall-Agile	[15]	Waterfall - Requirements analysis - Planning	Agile approach - Design - Development - Implementation	Agile approach - Testing
Hybrid V-model	[30]	V-model - User requirements - System requirements - Planning	Scrum - Design - Implementation - Unit testing	V-model - Integration - System testing
Agile-Stage-Gate (Scrum-Stage-Gate)	[2], [13], [16], [22], [48]	Stage-Gate for administrative and strategic activities Scrum for operative activities - Discovery - Idea generation - Scoping	Stage-Gate for administrative and strategic activities Scrum for operative activities - Development - Implementation	Stage-Gate for administrative and strategic activities Scrum for operative activities - Testing - Validation - Launch

Water-Scrum-Fall

The Water-Scrum-Fall (Figure 2) methodology by West [9] combines the traditional Waterfall methodology with agile Scrum. It is based on the view that there must be a structural framework for a project which is provided with the established Waterfall methodology. Within this traditional process approach, agile phases are integrated. The complex part of the project, the development, is done based on the Scrum methodology [9].

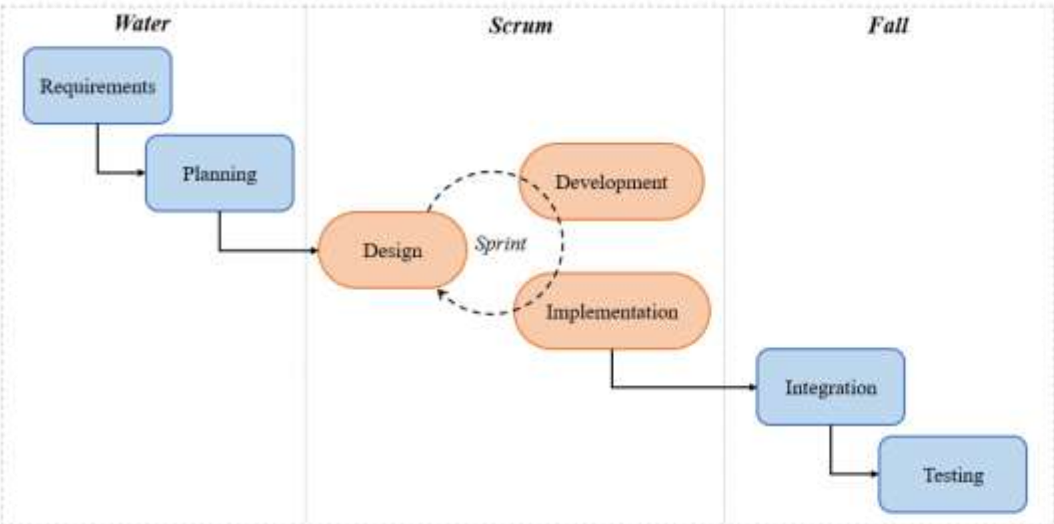


Fig. 2. Water-Scrum-Fall diagram. Source: adapted from [29]

The Waterfall methodology is the best known and simplest process model of traditional project management and operates in a sequential manner [15, 22, 27]. The individual project phases are completed one by one [15]. In order to get to the finished product at the end, each phase must be completed before moving onto the next [9]. It is also feasible to return to a previously completed phase if adjustments or corrections are required.

Scrum is one of the best known and most popular agile methodologies. Many Scrum aspects are common to agile methodologies, such as iterations, incremental development, self-managed teams, and flexibility in the face of changing requirements [3]. The term "iterative approach" refers to the division of the project duration into iterations or sprints, where the overall project is divided into several small projects [7]. Each sprint is structured in the same way: At the beginning of the sprint, the team decides which features will be developed during the sprint, team members then work on those features, and at the end of the sprint, the team meets with the customer to review and receive feedback on the features developed during the sprint [3]. The customer actively participates in the development process and can influence the course of the project throughout its duration. Sprints are usually two to four weeks long [48]. Each sprint is based on a sprint backlog, which describes a set of priority features (or product increments) to be developed in the current sprint, selected because they are high priority and can be completed within the specified timeframe of the sprint. While a sprint is running, the sprint backlog must not be changed [48]. Scrum is adaptive because it allows the team to respond to constantly changing requirements, market situations, changes in the project team, and other factors. Changing the project plan and scope does not require renegotiation of the contract; the changes are continuously adjusted.

In the initial phase of the Water-Scrum-Fall methodology, an upstream project planning phase takes place in which the agile realization is prepared and plans for time, budget and scope management are set up [29]. In addition, user requirements and system requirements are created in this phase. The upstream Waterfall phase makes it possible to minimize initial doubts, as initial documentation is created, and an initial contractual commitment is made [9]. The development is done according to agile methodologies in the second phase. Implementation takes place in iterative development steps. This leads to short-term partial results. The agile phase minimizes the risk of rework, delays, rescheduling and missed deadlines [9]. In the process, Water-Scrum-Fall can promote the separation between testing and development, so that testing becomes part of the release process. As soon as all requirements have been implemented by the development team, the agile part of the project is ended. In the final phase of the project, the agile solution is again delivered using the traditional procedure based on establishing quality control gates to reduce the frequency of software releases [29]. The product has typically already been tested to a certain extent at this point. This helps to manage high level test and project acceptance criteria [21].

Water-Scrum-Fall is a good introduction for companies that have been used the traditional approach and are now taking the first step towards agile. It also requires new roles that did not previously exist in the company. Scrum requires beside the development team the filling of the roles of “Scrum Master” and “Product Owner” and the assignment of specific rights and responsibilities [42]. The team itself is cross-functional, but there is no clear or strictly described team architecture.

Waterfall-Agile

At first glance, the methodology of the Waterfall-Agile model (Figure 3) seems very similar to West's Water-Scrum-Fall methodology. However, these two methodologies differ in the final phase. For example, West's final phase is based on the traditional project approach. The final phase of a project which uses the Waterfall-Agile methodology [15] is still within the agile approach. The project plan is scoped, and the first agile sprint planned before the start of the project [15]. This requires a complete project plan, but specific details of each sprint are not defined until the first sprint is completed. The development, design, and implementation are based on agile methodologies. At each iteration, the requirements are defined, and customer feedback is sought. Tests are carried out and corrections made to allow for continuous improvement. The contents of the individual project phases are sensibly selected and assigned before the start of the project but can be exchanged in the further course of the project according to the specified amount of effort.

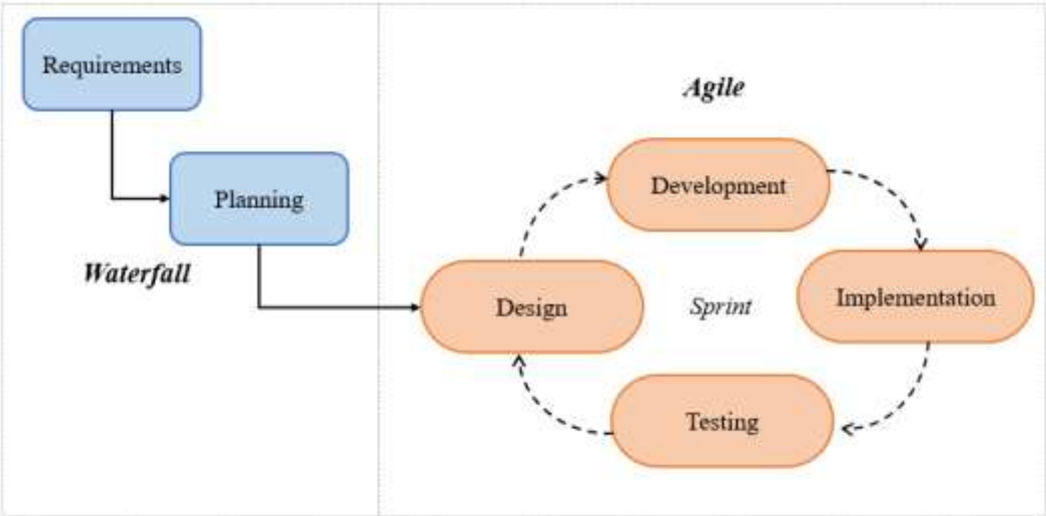


Fig. 3. Waterfall-Agile diagram. Source: adapted from [15]

The formal and traditional approach is used to define the outcome for each iteration [15]. The implementation is very agile within the individual phases. Agile shortens delivery time and facilitates early-stage feedback gathering to better meet customer requirements. The development and the test take place with short agile sprints, which are often implemented with Scrum.

According to Hassani et al. [15], there are various roles at Waterfall-Agile which are taken on by the project team. In traditional shaped projects, the project manager is responsible for the planning and managing the project so that it is successfully completed, and the project objectives are achieved. The project manager ensures compliance with defined workflows and can realize the requirements fixed at the beginning of the project at defined costs and deadlines. Developers are responsible for processing the individual work packages. The tester is responsible for monitoring the achievement of quality objectives and testing the product. The Waterfall-Agile methodology is unique in that there is no clear specification as to where, when, or how traditional planning transitions into agile implementation. This is something that can be decided on a project-by-project basis. It is also quite possible that the project is defined and planned with an agile approach, and then later developed and implemented according to traditional procedures [15].

Hybrid V-model

The hybrid V-model (Figure 4) by Hayata & Han [30] is similar to Water-Scrum-Fall in the sense that it uses a traditional approach upfront and at the end, with an agile phase embedded in between. However, this methodology should be considered as a new separate methodology as it is not based on the Waterfall methodology but on the V-model, which is another traditional type of methodology. In this pattern, Scrum is inserted into a traditional software development and IT project management process. The idea of this hybrid methodology is to conduct the phases with a "higher abstraction level" according to the V-model, while the more detailed phases are done according to Scrum. Scrum is particularly suitable for this, because here communication within the development team is exercised very intensively and thus supports the implementation phase through joint iterative thinking [30].

The V-model is a process methodology for software development and, like the Waterfall methodology, it organizes the software development process in phases. In contrast to the Waterfall methodology, it permits feedback to preceding phase [23]. A further and important extension of the V-model are the quality assurance measures, as the individual development phases are confronted with test phases and prototypes are provided during the development, which causes an improvement and a warranty of the quality [23]. By the iterative development not only project risks are minimized, but one has a better overview of the total costs of the entire project and system life cycle [23].

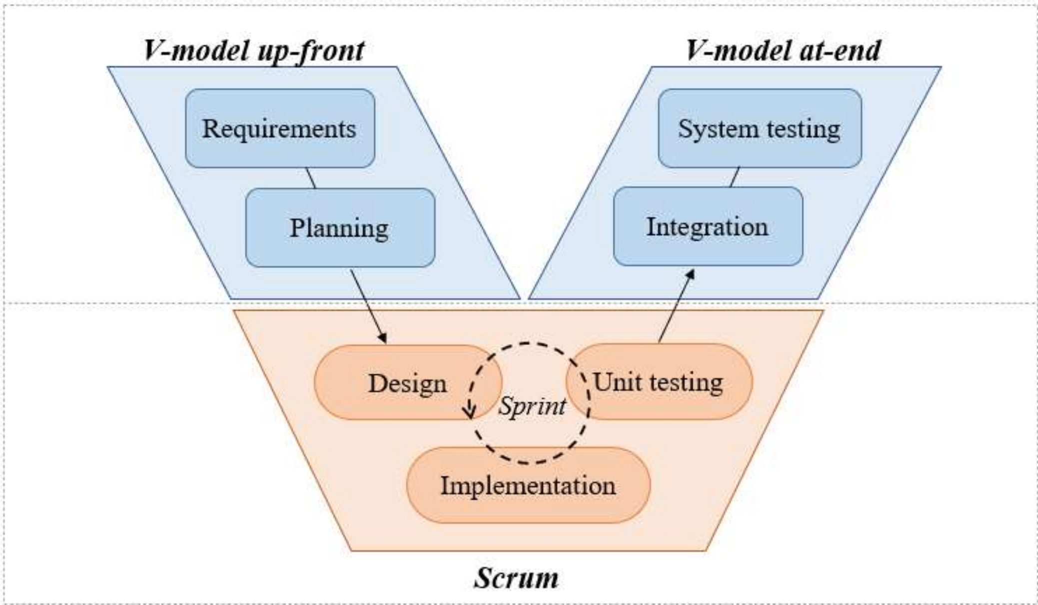


Fig. 4. Hybrid V-model diagram. Source: adapted from [30]

In the hybrid V-model, the traditional approach is applied to the project in the initial and final phases, where, according to the authors, there is a greater need for planning. Then, the agile approach is applied to the development, implementation, and testing phases, where the need for agility is greater [30]. On the left, user and system requirements can be gathered, specified, and analyzed at the beginning of the development project [30]. This can minimize potential disagreements over project goals as they are clearly stated. At the bottom of the V, the agile approach is used for design, implementation and unit testing, establishing an iterative way of working and thus reducing the risk for delays [30]. Subsequently, on the right side, the implementation that has taken place is tested according to the specifications from the left side. Through these tests, the V-model provides a high level of product safety and quality [30].

Agile-Stage-Gate (Scrum-Stage-Gate)

The traditional stage-gate process introduced by Cooper [43] has become one of the standards in product development worldwide. The original Stage-Gate process was created in the late 1980s to address the need to incorporate best practices into new product projects in a more systematic and disciplined manner [12]. Sharp, early, and fact-based product definition was a foundational principle of the original stage-gate methodology [13]. The methodology is based on multiple stages. Each stage includes cross-cutting activities from the task spectrum of different functional areas or departments of a company [13, 45]. Once the individual stages have been completed, the results are reviewed using predefined criteria as part of a milestone analysis (gates) [45]. In the process, defined milestones are used to check whether the planned development results have been achieved and whether they meet customer requirements [46]. The aim of the methodology is to ensure process quality in innovation development. The traditional stage-gate process may be too linear, too rigid, and too planned to handle today's more innovative, dynamic projects. According to critics, it is not adaptive enough, it is not context-based and it is too bureaucratic [12]. This plan-driven methodology requires that project decisions are made early and plans are adhered to during development. Deviations can only be detected after the fact and compensated for with a time delay. The stage-gate process is hardly capable of taking into account the new dynamics and the increase in product complexity [46].

The hybrid Agile-Stage-Gate methodology (Figure 5) integrates agile sprints by breaking the development process within stages into short increments driven by short-term, minimal planning [43]. Replacing traditional project management tools, such as Gantt charts, milestones, and critical path planning, with agile tools and processes embeds the agile way of working within Stage-Gate [13]. This seeks to add flexibility and speed while retaining the useful structures of Stage-Gate. The use of Scrum does not necessitate the elimination of Stage-Gate. Instead, Scrum can be combined with Stage-Gate to create a hybrid Agile-Stage-Gate methodology that contains features of both systems [48]. The existing Stage-Gate-system provides focus, structure, and control, with the benefits of an agile approach and mindset like speed, agility, and productivity [13]. Each stage is composed of a series of time-boxed sprints. This adaptivity is accomplished through the incorporation of iterative development cycles designed to get something in front of potential users early and often. Each sprint begins with a sprint planning meeting, in which the project team determines realistic goals for the sprint and then maps out an action plan to accomplish those goals [12]. Each day of the sprint begins with a daily scrum, or stand-up meeting, in which the team members review what was accomplished the previous day, what the plan is for today, and what problems have arisen. In each iteration something like a rapid prototype or a representation of the proposed product, is built to show the customer [12]. At each stage, the adoption of agile *sprints helps to increase responsiveness and adaptability and minimizes drawbacks* [19]. Its core element is a continually evolving product definition that emerges through short-term, dynamic planning [13].

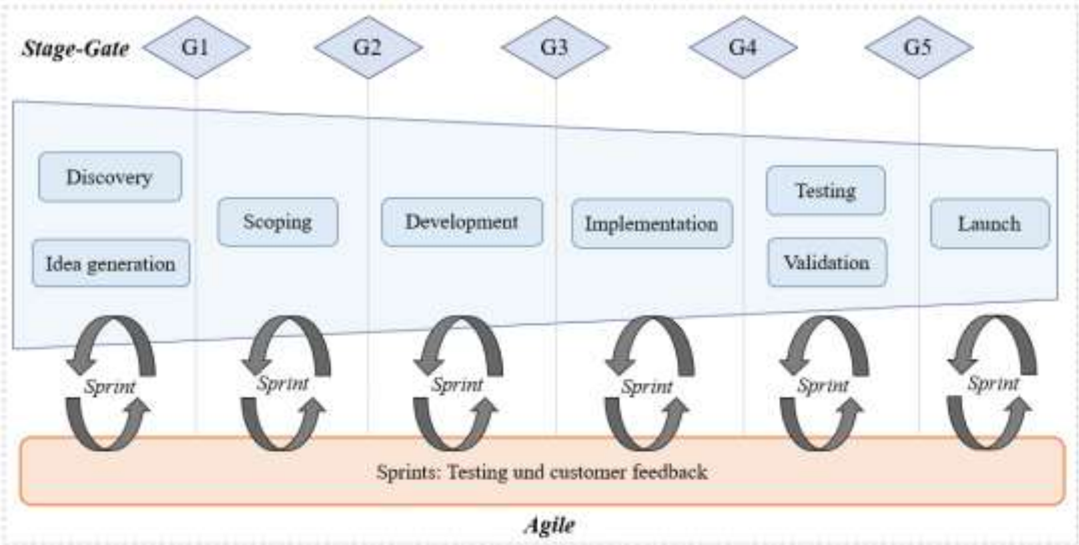


Fig. 5. Agile-Stage-Gate diagram. Source: adapted from [2, 12, 48]

Within the stages, the project is driven forward on a tactical and operational level. In each stage, the traditional and agile approach run simultaneously. Strategic decisions are made with the help of the stage-gate process. The operational one is carried out by the agile approach The process follows a superordinate Stage-Gate process with the usual five phases (1. idea generation, 2. prototype, 3. development, 4. validation, 5. launch) and any number of Scrum iterations embedded in the stages. The Agile-State-Gate methodology is designed for one or several teams to perform activities simultaneously. The work results are compiled by the teams at the end of the processing stage and analyzed together.

Typical agile roles are also relevant for Agile-Stage-Gate, including product owner, Scrum master and development team [43]. The agile roles give new sense of ownership, increased motivation, and enhanced communication and knowledge sharing. The Scrum master tasks range from communication between stakeholders to information gathering to organizing adequate resources. In addition, so-called gate keepers, who dictate the progress or termination of the project between the stages, can be added to the roles of the project team [43].

Frequently, the literature also refers to a Scrum-Stage-Gate methodology. This is not another hybrid methodology but is the same as the Agile-Stage-Gate. The difference in the name is due to the fact that the agile sprints are carried out with Scrum. In the Agile-Stage-Gate methodology, the agile approach is kept general and does not necessarily have to be Scrum. The Scrum methodology is the particular agile approach that seems most appropriate for hardware development, and indeed, is the methodology used for all the hardware case studies uncovered so far in industry [43]. Therefore, the two methodologies Agile-Stage-Gate und Scrum-Stage-Gate have been summarized as one approach (see Table 3).

3.3 Advantages and benefits of hybrid project management

Hybrid project management is designed to maximize project success [17, 22]. Nevertheless, there are some advantages and disadvantages of this project management approach. In this section, we analyze the advantages and benefits of hybrid project management. We have defined “advantages and benefits” broadly as any positive effects that may result for the project or the organization as a result of using the hybrid approach to project management. The advantages include the increase in efficiency [5, 29]. Due to the larger selection of techniques and methods, a suitable tool can be applied depending on the project type and project status. In this way, the project benefits can be increased under certain circumstances, a better result can be achieved, and the goal can be reached more quickly with lower costs [13, 20]. At the start of the project, it is often unclear how the project goals are to be achieved. Through the hybrid approach, the project's target plan can concretize the objective step by step, even with long-term planning of time, costs and milestones [15, 22, 29]. The focus is on customer requirements and benefits [4, 18]. Permanent feedback ensures that the product will generate the highest customer benefit [17]. Another advantage of the hybrid approach is the higher creativity in finding solutions. Through iterative detailed planning [15], the project team develops the optimal solution variant for the current project status in individual iterations. If changes do occur, the hybrid approach can be used to deal with these changes flexibly. Hybrid project management with an agile component in project implementation allows to react much more flexibly than would be the case with purely classic project management [5, 8, 12, 15, 18, 32]. On the contrary, changes in prioritization or new requirements can be incorporated flexibly without having to completely reschedule the project. A side effect of the hybrid project management approach is motivated project teams [28]. By eliminating the classic leadership roles, the employees will achieve the project goal on their own responsibility [4]. This not only increases employee motivation, but also the personal development of team members in social as well as professional competence [32].

3.4 Disadvantages and challenges of hybrid project management

Despite all the advantages, there are also disadvantages of the hybrid project management approach that should not be ignored. For analytical purposes, we have defined “disadvantages and challenges” broadly as any “hurdle, barrier, concern, or critique” [49] towards the hybrid approach. A major disadvantage is that comprehensive methodological knowledge is necessary for the project management and the team [28, 41]. Everyone working on the project needs a high level of methodological competence [32]. The challenge is to select the right tool in the first step and to apply it correctly afterwards [22]. Only in this way can the advantages of hybrid project management unfold their full potential. Therefore, an increased need for training and familiarization should be planned for [22]. The hybrid approach also requires a high degree of transparency and communication [1]. Risks, problems, and errors are addressed directly, constructive criticism is voiced, and solutions are sought together. By handling information transparently, hybrid project management enables decisions to be made based on the most complete information possible. However, this is only possible if there is comprehensive communication, particularly at the interfaces between the methodologies [24]. This in turn leads to an increased administrative effort, through corresponding reports and documentation [20, 21].

3.5 Suitability for type of projects and firms

In recent years, interest in the hybrid approach has increased. Hybrid methodologies are used more often regardless of the size of the organization, industry sector or type of the project. According to research by Kuhrmann et al. [47], the hybrid approach prevails and is used by companies regardless of their size and industry. However, it can be said that large-scale organizations are more likely to adopt a hybrid approach, combing the traditional and agile project management approach [16, 19]. As pointed out in the literature, hybrid project management is easier to implement in large enterprises. Organizations with multiple teams display an increased use of hybrid methodologies [28]. Therefore projects with a high number of team members might be best suited for hybrid project management [5]. Especially large organizations with well-structured processes with systematic milestones are suitable for the implementation of an hybrid approach [16]. Hybrid project management is particularly suitable for large projects, nevertheless Alves et al. [21] state that the hybrid project management approach can also be used in small and medium-sized companies. Small and Medium Enterprises (SMEs) usually need simpler solutions and easier-to-use-systems [21]. Very small projects do not require a hybrid approach [15], the effort in implementing the hybrid approach and making them a success is not worth it.

Hybrid project management methodologies are suitable for projects that involve great uncertainty or are risky. Brandl et al. [8] add that the hybrid approach is particularly fitting for heavy-weighted, complex or business-critical innovation projects [8]. Kosztyan et al. [50] mention that a software development project is more likely to survive the risk effects if its project plan is managed by a hybrid project management approach [18]. The great benefit of the hybrid project management approach is that they are suitable for all types of projects, regardless of company size or project complexity [15]. The hybrid approach can be applied to physical products (hardware, not just software), from food and toys to heavy industrial equipment [12]. Innovation projects in high technology-based companies also benefit from hybrid methodologies [16]. Especially in software development or digital projects, there are hardly any limits with this solution.

3.6 Prerequisites and success factors

Finally, there are several “prerequisites and success factors” to using hybrid project management, which we define as any factors that enable the successful adoption of hybrid project management, or, should be fulfilled before being able to successfully adopt the approach in an organization. The implementation of hybrid management requires a clear alignment between the project team, the organizational objectives, and the project implementation team [19]. Often it is not easy to combine different traditional and agile methodologies, because they are two completely different approaches. The problem is determining which features or components (agile or traditional) are necessary for the hybrid approach architecture to be developed [44]. This statement make sense considering that a major project can rapidly become chaotic without at least a high-level planning and without documentation [21]. However, because the goal is to achieve the best result, project teams may believe they need to apply more than one approach [6]. At the start of the project, it must therefore be clearly defined which part of the project is to be pursued and which project management methodology should be used. Both management and developers agree that actual development does not adhere strictly to current methodologies anyway. Especially under deadline pressure, development proceeds spontaneously and shortsightedly [45]. Nevertheless, adjustments or changes to the methodologies can always be made later, should problems or changes in requirements arise. Organizations should therefore always decide individually which methodologies and techniques are best suited for a project. This is the only way to achieve the desired goals in the team in the long term. Customer-centric methodologies make sense in order to counter the sometimes difficult framework conditions of hybrid touchpoints by having experienced consultants flexibly align the adaptation of proven agile frameworks to the circumstances of the organization. Employees and team members should be open to new methodologies in order to give the hybrid approach a chance. All team members who participate in hybrid project management should have a broad knowledge of the agile approach, even if they have previously only worked traditionally. The hybrid approach does not need to be completely relaunched. In most cases, it is sufficient to use the existing processes, which is in majority of cases a traditional approach [5]. The team characteristic is typified by the fact that the team present good tolerance for alterations and deal with frequent changes of scope, so are more appropriate for the development of innovations [20].

Before adopting or introducing hybrid methodologies, especially Agile-Stage-Gate, firms should have already successfully used an traditional approach and methodology such as Stage-Gate-Systems [13]. This makes the transition or change to hybrid methodologies easier. It is also recommended to first develop a landscape framework [20]. Hybrid methodologies also requires a change in company culture, norms and processes [28]. The project team and its members must be highly connected and engaged with the entire organization. It is difficult to manage when the team is globally distributed, as much time is spent in meetings and large projects are split into smaller interconnected sub-projects. The involvement of several consultants and partner companies facilitates the use of an hybrid project management approach on top [20].

4. Discussion

In complex environments, project management requires the application of increasingly refined sets of techniques and tools, which can be adjusted according to the particularities and the evolution of each project [20]. These adaptations should consider the requirements and specific influences and wishes of the customer, which makes hybridity a suitable solution in project management. The systematic literature research has shown that there are various hybrid project management methodologies that combine different traditional and agile methodologies. There is no doubt that project management will change even more and must have many new system components as well as methods and interfaces. Today’s organizations need to balance the specific characteristics of their environments and their projects with the need for greater agility to respond to the demands of innovation [20]. Traditional project management is no longer sufficient on its own, especially against the backdrop of digitization and technological change and increasing complexity. The agile approach assumes a flexible project structure, where dependencies between tasks can be flexible and lower-priority tasks can be postponed until the next project [18]. Given the strengths and weaknesses of both approaches, a combination seems to make sense, depending on the specific firm and project characteristics, as discussed above. In order to give a structured overview of these findings, we have summarized the findings regarding our research questions 3, 4 and 6 in Table 4.

Table 4. Summary aspects of the hybrid project management

Advantages / benefits	Disadvantages / challenges	Prerequisites / success factors
Efficiency improvement	Comprehensive methodological knowledge required	Clear coordination, high-level planning, detailed documentation
Maximization of project success, better result	Training and familiarization required	High number of team members, well networked, open to new methods
Flexible response to changes	Increased administrative effort (reports and documentation)	Use customer-centric approaches
Rapid achievement of project goals at lower cost	High level of transparency and communication necessary	First develop a landscape framework
Higher creativity in finding solutions		Good tolerance for alterations
		Already successfully used traditional approaches, a broad knowledge of agile methods
		Involvement of experienced consultants

When analyzing the specific advantages and benefits of hybrid project management, it seems that the advantages they offer are very much associated with the agile approach. Consequently, that would mean that hybrid project management only offers substantial benefits compared to traditional project management, but not compared to agile project management. So what is the value of the hybrid approach? In our view, the hybrid approach enables companies to use certain agile practices, even if there are constraints that impede the adoption of a pure agile approach. As previously noted in the literature [4, 9], there are several reasons why organizations only gradually move from traditional methodologies toward the agile approach, including governance and compliance requirements, as well as, budgetary and time requirements that need to be considered. Especially large-scale organizations tend to experience many challenges when adopting agile methodologies, as the agile approach has been designed for smaller projects [51]. This idea is consistent with the finding that hybrid project management is especially suitable for larger organizations and projects (section 3.5). Hence, it can be said that hybrid project management helps certain types of organizations to adopt agile practices that would otherwise not have been able to so.

Additionally, our review has shown that hybrid project can mitigate risks compared to pure agile approaches when projects are exposed to great uncertainty or risks. Some papers demonstrate that a hybrid approach to project management can provide potential improvements, that is, they can provide the same budget, time, scope and quality outcomes as the traditional approach, while at the same time attaining the same level of stakeholder success that the agile approach delivers [4]. Organizations aim to achieve more flexibility by integrating the hybrid project management approach in their companies. A software development project is more likely to survive if a project plan is managed by a hybrid project management approach [18]**.** Hybrid project management provides a way to manage and implement projects more effectively and efficiently. Hybrid methodologies allow both planning and the flexible structure, and therefore, it is assumed that this is the supreme technique of project management. This assumption is reinforced by the fact that this technique provides the highest ratio of feasible solutions and the best scheduling performance [17]. Although agile thinking was first adopted in the context of software development, both agile and hybrid methodologies are not limited to this domain and are suitable for various contexts [35].

Against the background of global and virtual working teams, project management will be even more in focus for organizations to work productively. These hybrid systems that enable iteration and continuous evolution represent the future, according to some authors [12]. Future application development professionals will likely apply the most appropriate hybrid process to each problem. The hybrid approach might form a significant portion of the project population in the future [4, 9].

5. Conclusion

5.1 Summary and implications

We have presented a synthesis of findings from a systematic literature review in order to provide an overview of different definitions and methodologies to hybrid project management, including for example the Water-Scrum-Fall and Waterfall-Agile methodologies. Additionally, we have discussed advantages and disadvantages of the hybrid approach, as well as, their suitability and prerequisites. Important for the successful implementation of the hybrid approach are certain structural requirements that enable a more agile project management approach to deal with the rapidly changing requirements and the uncertain, highly complex, and turbulent environment [8].

This research highlights the increasing importance of the hybrid approach. This has important implications for both, business organizations and academia. Organizations should consider the hybrid approach as an additional option to traditional and agile project management when selecting a suitable project management approach. Above all, new competence profiles for project control and implementation must be given greater consideration in the education and training of project managers and project teams. Academia should incorporate the topic into their curriculums and furthermore address the research gaps that are presented in the subsequent section.

5.2 Research gaps and future research directions

While we were able to find some answers to all of our pre-defined research questions, we also have identified a number of shortcomings and research gaps. These are both, gaps in the content of the research, as well as, shortcomings in the methodology and robustness of studies. In the following paragraphs, research gaps and opportunities will first be discussed for the theme of *development of hybrid methodologies*, before the *evaluation of the hybrid approach* in general, as well as, the *evaluation of the different hybrid methodologies* will be analyzed.

Regarding the question how traditional and agile methodologies can be combined in a hybrid project approach, it can be summarized that various new methodologies have been proposed by a number of authors. While these methodologies are interesting and have advanced the discussion in the field, a general procedure to develop a hybrid approach or criteria to guide a meaningful combination of traditional and agile elements are still missing. An interesting future research opportunity is therefore to develop procedures, criteria or frameworks that help organizations to select appropriate methods and design bespoke hybrid methodologies that are tailored to the specific project and organizational context. This can include general recommendations to guide the process, as well as, specific factors that influence the suitability of certain practices for the specific environment.

Moreover, we see major research gaps in the evaluation of the hybrid approach to project management, i.e. the question of advantages, benefits, disadvantages and challenges. First, as explained in the discussion section of this paper, the advantages of the hybrid approach that can be found in the literature seem to overlap with the advantages of the agile approach. Therefore, more research is necessary to better distinguish between these two approaches in the evaluation. Second, only few papers [4, 17] systematically evaluate the success of the hybrid approach. We acknowledge that project success is a concept that is difficult to measure. Nevertheless, the scientific examination of the relationship between project approaches and project success is essential for an overall evaluation of the project approaches. Third, the robustness and academic rigour of some results in this category seem to be questionable. While the results appear plausible, many findings seem to be based on personal experience and narrative evidence by the respective authors, rather than empirical findings. Only few studies are based on quantitative empirical [4, 17] or qualitative empirical methods [22]. We therefore recommend to increase the number of studies based on a robust research design to evaluate the alleged superiority of the hybrid approach.

While we have made a first step to compare the different individual hybrid methodologies in a structured way, clearly more research is necessary to validate these methodologies. Moreover, we recommend to evaluate the advantages and disadvantages of the individual hybrid methodologies against each other, using a structured and rigorous research design.

5.3 Limitations and threats to validity

We are aware that our research may have some limitations. As our results rely on prior research that was conducted in specific contexts, the generalizability of some results might be limited. Additionally, limitations and bias from previous studies might have been adopted into our research.

Moreover, some threats to validity may arise from the design of our systematic literature review. To identify and discuss possible problems, we have taken into account typical threats to validity of systematic literature reviews, as pointed out in the literature [52]. First, threats to validity may arise from incorrect or incomplete search terms. This may also be applicable to our research, as designing a search string is always a trade-off between comprehensiveness and feasibility in terms of the number of results that can be manually evaluated. However, we have tried to mitigate this risk by experimenting with different search terms in several explorative searches, before determining the final search term. Second, the choice of databases may be a threat to validity. In general, individual databases only include a selection of the universe of literature due to incompleteness and deliberate selection. Our search was deliberately limited to the WoS database which only includes high quality academic literature from various publishers and organizations. Using additional databases which are less selective in terms of quality, as well as, integrating grey literature may bring up additional findings. However, due to the backward search that we have conducted, we are confident that the selection bias could be limited while maintaining a quality filter through the initial search. Third, in the manual screening of the articles, subjectivity is inevitable. We have tried to increase objectivity by using guiding research questions as inclusion criteria, as well as, by critically discussing the inclusion and exclusion of individual articles within the team of authors. Overall, due to the transparency in the explanation of our research design, we are convinced that our study is replicable and that other researchers will be able to evaluate the strengths and limitations of our research when interpreting the results.

References

[1] V. Yadav, M. Adya, D. Nath, and V. Sridhar, "Investigating an 'Agile-Rigid' Approach in Globally Distributed Requirements Analysis," *PACIS 2007 Proceedings. 12. Pacific Asia Conference on Information Systems*, pp. 150–165, 2007.

[2] T. Žužek, J. Kušar, L. Rihar, and T. Berlec, "Agile-Concurrent hybrid: A framework for concurrent product development using Scrum," *Concurrent Engineering*, vol. 28, no. 4, pp. 255–264, 2020, doi: 10.1177/1063293X20958541.

[3] A. Ziółkowski and T. Deręgowski, "Hybrid Approach in Project Management – Mixing Capability Maturity Model Integration with Agile Practices," *Social Sciences*, vol. 85, no. 3, pp. 64–71, 2014, doi: 10.5755/j01.ss.85.3.8416.

[4] A. Gemino, B. Horner Reich, and P. M. Serrador, "Agile, Traditional, and Hybrid Approaches to Project Success: Is Hybrid a Poor Second Choice?," *Project Management Journal*, vol. 52, no. 2, pp. 161–175, 2021, doi: 10.1177/8756972820973082.

[5] M. Špundak, "Mixed Agile/Traditional Project Management Methodology – Reality or Illusion?," *Procedia Social and Behavioral Sciences 27th IPMA World Congress*, vol. 119, pp. 939–948, 2014, doi: 10.1016/j.sbspro.2014.03.105.

[6] G. Fernandes, S. Moreira, M. Araújo, E. B. Pinto, and R. J. Machado, "Project Management Practices for Collaborative University-Industry R&D: A Hybrid Approach," *Procedia Computer Science International Conference on Enterprise Information Systems*, vol. 138, pp. 805–814, 2018, doi: 10.1016/j.procs.2018.10.105.

[7] V. Vinekar, C. W. Slinkman, and S. Nerur, "Can Agile and Traditional Systems Development Approaches Coexist? An Ambidextrous View," *Information Systems Management*, vol. 23, no. 3, pp. 31–42, 2006, doi: 10.1201/1078.10580530/46108.23.3.20060601/93705.4.

[8] F. J. Brandl, M. Kagerer, and G. Reinhart, "A Hybrid Innovation Management Framework for Manufacturing – Enablers for more Agility in Plants," *Procedia CIRP 51st CIRP Conference on Manufacturing Systems*, vol. 72, pp. 1154–1159, 2018, doi: 10.1016/j.procir.2018.04.022.

[9] D. West, "Water-Scrum-Fall Is The Reality Of Agile For Most Organizations Today: for Application Development & Delivery Professionals," *Forrester Research*, vol. 26, pp. 1–17, 2011.

[10] M. Durbin and F. Niederman, "Bringing templates to life: overcoming obstacles to the organizational implementation of Agile methods," *International Journal of Information Systems and Project Management*, vol. 9, no. 3, pp. 1–18, 2021, doi: 10.12821/ijispm090301.

[11] B. Boehm and R. Turner, "Management Challenges to Implementing Agile Processes in Traditional Development Organizations," *IEEE Software*, vol. 22, no. 5, pp. 30–39, 2005, doi: 10.1109/MS.2005.129.

[12] R. G. Cooper, "Idea-to-Launch Gating Systems: Better, Faster, and More Agile," *Research-Technology Management*, vol. 60, no. 1, pp. 48–52, 2017, doi: 10.1080/08956308.2017.1255057.

[13] R. G. Cooper and A. F. Sommer, "Agile–Stage-Gate for Manufacturers," *Research-Technology Management*, vol. 61, no. 2, pp. 17–26, 2018, doi: 10.1080/08956308.2018.1421380.

[14] M. Bogdanova, E. Parashkevova, and M. Stoyanova, "Agile Project Management in Governmental Organizations - Methodological Issues," *IJASOS- International E-Journal of Advances in Social Sciences*, vol. 6, no. 16, pp. 262–275, 2020, doi: 10.18769/ijasos.616037.

[15] R. Hassani, Y. El Bouzekri El Idrissi, and A. Abouabdellah, "Digital Project Management in the Era of Digital Transformation: Hybrid method," *Proceedings of the 2018 International Conference on Software Engineering and Information Management*, pp. 98–103, 2018, doi: 10.1145/3178461.3178472.

[16] E. C. Conforto and D. C. Amaral, "Agile project management and stage-gate model - A hybrid framework for technology-based companies," *Journal of Engineering and Technology Management*, vol. 40, no. 1, pp. 1–14, 2016, doi: 10.1016/j.jengtecman.2016.02.003.

[17] M. R. Farokhad, J. R. Otegi-Olaso, L. S. Pinilla, N. T. Gandarias, and L. N. L. de Lacalle, "Assessing the Success of R&D Projects and Innovation Projects through Project Management Life Cycle," *Proceedings of the 2019 10th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS), Metz, France*, pp. 1104–1110, 2019, doi: 10.1109/IDAACS.2019.8924298.

[18] Z. T. Kosztyán, R. Jakab, G. Novák, and C. Hegedűs, "Survive IT! Survival analysis of IT project planning approaches," *Operations Research Perspectives*, vol. 7, pp. 1–17, 2020, doi: 10.1016/j.orp.2020.100170.
[19] F. P. Zasa, A. Patrucco, and E. Pellizzoni, "Managing the Hybrid Organization: How Can Agile and Traditional Project Management Coexist?," *Research-Technology Management*, vol. 64, no. 1, pp. 54–63, 2021, doi: 10.1080/08956308.2021.1843331.
[20] F. Copola Azenha, D. Aparecida Reis, and A. Leme Fleury, "The Role and Characteristics of Hybrid Approaches to Project Management in the Development of Technology-Based Products and Services," *Project Management Journal*, vol. 52, no. 1, pp. 90–110, 2021, doi: 10.1177/8756972820956884.
[21] P. R. Alves, A. Tereso, and G. Fernandes, "Project Management System Implementation in SMEs: A Case Study," *Proceedings of 33rd International Business Information Management Association Conference IBIMA 2019*, pp. 8322–8332, 2019.
[22] K. Edwards, R. G. Cooper, T. Vedsmand, and G. Nardelli, "Evaluating the Agile-Stage-Gate Hybrid Model: Experiences From Three SME Manufacturing Firms," *International Journal of Innovation and Technology Management*, vol. 16, no. 8, pp. 229–263, 2020, doi: 10.1142/S0219877019500482.
[23] P. Czechowski, *Hybrides Projektmanagement: Definition & Methoden.* [Online]. Available: https://ifm-business.de/aktuelles/business-news/hybrides-projektmanagement-definition-und-methoden-von-traditionell-ueber-agil-bis-hybrid.html (accessed: Jul. 6 2021).
[24] J. Strasser, *Hybrides Projektmanagement – Wie Sie agile und klassische Methoden verbinden.* [Online]. Available: https://www.theprojectgroup.com/blog/projektmanagement-methoden/ (accessed: Jul. 6, 2021).
[25] J. Nuottila, K. Aaltonen, and J. Kujala, "Challenges of adopting agile methods in a public organization," *International Journal of Information Systems and Project Management*, vol. 4, no. 3, pp. 65–85, 2016, doi: 10.12821/ijispm040304.
[26] T. Gustavsson, M. Berntzen, and V. Stray, "Changes to team autonomy in large-scale software development: a multiple case study of Scaled Agile Framework (SAFe) implementations," *International Journal of Information Systems and Project Management*, vol. 10, no. 1, pp. 29–46, 2022, doi: 10.12821/ijispm100102.
[27] J. Binder, L. Aillaud, IV, and L. Schilli, "The Project Management Cocktail Model: An Approach for Balancing Agile and ISO 21500," *Procedia Social and Behavioral Sciences 27th IPMA World Congress*, vol. 119, pp. 182–191, 2014, doi: 10.1016/j.sbspro.2014.03.022.
[28] M. Brown, S. Dey, and G. Tuxworth, "Selection factors determining the hybrid approach: A preliminary study," *Americas Conference on Information Systems (AMCIS)*, pp. 1–6, 2020.
[29] W. Wysocki and C. Orłowski, "A multi-agent model for planning hybrid software processes," *Procedia Computer Science 23rd International Conference on Knowledge-Based and Intelligent Information & Engineering Systems*, vol. 159, pp. 1688–1697, 2019, doi: 10.1016/j.procs.2019.09.339.
[30] T. Hayata and J. Han, "A hybrid model for IT project with Scrum," *Proceedings of 2011 IEEE International Conference on Service Operations, Logistics and Informatics*, pp. 285–290, 2011, doi: 10.1109/SOLI.2011.5986572.
[31] J. Webster and R. T. Watson, "Guest Editorial: Analyzing the Past to Prepare for the Future: Writing a literature Review," *MIS Quarterly*, vol. 26, no. 2, pp. 13–23, 2002. [Online]. Available: https://www.jstor.org/stable/4132319
[32] A. M. Cavalieri Barbosa and M. C. P. Saisse, "Hybrid project management for sociotechnical digital transformation context," *Brazilian Journal of Operations & Production Management*, vol. 16, no. 2, pp. 316–332, 2019, doi: 10.14488/BJOPM.
[33] E. Papadakis and L. Tsironis, "Towards a hybrid project management framework: A systematic literature review on traditional, agile and hybrid techniques," *The Journal of Modern Project Management*, vol. 8, no. 2, pp. 124–139, 2020, doi: 10.19255/JMPM02410.
[34] J. Heimicke, R. Chen, and A. Albers, "Agile Meets Plan-Driven – Hybrid Approaches In Product Development: A Systematic Literature Review," *Proceedings of the Design Society: DESIGN Conference*, pp. 577–586, 2020, doi: 10.1017/dsd.2020.259.

[35] E. Papadakis and L. Tsironis, "Hybrid methods and practices associated with agile methods, method tailoring and delivery of projects in a non-software context," *Procedia Computer Science International Conference on Enterprise Information Systems*, vol. 138, pp. 739–746, 2018, doi: 10.1016/j.procs.2018.10.097.

[36] K. Rahi, M. Bourgault, and C. Preece, "Risk and vulnerability management, project agility and resilience: a comparative analysis," *International Journal of Information Systems and Project Management*, vol. 9, no. 4, pp. 5–21, 2021, doi: 10.12821/ijispm090401.

[37] S. Morcov, L. Pintelon, and R. J. Kusters, "Definitions, characteristics and measures of IT project complexity-a systematic literature review," *International Journal of Information Systems and Project Management*, vol. 8, no. 2, pp. 5–21, 2021, doi: 10.12821/ijispm080201.

[38] C. Iriarte and S. Bayona, "IT projects success factors: a literature review," *International Journal of Information Systems and Project Management*, vol. 8, no. 2, pp. 49–78, 2020, doi: 10.12821/ijispm080203.

[39] J. vom Brocke, A. Simons, B. Niehaves, K. Riemer, R. Plattfaut, A. Cleven, "Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process," in *17th European Conference on Information Systems (ECIS), Verona, Italy*, 2009, 2206–2217.

[40] S. Stahlschmidt and D. Stephen, "Comparison of Web of Science, Scopus and Dimensions databases," *KB Forschungspoolprojekt; DZHW: Hannover, Germany*, pp. 1–37, 2020. [Online]. Available: https://bibliometrie.info/downloads/DZHW-Comparison-DIM-SCP-WOS.PDF

[41] O. Mikhieieva, A. Nuseibah, C. D. Grewe, C. Wolff, and C. Reimann, "Implementing a Project Management Approach for Public-Funded Projects in HEIs," *Proceedings of the 2017 9th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*, pp. 247–252, 2017, doi: 10.1109/IDAACS.2017.8095085.

[42] A. F. Sommer, I. Dukovska-Popovska, and K. Steger-Jensen, "Agile Product Development Governance – On Governing the Emerging Scrum/Stage-Gate Hybrids," *IFIP International Federation for Information Processing 2014 Advances in Information and Communication Technology*, pp. 184–191, 2014, doi: 10.1007/978-3-662-44739-0_23.

[43] R. G. Cooper, "Agile–Stage-Gate Hybrids," *Research-Technology Management*, vol. 59, no. 1, pp. 513–526, 2016, doi: 10.1080/08956308.2016.1117317.

[44] A. Q. Gill, B. Henderson-Sellers, and M. Niazi, "Scaling for agility: A reference model for hybrid traditional-agile software development methodologies," *Information Systems Frontiers*, vol. 20, no. 2, pp. 315–341, 2018, doi: 10.1007/s10796-016-9672-8.

[45] D. Karlstrom and P. Runeson, "Combining Agile Methods with Stage-Gate Project Management," *IEEE Software*, vol. 22, no. 3, pp. 43–49, 2005, doi: 10.1109/MS.2005.59.

[46] M. Krug, J. Ays, F. Sauermann, J.-P. Prote, and G. Schuh, "Synchronization of Scrum and Stage-Gate in Hybrid Product Development Projects of Manufacturing Companies," in *Production at the leading edge of technology: Proceedings of the 9th Congress of the German Academic Association for Production Technology (WGP), September 30th - October 2nd, Hamburg 2019*, J. P. Wulfsberg, W. Hintze, and B.-A. Behrens, Eds., Berlin, Heidelberg: Springer, 2019, pp. 421–430.

[47] M. Kuhrmann, P. Diebold, J. Münch, P. Tell, V. Garousi, M. Felderer, K. Trektere, F. McCaffery, O. Linssen, E. Hanser, C.R. Prause, "Hybrid software and system development in practice: waterfall, scrum, and beyond," *Proceedings of the 2017 International Conference on Software and System Process*, pp. 30–39, 2017, doi: 10.1145/3084100.3084104.

[48] A. F. Sommer, C. Hedegaard, I. Dukovska-Popovska, and K. Steger-Jensen, "Improved product development performance through Agile/Stage-Gate hybrids: The next-generation Stage-Gate process?," *Research-Technology Management*, vol. 58, no. 1, pp. 34–45, 2015, doi: 10.5437/08956308X5801236.

[49] L. Kostyak, D. M. Shaw, B. Elger, and B. Annaheim, "A means of improving public health in low- and middle-income countries? Benefits and challenges of international public–private partnerships," *Public Health*, vol. 149, pp. 120–129, 2017, doi: 10.1016/j.puhe.2017.03.005.

[50] Z. T. Kosztyán and I. Szalkai, "Multimode resource-constrained project scheduling in flexible projects," *Journal of Global Optimization*, vol. 76, no. 1, pp. 211–241, 2020, doi: 10.1007/s10898-019-00832-8.

[51] M. Tanveer, “Agile for large scale projects — A hybrid approach,” in *2015 National Software Engineering Conference (NSEC)*, 2015, pp. 14–18.

[52] X. Zhou, Y. Jin, H. Zhang, S. Li, and X. Huang, “A Map of Threats to Validity of Systematic Literature Reviews in Software Engineering,” in *2016 23rd Asia-Pacific Software Engineering Conference (APSEC)*, 2016, pp. 153–160.

Biographical notes

Janine Reiff

Janine Reiff is a student in the master’s program in Business Informatics (Information Systems) at Reutlingen University, Germany. Before graduating with a bachelor's degree in 2021 from the same university, Janine Reiff already gained her first practical experience in IT project management. Her current research interest is the implementation and use of modern project management methods in companies.

Dennis Schlegel

Dennis Schlegel is a Professor of Business Informatics (Information Systems) at Reutlingen University, Germany. His current research interest lies in the business and societal implications of emerging information technologies. After graduating with a PhD from Leeds Beckett University in 2013, Dennis Schlegel has gained many years of practical experience at a Big Four consultancy firm, most recently at Senior Manager level, before returning to academia.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

Risks associated with the development process of in-house information system projects

Chia-Ping Yu
Department of Information Management, Tamkang University
No. 151 Ying-Chuan Road, Tamsui, New Taipei, Taiwan, 25137
R.O.C. (Republic of China)
cpyu@mail.tku.edu.tw

Wan-Ying Lin
Department of Information Management, Tamkang University
No. 151 Ying-Chuan Road, Tamsui, New Taipei, Taiwan, 25137
R.O.C. (Republic of China)
alyssabubble@gmail.com

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

C.-P. Yu, W.-Y. Lin, “Risks associated with the development process of in-house information system projects”, *International Journal of Information Systems and Project Management*, vol. 10, no. 2, pp. 66-78, 2022.

International Journal of
Information Systems and Project Management

ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X

Available online at ijispm.sciencesphere.org

Risks associated with the development process of in-house information system projects

Chia-Ping Yu
Department of Information Management, Tamkang University
No. 151 Ying-Chuan Road, Tamsui, New Taipei, Taiwan, 25137
R.O.C. (Republic of China)
cpyu@mail.tku.edu.tw

Wan-Ying Lin
Department of Information Management, Tamkang University
No. 151 Ying-Chuan Road, Tamsui, New Taipei, Taiwan, 25137
R.O.C. (Republic of China)
alyssabubble@gmail.com

Abstract:
To provide a risk management perspective for managers responsible for in-house project development, we investigated how the risks associated with an in-house information system (IS) project evolve during the software development process. We conducted interviews and content analysis to examine the risks that affect project delivery quality. Three companies participated in this research. The results of this study indicate that risks related to organizational structure persist throughout the software development process. Content analysis indicated that in the conducted interviews, sentences regarding task- and actor-related risks characterized the first two phases of this process, and sentences regarding technology-related risks characterized the last two (third and fourth) phases. The results also suggest that different types of risks exert pressure on in-house project teams to reassess the weaknesses and resource allocation in a project and the possible solutions to any potential problems. This research explains risk dynamics throughout the life cycle of in-house IS development. Moreover, the findings of this study can help project managers identify the risks associated with the project development process that directly affect the project results.

Keywords:
risk; in-house IS project; project development process.

DOI: 10.12821/ijispm100204

Manuscript received: 3 January 2021
Manuscript accepted: 14 March 2022

1. Introduction

In-house projects are projects developed within a company, and companies frequently develop such projects [1]-[5]. In-house projects are a competitive asset because they involve developing services, business knowledge, and governance procedures that fit the organization [1]. Some researchers have identified the factors affecting whether companies choose to develop in-house projects or outsource projects. These factors include contract problems, problems related to power and politics, organizational structure, and business environment [3],[6]. Many studies have assessed the risks involved in the evaluation of the decision-making in an in-house project, including those related to cost, service quality, company strategies, or resource accessibility [7]-[9]. The primary concern related to in-house projects is the lack of product quality, and the factors affecting the product quality in an in-house project must be subjected to risk management in the project development process [5],[6],[9],[10]. Although a growing number of researchers have investigated the risks involved in decision-making related to in-house projects, limited attention has been focused on the risks in different phases of an in-house software development process.

Several studies [11]-[15] have suggested the existence of four types of project risks: those related to tasks, structures, actors, and technologies. Task-related risks include task ambiguity, task complexity, continual requirement changes, and wrong function design, all of which lead to an increase in cost caused by the requirement of additional or revised functions [11]-[15]. Inefficient communication, incentive mechanisms, or governance; poorly defined responsibilities; unrealistic schedules; and inappropriate workflow and coordination, are some structure-related risks [13]-[15]. Actor-related risks include low skills, poor attitudes, low experience, and low capability as well as ethical issues among project participants [12],[13]. Such risks entail an extra cost related to training or the extension of the project schedule. Finally, technology-related risks include technical complexity, unreliable components, untried technology, and system extendibility [11],[14],[15]. In in-house information system (IS) projects, skilled actors use flexible communication channels and powerful business domain knowledge to reduce risks related to the organization structure and actors. However, the creeping project scope or complexity of the integration between the new technology and legacy systems may increase the risks involved in these projects [2],[16]. Therefore, these projects might involve different risks than do those involving outsourcing. Thus, managers of in-house projects must identify task-, structure-, actor-, and technology-related risks that might lead to unrealistic expectations or underperformance.

The participants of an in-house project use their domain knowledge and social capital to reduce task-, actor-, and structure-related risks [2],[9]. This statement is valid under the premise that these participants are familiar with relevant business processes and have formed the informal or formal social relationships required to clarify what the relevant tasks involve and construct an effective communication system for the project [2],[8]. To face task-related risks, managers of in-house projects define appropriate boundaries for the project. They solve a variety of unforeseen problems related to the ambiguity of tasks because they understand the relevant business processes that must be adopted; they also address the structured, unstructured, or nonroutine problems that might be encountered in the project [2],[3],[17]. In an in-house project, smooth and effective communication structures play a critical role in the acquisition, distribution, exploration, and utilization of core knowledge or internal information. The manager of an in-house project must manage the risks of an ineffective coordination mechanism, an inappropriate job design, or actor turnover because in-house projects involve interwoven business processes [1],[6]. Furthermore, the manager must reduce or avoid the use of overly complex technologies to control technology-related risks. Incompatibility among legacy and new systems as well as poorly designed interfaces may increase technical complexity. Moreover, the manager might face a limited choice of methodologies and technologies [13], [18].

To achieve success, the manager of an IS project must be aware that different risk indicators must be emphasized in different project types [13],[15],[19]. Effective risk management enables the successful implementation of an Information Systems (IS) project [16]. The present study investigated the risks involved in in-house projects by analyzing four project phases: the planning, analysis, design, and implementation phases. Social technology theory was adopted to identify the risks involved in in-house IS project development. Effective risk identification can guide project practitioners to focus on specific risks, identify possible threats in the development process of the in-house project, and improve the quality of the in-house project. The results of this study can aid system developers in understanding what type of risks they might encounter throughout the system development process. Moreover, project members can use these results as a guideline when proposing a comprehensive risk management plan for in-house project development. Project managers can learn crucial lessons from the risk management process for an in-house project and then reassess their previous development direction. In summary, the results of this study would enable the development of practical risk management mechanisms for in-house projects.

2. Literature review

2.1. Project risk management

The main aim of risk management is to identify risks that are likely to compromise the success of a project and thus must be controlled [20]-[23]. Lyytinen and Newman [15] suggested that the system development process involves the interaction between technical and social subsystems. Their theory assumes that the outputs of an IS are affected by the interactions between actors, tools, techniques, and tasks in the technical and social subsystems [13],[15],[24]. Therefore, the problems associated with and failures of IS projects have been attributed to not only technical issues but also organizational behavioral issues [21],[22]. When subsystems are dependent on each other, a plan must be developed to ensure that all subsystems coordinate their work and that the performance of the organizational system is maximized [13],[15],[24]. Therefore, technical and social perspectives must be considered in the risk management process related to the system development life cycle.

On the basis of the sociotechnical model, studies have defined four types of risks for IS projects [14],[17],[25]: risks related to tasks, structures, actors, and technologies. The task-related risks in an IS project include the requirements, goals, approaches, and products. Wallace et al. [20] found that ambiguity and creeping scope are critical task-related risks that affect the process outcomes of a project. Structure-related risks include risks related to communication systems, government structures, authority relations, schedules, physical arrangement, coordination mechanisms, and workflow in software development [21],[22]. According to Huang et al. [25], the risks involved in the enhancement of the fitness between organizations and enterprise resource planning systems include organizational culture, business processes, organizational adaptation, and resource allocation. These structure-related risks might lead to an increase in project cost or delayed project delivery. Actor-related risks include any attributes and capabilities of groups or individuals who affect or are affected by the achievement of project goals [12],[13]. These risks include unsatisfactory outcomes from different participants, poor skills, ethical problems, or the lack of actors. Beranek et al. [12] focused on user risks in the software development process and found that user participation is the primary actor risk. Finally, technology-related risks include risks related to how work is performed or to the methods, tools, infrastructure, and equipment used to develop and implement a software system.

Changes in any component of the sociotechnical model affect some or all the other components [15],[24],[26]. Risks occur if the interdependent relationships between technical and social subsystems cannot be managed at critical times of change. In the case of an in-house project, a structural change might affect the people involved, the technology that they use, and their defined tasks. In this study, we attempted to identify the risks involved in in-house software development projects.

2.2. Risks in the software development life cycle

Traditional project management methods, such as the waterfall method, and the Project Management Body of Knowledge focus on large projects and involve considerable documentation, standardization, and numerous planning and control processes; thus, they lack flexibility and agility for handling changes in management [28],[29]. Agile project management is characterized by frequent feedback loops and iterative reviews; thus, agile risk management emphasizes human factors, including communication, participation, and collaboration among stakeholders interested in the project, as well as the control of relevant resources [19],[30],[31]. Consequently, risk management is a crucial part of the software development process.

According to several authors [1],[9],[24],[27], in an IS project, users' requirements and the organization's strategic goals should be aligned with the developed technology applications and systems, which enables business needs to be supported while maximizing performance and minimizing risks. In in-house projects, business needs are met through the development of application systems, whose feasibility is examined through post-implementation reviews [7],[8],[30].

In the planning phase of an IS project, the project team conducts a feasibility analysis for the required system and then plans the project. Thus, risks related to system requirements, such as those related to uncertain, frequently changing, inadequate, and unachievable requirements, are primarily managed in this phase [20]-[23]. The managers and participants in an in-house project are insiders who are familiar with relevant business processes; therefore, these insiders can identify business requirements more precisely than can external personnel. In-house system development avoids the risk of escalated project cost caused by task complexity. The precise identification of business requirements can positively affect the project development process and lead to appropriate scheduling and adequate staffing [13],[18]. The participants of an in-house IS project define project tasks from only a business viewpoint; however, the task specificity and complexity might be higher than expected, and the designed IS might have inappropriate functions. The managers of in-house projects might possess sufficient knowledge and experience related to specific relevant tasks [4],[9]. Nevertheless, they face many challenges when integrating various business requirements and determining an appropriate project boundary under limitations related to factors such as time, budget, and human resources.

The objective of the analysis phase of an IS project is to translate project requirements into explicit system inputs, processes, outputs, and interfaces [18],[31]. In this phase, the project manager should consider the task-, structure-, and actor-related risks [13],[26]. In an in-house project, the project manager might not be concerned regarding inappropriate communication when identifying project requirements because the organizational cohesion might be high. Some project managers might face political conflicts, which can lead to power plays or inefficient communication [1],[7]-[9].

The objective of the design phase of an IS project is to convert the descriptions of analysis models into logical and physical system specifications. The risks related to the outcome of this phase include system functionality risks, resource usage risks, technology-related risks, and performance risks [18],[32]. In an in-house project, the integration of existing and new technologies leads to increased technology-related risks, such as those related to poor interfaces, system extendibility, and system maintainability [6],[17], as well as actor-related and structure-related risks, such as those related to inappropriate authority, poor coordination, and a lack of experience among staff in using a new technology.

In the implementation phase of an IS project, the designed system is constructed, installed, and maintained [7],[18]. Risks related to the satisfaction criteria of the project, such as the scheduling and timing risks, personnel management risks, and performance risks, are focuses in this phase [15],[16],[18],[32]. In an in-house project, when staff can effectively acquire sufficient knowledge regarding existing systems, the risk of using old technology can be decreased. However, the technical complexity and unfamiliarity toward new technologies are critical factors that lead to unrealistic expectations or a decline in technical performance when members of in-house projects are inexperienced in using new technologies. The characteristics of the different phases and risks involved in the software life cycle are summarized in Table 1.

Table 1. Characteristics of the phases and risks involved in the software life cycle

Life cycle Phase	Objectives	Risks
Planning	1. Identifies the system request 2. Feasibility analysis 3. Plans the project	1. Uncertainty requirements 2. Changing requirements 3. Inadequate requirements 4. Ambiguous requirements
Analysis	1. Translate the requirements specified into explicit terms of system inputs, processes, outputs, and interfaces	1. Changing requirements 2. Inefficient communication 3. Poor physical arrangements 4. Poor beliefs/skills/experience

Life cycle Phase	Objectives	Risks
Design	1. Convert the analysis models into logical and physical system specifications	1. System functionality risks 2. Resource usage risks 3. Technology-risks
Implementation	1. Build system 2. Install system 3. Maintain system	1. Scheduling and timing risks 2. Personnel management risks 3. Performance risks

In-house projects involve various risks that must be managed in the system development process. Therefore, this study examined the types of risks involved in in-house software development processes by investigating the frequencies of sentences related to these risks in interviews conducted with relevant individuals.

3. Methodology

The primary purposes of this study were to investigate the risks involved in in-house software development projects and to understand the evolution of these risks. In addition, we collected data that provide an experiential description of events, situations, and interactions between risks and the project in the entire system development life cycle. We conducted content analysis to identify differences in context, coded responses to open-ended questions in interviews, identified the intentions and other characteristics of participants, assessed the risks in the system development life cycle, and described the trends indicated by the data [33],[34].

We conducted a case study on in-house IS projects of different sizes conducted in different industries. Taiwanese manufacturing companies had an annual production value of more than 20 trillion New Taiwan dollars in 2021, and many Taiwanese companies have used technologies to enhance the efficiency, speed, and cost-effectiveness of manufacturing. These technologies were developed through coordination between various departments and involved big data sharing for supporting various business functions. In addition, the information technology (IT) service industry uses complex information systems to conduct daily operational processes and adopts in-house projects to maintain its competitive advantage. The risk management of these projects is critical when the manager faces challenges related to limited resources, security threats, and technology complexity. Thus, manufacturing and IT service industries are suitable cases for the present study. Cases related to power supply manufacturing, semiconductor foundry development in a manufacturing company, and a cloud computing service company were examined in this study. Moreover, the sizes of the projects selected for examination ensured that project portfolio analysis could be conducted on both a large and small scale.

To acquire a broad understanding of the risks involved in the entire IS development process, we recruited seven individuals from three companies who were working or had worked in different project roles. The responses of project managers and senior programmers to interview questions related to project risks are crucial because these individuals are involved in all phases of a software development project. All the participants in this study had at least 10 years of experience in managing projects. Three of the seven participants were project managers, and four participants were senior programmers. In this study, a “small” project was defined as one that lasted no more than three months, cost less than $50,000, had low functional complexity, involved no more than four team members, and had low risk. A “large” project was defined as one that lasted more than one year, cost higher than $500,000, had high functional complexity, involved more than 10 team members, and had high risk. Table 2 presents some information related to the participants.

Two researchers conducted participant interviews according to a predefined framework. First, the researchers obtained some basic background information regarding the project managers and the companies of these managers. Second, the researchers obtained information on project characteristics, including the project goals, budget, duration, members, and phases. Finally, the researchers obtained information related to risk management in the projects that the participants were or had been involved in. The shortest interview session lasted approximately 30 min; the longest session lasted approximately 90 min; and the average interview duration was 60 min.

In all the interviews, the researchers took notes, and the participants were encouraged to identify which issues were crucial to them in the context of their work. The coding scheme was defined according to the four components of the sociotechnical model proposed by Lyytinen and Newman [15] and the four phases of the system development life cycle proposed by Yu et al. [13].

Table 2. Information related to the participants and their companies

Case description	Case (Project)	Interviewees
Time >1 year Cost >$500,000 Project team members >10	1*	1 Senior programmer
	2**	1 Project manager, 2 Senior programmer
Time: 3 months~1year Cost: $50,000~$500,000 Project team members: 4~10	3**	1 Project manager
	4***	1 Project manager
Time <3 months Cost <$50,000 Project team members <4	5*	1 Project manager

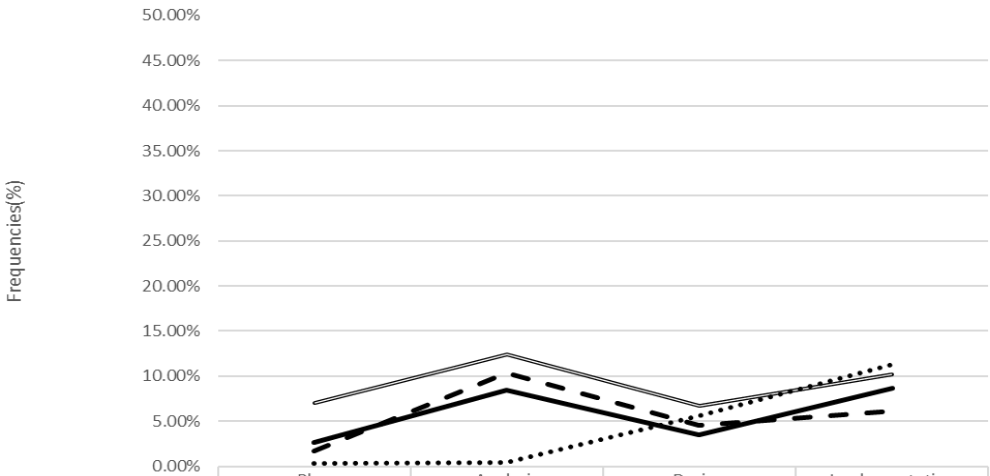
Note: * semiconductor foundry development and manufacturing; ** power supply manufacturing; *** cloud computing service provision

The two research assistants were trained to ensure that they coded units (i.e., themes) into suitable categories for reproducibility and reliability. The coding results of the coders were assessed by the authors of this study [33],[34]. To solve conflicts between the two coders, each coder was first asked to refer to the coding book, which contained the definition of each category, example, and keyword, to determine the correct category. The coders then had to explain their coding results and communication to each other to clarify the coding rules. Subsequently, the researchers joined the discussion to check each category's definition and helped solve the coding conflicts and eliminate coding ambiguities. The training data comprised 10%–20% of the entire data, and training lasted for several sessions until the intercoder reproducibility was approximately 90%. After training ended, the intercoder reliability values for software development risk and software development process were 92.10% and 91.33%, respectively. Subsequently, the coding rules were applied to all the data, and the official coding process began. Finally, after the official coding ended, the coder reproducibility values for software development risk and software development process were 91.72% and 92.89%, respectively.

4. Results and discussion

A total of 1,602 verbal sentences related to the four phases of the projects of the three considered companies were obtained in the interviews. The number of units used in the content analysis was 784. Of these units, 767 were classified into the software development risk or software development process categories. Frequency analysis was conducted on the four risk categories to compare the differences in project development patterns between the examined projects and to identify the characteristics of the four project stages. In Fig. 1, the *x*-axis represents the project phase, and the *y*-axis represents the frequency (in percentage) of sentences related to each risk category. Fig. 1 indicates that the frequencies of sentences related to the four types of risks differed. In the entire software development process, the highest sentence frequency was obtained for structure-related risks (38.1%). The frequencies of sentences regarding structure-related and actor-related risks peaked in the analysis phase. The frequency of sentences regarding task-related risks peaked in the implementation phase and was high in the analysis phase. The minimum frequencies of sentences regarding task-related and actor-related risks were obtained in the planning phase, and the minimum frequency of sentences regarding structure-related risks was obtained in the design phase. The frequency of sentences regarding technology-related risks increased during the last two project phases.

Overall, the results indicated that structure-, task-, and actor-related risks were the primary risks in the entire software development process. The participants mostly paid attention to task-related and structure-related risks during the first two project phases and to technology-related risks in the last two phases. The personnel working in the examined in-house projects had a common goal, worked under common staff management regulations, and adopted the same technology-based working process to achieve their aim. Thus, the project managers mainly focused on managing structure-related risks in the entire software development process. In addition, the managers adopted informal and formal communication systems to clarify projects tasks quickly. The administrative regulations might have aided the managers in meeting the project schedule and accessing appropriate human resources.



	Plan	Analysis	Design	Implementation
Task Risks	2.65%	8.42%	3.49%	8.67%
Structure Risks	7.01%	12.44%	6.75%	10.19%
Actor Risks	1.66%	10.40%	4.53%	6.11%
Technology Risks	0.37%	0.40%	5.60%	11.31%

Fig. 1. Frequencies of sentences regarding task-, structure-, actor-, and technology-related risks in the four software development phases.

4.1. Task-related risks

The frequency of sentences regarding task-related risks was high in the analysis and implementation phases (Fig. 1). The primary task-related risks were task ambiguity, continuous change, and task specification. The increase in the frequency of the aforementioned sentences from the planning stage to the analysis stage indicated that task-related risks were identified early in the projects and that the participants had strong business expertise and were familiar with the relevant business process. The frequency of sentences regarding task-related risks decreased considerably in the third phase. The increase in this frequency in the fourth phase indicated that task-related risks increased because of continual changes in the project scope or task specificity, which might have led to increased system complexity.

The results of our study are consistent with those of previous empirical studies [13],[15] that have indicated that the task requirements for users familiar with the relevant business domain are strongly associated with the task that is clarified at the beginning of the project. The project teams emphasized the identification of tasks-related risks in the analysis phase. Thus, the project team members might have quickly strengthened their business domain knowledge and experiences with regard to specific system requirements [1]. These skilled and experienced members affected the effectiveness of the requirements gathering and swiftly encouraged the individual part involved in the project. As such, a low level of task-related risk may assure business units of the viability of the project and enable the fulfillment business needs.

Continuously changing requirements and task specificity were the main task-related risks in the implementation phase. The project team members cooperated with other parties and exerted considerable effort in increasing the task specificity to fulfill each party's requirements. On the basis of system requirements, the task specificity changed in the last project phase. Moreover, ambiguous task definition may limit the scope of the system, which has ripple effects on function suitability and system complexity. Project manager B said, "*Dealing with minor changes or discrepancies in requirements is unavoidable. Our project team must rebenchmark procedures on the basis of [requirement] changes or errors. At this point, we reassess the required workforce and adjust the schedule, hardware, and software….*"

High task-related risk may exist in the early project phases; however, an increase in task-related risk should not be considered a negative phenomenon. The high frequency of sentences regarding task-related risks in the analysis phase indicated that the participants focused on the project requirements by clarifying and promoting users' involvement early in the project. The managers relied on users to identify complete requirements for the entire system. In the implementation phase, project team members frequently used sentences regarding task-related risks to indicate their willingness to collaborate with other members to develop correct system functions.

4.2. Structure-related risks

Consistent with the results of previous studies [13],[15], the participants of the present study focused on structure-related risks throughout the software development process (Fig. 1). The primary structure-related risks were an inefficient or poor communication system, poorly defined responsibilities, an inefficient governance structure, and inappropriate workflow and coordination. The sentences regarding structure-related risks guided the participants to connect with others who rapidly committed to their interests or group goals. In an in-house project, if structure-related risks are focused on throughout the entire software development process, a suitable communication system, responsibility policy, and governance structure in addition to good coordination and an appropriate incentive system can be maintained. For example, director E said, "*We need smooth communication systems to access resources for our project. First, we need to evaluate the feasibility of the IS project and assess whether it is worthwhile. Next, we have to check who should be involved in the IS project and support the IT and business fields. Finally, the timetable for each task should be arranged….*"

As depicted in Fig. 1 the frequency of sentences regarding structure-related risks was high for the analysis and implementation phases but low for the design phase. In the analysis phase [13],[23], task ambiguity lead to different interpretations or conflicts. To understand the project requirements clearly, project members had to share relevant knowledge and information through a communication structure, with most of them focusing on structure-related risks such as task assignment, communication through the chain of command, and the coordination mechanism or incentive system.

In the implementation phase, project members engaged in coordination or managerial processes, such as proposing the development of an IT strategy or integrating new technology with existing systems. Director A said, "*Based on the schedule, weekly meetings are held to review the timetable. In the earlier phase, revisions are made to paperwork only when miscommunication occurs… but the communication problems between IT staff and users are considerably more serious (cause a higher risk) than are those between IT staff and consultants. Fortunately, serious communication gaps between the technology and business units do not occur when they come to an agreement after frequent negotiations. In fact, good communication plays an important role in solving problems*." Consequently, sentences regarding structure-related risks frequently occurred throughout the software development life cycle, which indicated that the participants prioritized the development of a strong social relationship among project team members or the reinforcement of cooperative relationships to reduce any potential conflicts.

4.3. Actor-related risks

As illustrated in Fig. 1, actor-related risks were not a priority in the planning phase. The actor-related risks increased in the analysis phase and remained stable in the later phases. The major actor-related risks were the lack of actors, actor turnover, and ethical problems. Our data indicated that the actor-related risks were still serious during the last two phases of the software development process. The frequency of sentences regarding actor-related risks peaked in the analysis phase, which indicated that project team members had to manage coordination processes effectively to achieve the common goals of their project.

Project team members identified the actor-related risks in their project and then reduced the level of these risks by adopting appropriate human resources quickly and urgently coordinating with others. Project team members allocated human resources to decrease actor turnover to ensure that sufficient skilled actors were available for implementing the developed system. The project team members had to compete for resources against other teams within their organization. Specifically, human resources were the most critical resource within the organization. In the design and implementation phases, the members had to acquire appropriate knowledge. They defined project requirements in the analysis phase and transformed business needs into detailed specifications for guiding system implementation. Project team members should examine problems from both business and technical viewpoints. Senior programmer D said, "*Perhaps only certain people hold…key skills… In the beginning, we would rather find some people who are more familiar with IT because they can provide expertise. They see the whole picture of the IS project. Simply speaking, they coordinate more closely with the IT unit because they do not examine problems from only a business point of view*."

According to the aforementioned text, sentences regarding actor-related risks paved the way for coordination and conflict among project team members and allowed the manager to synchronize the functioning of business and technical teams. Furthermore, when actor-related risks emerged and were appropriately assessed, the project manager could effectively manage the low-level actor turnover, thereby solving conflicts among project team members. In summary, sentences regarding actor-related risks allowed each project team member to assess and adjust their needs, skills, responsibilities, and value in their project.

4.4. Technology-related risks

Consistent with previous research [13],[15], the frequency of sentences regarding technology-related risks peaked in the implementation phase (fourth phase, Fig. 1). In a successful in-house IS project, customized services can be developed by assessing the adoption of and satisfaction toward the newly developed system [1],[6],[19]. To provide high-quality technical services to internal personnel, members of the technical unit focus on new technologies, novel methods, technical complexity, technical maintainability, or scalability during the design and implementation stages. In an in-house IS project, considerable technology resources must be used for developing system functions that fit the tasks of the business unit. Thus, the project team members identified technology-related risks after the system requirements were defined in the first phase of the software development process.

During the last two project phases, project team members had to address many technology-related risks. In practice, technology-related risks include the need for alignment between legacy systems and the new system, the presence of massive historical data, the resistance of users to new technology, and changes in business processes. Project managers C said, "The development of new technology is a part of our work. But, frankly speaking, developing new technology or using new technology components is not the priority…. in fact, we have diverse data formats, complex system interactions, and different technology platforms…in the IS project, the critical activity is to take care of maintenance issues and system integration...alongside these, [personnel] training is a bigger issue."

An in-house project should never be treated as only an IT adaptation for managing technology-related risks. To develop a compatible, maintainable, and customizable IS, project team members should not only assess technology-related risks but also consider the possible interactions of technology-related risks with task-, actor-, or structure-related risks. These interactions can lead to the failure of IS delivery for specific business users. Therefore, in the projects investigated in the present study, in the final project phase, project team members identified and monitored all types of risks and more deeply understood the gap between business needs and technology. Managers of in-house IS projects should be proactive in ensuring that their existing systems and users can be integrated with the new technology platform and new business process.

4.5. Risks involved in large, medium-size, and small projects

Fig. 2 illustrates the frequencies of sentences regarding the four types of risks in large, medium-size, and small projects. No major difference existed between the frequencies of sentences regarding task-, actor-, and technology-related risks in these projects. In the case of small projects, the frequency of sentences regarding structure-related risks peaked in the planning and design phases; however, in the case of large and medium-size projects, this frequency peaked in the analysis phase. Thus, small projects entail different structure-related risks than large and medium-size projects do. Organizational culture, resource allocation, and communication structure might affect structure-related risks in an IS project.

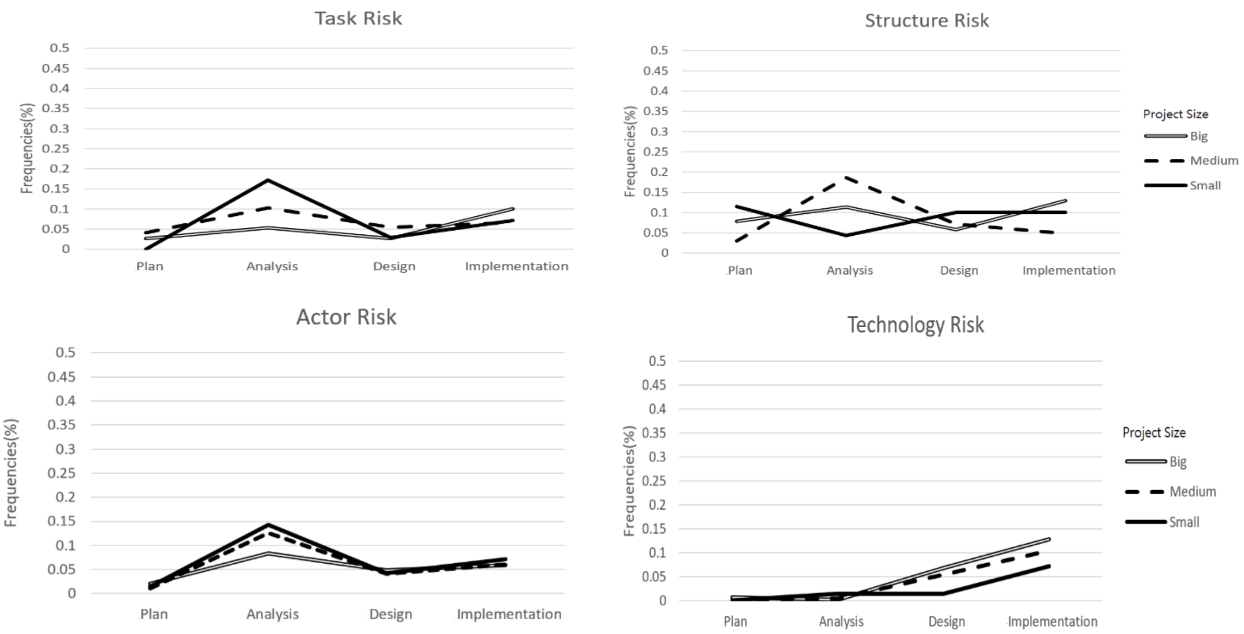


Fig. 2. Frequencies of sentences regarding task-, structure-, actor-, and technology-related risks in different phases of large, medium-size, and small projects

Table 3 presents the risks involved in general projects (examined in previous studies) and in-house projects (examined in the present study). In in-house projects, task-related risks are not the main concern because project team members are familiar with the relevant business process; however, in the last project phase, continual changes in project requirements change the scope of the developed system and might result in the development of wrong functions and system complexity. Although only insiders are involved in an in-house project, the level of structure-related risks, including communication, coordination mechanisms, or membership conflicts, in such a project may not be lower than that in general projects. Many actor-related risks are associated with the design phase of an in-house project. Project members must compete for human resources against other units in their organization to transform business needs into system specifications. The level of technology-related risks increases rapidly when the team members involved in an in-house project focus on not only the use of the newly developed technology but also the integration of the new system with legacy systems to deliver high-quality technology services to organization insiders.

Table 3. Risks involved in general projects and in-house projects

General projects (examined in previous studies)	
▪ Task-related risks are the primary target for management in the planning phase [13],[18],[20]-[23].	
▪ The project manager may be focused on task-, structure-, and actor-related risks in the analysis phase [1],[7]-[9],[13],[18], [26],[30].	
▪ The project manager focuses on technology-related risks in the design and implementation phases [6], [15]-[18], [31].	
In-house projects (examined in this study)	
Task-related risks	The level of task-related risks remains relatively consistent throughout the system development process and increases in the last project stage.
Structure-related risks	Structure-related risks are dominant throughout the entire project. However, these risks are not priority risks.
Actor-related risks	Actor-related risks are not priority risks in the planning phases, and the level of these risks remains stable in the later phases.
Technology-related risks	The level of technology-related risks is high in the fourth (implementation) phase.

In summary, the team members involved in the in-house projects examined in this study spoke sentences regarding task-, structure-, actor-, and technology-related risks throughout the system development process; however, the frequencies of these sentences were not the same. Sentences regarding structure-related risk dominated all the project phases; sentences regarding task-related and actor-related risks characterized the first two project phases (i.e., the planning and analysis phases); and sentences regarding technology-related risks characterized the last project phase (i.e., the implementation phase). Each type of risk pressured the project teams to reassess their weaknesses, examine the resource allocation in the project, and obtain possible solutions to problems. The managers of in-house projects must deeply understand the signs of each type of risk to ensure successful project implementation.

5. Conclusion

The findings of this study are as follows. First, according to our empirical data, structure-related risks are the main risks in the overall software development process. Actor-, task-, and technology-related risks interact with structure-related risks in this process. Technology-related risks are pronounced during the last two project phases (i.e., the design and implementation stages). Second, organization insiders participate in in-house projects, and these insiders work under the same regulations and project objectives. Thus, in an in-house project, the project team focuses more on structure-related risks than on the task-related and actor-related risks in the planning phase. Third, the project team of an in-house project focuses on structure-related risks because the project parties are business oriented. To eliminate the knowledge gap between the business and technology units, project team members must share their knowledge of their project domain and reach a consensus regarding the project value.

This study makes several contributions to the literature on risk management in in-house IS projects. First, by using the sociotechnical model, we identified four types of risks in the aforementioned projects: task-, structure-, actor-, and technology-related risks. The results of this study provide a preliminary understanding of the risks involved in different phases of in-house IS projects. We determined that the social subsystem is associated with actor-related and structure-related risks, and insiders might possess deep understanding regarding the business goals, requirements, and system functions associated with an in-house project. The technical subsystem is associated with task-related and technology-related risks, and the participants in an in-house project might know how certain technologies fit their organization. Second, this study examined the four identified risk types and found that structure-related risks are a major concern in in-house projects. In such projects, the management of structure-related risks is a priority because effective coordination may enable a clear definition of tasks, responsibilities, and incentives to align the actors, tasks, and technology in the project. Managers must consider the characteristics of the project to identify the main risks in the system development process.

In practice, project managers can manage risks effectively by adjusting the resource allocation appropriately to reduce specific risks in each phase of the software development process. In an in-house project, the project team might initially manage actor-related and task-related risks. However, project success is influenced by the coordination among various departments, which should be facilitated through the development of appropriate structures in all project phases. Therefore, managers of in-house projects should monitor structure-related risks. In addition, the participants of an in-house project must adopt efficient new technology, minimize technology complexity, achieve precise requirements, and use effective system development methods before the last project stage (i.e., the implementation stage).

Although this research offers valuable insights into the risks involved in in-house IS projects, it has some limitations. First, a major limitation of our study is that our analysis relied solely on Taiwanese interviewees who had been critical project participants for more than 5 years; thus, the results of this study may not be generalizable to all projects. Second, our study was an exploratory study with an ex post facto design, which can only indicate what was happening or what has happened. We used considerable data to understand project risks but could not determine the reasons that caused the evolution patterns of these risks. Despite the aforementioned limitations, the results of this study have crucial implications for the investigation of risks in in-house projects.

References

[1.] D. Whitten and D. Leidner, "Bringing IT back: an analysis of the decision to backsource or switch vendors," *Decision Sciences,* vol. *37,* no. *4,* pp. *605-621,* 2006.
[2.] M.K. Marvel and H.P. Marvel, "Outsourcing oversight: A comparison of monitoring for in-house and contracted services," *Public Administration Review,* vol. *67,* no. *3,* pp. *521-530,* 2007.
[3.] F.N. Veltri, C.S. Saunders and C.B. Kavan, "Information Systems backsourcing: correcting problems and responding to opportunities," *California Management Review,* vol. *51,* no. *1,* pp. *50-76,* 2008.
[4.] J. Kotlarsky and L. Bognar, "Understanding the process of backsourcing: two cases of process and produce backsourcing in Europe," *Journal of Information Technology Teaching Cases,* vol. *2,* no. *2,* pp. *79-86,* 2012.
[5.] P. Nagpal, "Backsourcing: a review and theoretically motivated view," *Journal of Management Information and Decision Sciences,* vol. *18* no. *1,* pp. *53-58,* 2015.
[6.] H. Solli- sæther and P. Gottschalk, "Stages-of growth in outsourcing, offshoring, and backsourcing: back to the future?," *Journal of Computer Information Systems*, vol. *55*, no. *2*, pp. *88-94,* 2015.
[7.] D. McKenna, "A study of out-sourcing versus in-sourcing tasks within a project value chain," *International Journal of Managing Projects in Business,* vol. *1,* no. *2,* pp. *216-232,* 2008.
[8.] A. Tiwana and S.K. Kim, "Concurrent IT sourcing: mechanisms and contingent advantages," *Journal of Management Information Systems*, vol. *33,* no. *1,* pp. *101-138,* 2016.
[9.] M. Benaroch, Q. Dai and R.J. Kauffman, "Should we go our own way? backsourcing flexibility in IT Services contracts," *Journal of Management Information Systems,* vol. *26,* no. *4,* pp. *317–358*. 2010.
[10.] A.A. Elias and S.K. Mathew, "Offshore IT outsourcing between India and New Zealand: a systemic analysis," *Pacific Asia Journal of the Association for Information Systems*, vol. *7,* no. *3,* pp. *33-54*. 2015.
[11.] P.L. Bannerman, "Risk and Risk Management in IS projects: a reassessment," *Journal of Systems and Software,* Vol. *81,* No. *12,* pp. *2118-2133,* 2008.
[12.] P.M. Beranek, G. Klein and J.J. Jiang, "Building User Engagement for Successful IS projects: Meaningfulness, Safety, and Availability," *Pacific Asia Journal of the Association for Information Systems*, vol. *6*, no. *3*, pp. *1-20,* 2014.
[13.] C.P. Yu, H. G. Chen, G. Klein, and R. Jiang, "The roots of executive information system development risks," *Information and Software Technology,* vol. *68,* pp. *34-44,* 2015.
[14.] J.H. Iversen, L. Mathiassen and P.A. Nielsen, "Managing Risk in Software Process Improvement: An Action Research Approach," *MIS Quarterly,* vol. *28,* no. *3,* pp. *395-433,* 2004.
[15.] K. Lyytinen and M. Newman, "Explaining information systems change: a punctated socio-technical change model," *European Journal of Information Systems*, vol. *17,* no. *6,* pp. *589-613,* 2008.
[16.] H. Mao, S. Liu and J. Zhang, "How the effects of IT capability and knowledge capability on organizational agility are contingent on environmental uncertainty and information intensity," *Information Development*, vol. *31*, no. *4,* pp. *358-382,* 2015.
[17.] A.E. Haroun and E.A. Elfaki, "Feasibility of adopting in-and –out-sourcing: a case study of PetroCost for engineering investment and construction Co. Ltd," *Journal of Quality in Maintenance Engineering,* vol. *18,* no. *1,* pp. *4-15,* 2012.
[18.] S. Liu and L. Wang, "Understanding the impact of risks on performance in internal and outsourced information technology projects: The role of strategic importance," *International Journal of Project Management,* vol. *32,* no. *8,* pp. *1494-1510,* 2014.
[19.] M. Durbin and F. Niederman, "Bringing templates to life: overcoming obstacles to the organizational implementation of Agile methods," *International Journal of Information Systems and Project Management*: vol. *9,* no. *3,* pp. *5-18,* 2021.
[20.] L. Wallace, M. Keil and A. Rai, "Understanding IS project Risk: A Cluster Analysis", *Information & Management,* vol. *42,* no. *1,* pp. *115-125,* 2004.
[21.] S. Liu, J. Zhang, M. Keil and T. Chen, "Comparing senior executive and project manager perceptions of IS project risk: a Chinese Delphi study," *Information Systems Journal,* vol. *20* no. *4,* pp. *319-355,* 2010.
[22.] M. Hofman and G. Grela, "Project portfolio risk categorisation – factor analysis results," *International Journal of*

Information Systems and Project Management, vol. *6*, no. *4*, pp. *39-58*, 2018.
[23.] C. Micán, G. Fernandes, and M. Araújo, "Project portfolio risk management: a structured literature review with future directions for research," *International Journal of Information Systems and Project Management*, vol. *8*, no. *3*, pp. *67-84*, 2020.
[24.] L.F. Luna-Reyes, J. Zhang, J.R. Gil-Garcia and A.M. Cresswell, "Information systems development as emergent socio-technical change: a practice approach," *European Journal of Information System*s, vol. *14*, pp. *93-105*, 2005.
[25.] S.Y. Hung, W.J. Yu, C.C. Chen and J.C. Hsu, "Enhancing organizational fit factors to achieve ERP project success," *Pacific Asia Journal of the Association for Information Systems*, vol. *5*, no. *1*, pp. *45-64*, 2013.
[26.] S. Chakrabarty, D. Whitten and K. Green, "Understanding service quality and relationship quality in is outsourcing: client orientation and promotion, project management effectiveness, and the task-technology-structure fit," *Journal of Computer Information Systems,* vol. *48*, no. *2*, pp. *1-15,* 2008.
[27.] S. Huang and W. Han, "Exploring the relationship between IS project duration and risk exposure: a cluster analysis", *Information & Management,* vol. *45,* no. *3*, pp. *175-182*, 2008.
[28.] M. Chaves, C. Araújo, L. Teixeira and D. Rosa, "A new approach to managing lessons learned in PMBoK process groups: the Ballistic 2.0 Model," *International Journal of Information Systems and Project Management,* vol. *4*, no. *1*, pp. *27-45*, 2016.
[29.] PMI, *A Guide to the Project Management Body of Knowledge (PMBOK Guide) - the Standard for Project Management*, *7*th ed. City of Publisher, Pennsylvania, USA: Project Management Institute, 2021.
[30.] M. Trzeciak, "Sustainable Risk Management in IT Enterprises," *Risks*, vol. 9, no. 135, 2021.
[31.] H. Taylor, E. Artman and W.J. Palzkill, "Information technology project risk management: bridging the gap between research and practice," *Journal of Information Technology*, vol. *27*, no. *1*, pp. *17-34*, 2012.
[32.] M.O. Dada, "The influence of project team relationships on cost growth," *Journal of Financial Management of Property and Construction*, vol. *19*, no. *1*, pp. *76-94*, 2014.
[33.] K.H. Krippendorff, *Content Analysis: An Introduction to Its Methodology*, *4*th ed, London: Sage, 2018.
[34.] K.A. Neuendorf, *The Content Analysis Guidebook*, *2*nd ed, Califormia, USA: Sage Publications, Inc, 2016.

Biographical notes

Chia-ping Yu
Chia-ping Yu is a Professor in the Department of Information Management at Tamkang University, Taiwan. She received her PhD in MIS (Management Information System) from National Sun Yat-sen University. Her research interests are project management, e-government management, and information security. Her works have appeared in the *Journal of Computer-Mediated Communication*, *Cyber Psychology and Behavior*, *Information & Management*, *Journal of Educational Technology & Society*, *Journal of Computer Information Systems*, and *IJEA (International Journal of e-adoption).*

Wan-Ying Lin
Wan-Ying Lin received her Master of Business Administration degree in information management from Tamkang University, and her research interests are project management and risk management.

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org

International Journal of
Information Systems and Project Management
ISSN (print):2182-7796, ISSN (online):2182-7788, ISSN (cd-rom):2182-780X
Available online at ijispm.sciencesphere.org