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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.

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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.

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- 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
- criteria and factors for success
- project manager role
- project manager skills
- portfolio management
- program management
- managing organization - structure
- tools and techniques
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Table of contents

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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 first number of the seventh volume of IJISPM. In this issue readers will find important contributions on research and practice in IS, shadow IT, project management practice, and project resilience.

The first article is the viewpoint of João Álvaro Carvalho and has the title "Research and practice in IS: insights from medicine that might contribute to overcoming the relevance deficit in the IS domain". The article focus on the relationship between Information Systems (IS) research and IS professional practice. The author shares the view of those that consider that the IS domain encompasses both, an academic facet and a practical facet. The two facets are interdependent and demand forms of collaboration between academics and practitioners that are only perceptible within an overarching view of scientific knowledge and of its production and use. The article aims at proposing such view. A main feature of the proposed view is that it involves distinguishing among different types of scientific knowledge and different modes of doing research. In particular, it involves emphasizing a form of research that is overlooked in IS – clinical research. Insights from the medicine domain are used to illustrate the place of clinical research and its role in connecting researchers and practitioners.

The second article, "Causing factors, outcomes, and governance of Shadow IT and business-managed IT: a systematic literature review", is authored by Stefan Klotz, Andreas Kopper, Markus Westner and Susanne Strahringer. Shadow IT and Business-managed IT describe the autonomous deployment/procurement or management of Information Technology (IT) instances, i.e., software, hardware, or IT services, by business entities. For Shadow IT, this happens covertly, i.e., without alignment with the IT organization; for Business-managed IT this happens overtly, i.e., in alignment with the IT organization or in a split responsibility model. The authors have conducted a systematic literature review and structure the identified research themes in a framework of causing factors, outcomes, and governance. As causing factors, were identified enablers, motivators, and missing barriers. Outcomes can be benefits as well as risks/shortcomings of Shadow IT and Business-managed IT. Concerning governance, are distinguished two subcategories: general governance for Shadow IT and Business-managed IT and instance governance for overt Business-managed IT. Thus, a specific set of governance approaches exists for Business-managed IT that cannot be applied to Shadow IT due to its covert nature. Hence, it was extended the existing conceptual understanding and allocate research themes to Shadow IT, Business-managed IT, or both concepts and particularly distinguish the governance of the two concepts.

The title of the third article is "Improving and embedding project management practice: generic or context dependent?", which is authored by Gabriela Fernandes and Madalena Araújo. Taking into account the contingency theory, this paper explores the extent to which key project management improvement initiatives and key embedding factors, identified in a previously developed conceptual framework, are dependent on organizational context, namely sector of activity, organization size, geographic area and project types. Therefore, aiming to guide professionals on making use of such framework in their organizations. The paper shows the explanatory power of the framework, which can be used by any organization independent of its sector of activity, dimension, geographic area and project types, however indicating the existence of slight differences. For example, Information and Technology companies might give more relevance to initiatives such as corporate standardization and tailoring of project management processes tools and techniques than Engineering and Construction companies.

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As Khalil Rahi states in the fourth article “Project resilience: a conceptual framework”, resilience is a novel but promising concept in project management studies. Resilience thinking can help projects maintain their performance through flexible, systemic and context-specific approaches once faced with disruptive events. The main goal of this paper is to advance an interdisciplinary understanding of project resilience by proposing a definition and a conceptual framework of this concept. To achieve this article's objectives, the literature on project risk management is first reviewed to identify current research effort and limitations of dealing with disruptions. Consecutively, the concept of resilience in its broader applicability is explored where two dimensions are sieved: awareness and adaptive capacity. The literature on the new concept of project resilience is also scrutinized, where its novel nature, the lack of scientific studies to conceptualize it, and its significance to project management are demonstrated. These facts helped propose a definition and a conceptual framework of project resilience.

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,

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VIEWPOINT

Research and practice in IS: insights from medicine that might contribute to overcoming the relevance deficit in the IS domain

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Research and practice in IS: insights from medicine that might contribute to overcoming the relevance deficit in the IS domain

Viewpoint

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Abstract:
During the ICIS 2018 conference, in San Francisco, two interesting panels addressed themes related to the recurrent debate within the IS domain about the relevance of IS research. One panel - Seeking Public Intellectuals in the Information Systems Discipline: Towards an Impact and Engagement Agenda - discussed the influence (or lack of) of the IS research community on public policies and on public opinion in what concerns problems that affect the society. The other panel - the Senior Scholar Panel - focused on the relationship between IS research and IS professional practice. The perception, by IS academics, that IS research is of little relevance for IS practitioners was addressed once more. These are two different dimensions of the relevance of IS research. Both are important to a pivotal domain in the modern society that creates scholarly knowledge crucial to understanding, influencing and leading the transformations that society is undergoing. Those dimensions are also critical if IS seeks to become a "vibrant, socially relevant and influential" domain as recently mentioned by Hassam and Mathiassen [1]. This article focuses on the relationship between IS research and IS professional practice. I share the view of those that consider that the IS domain encompasses both, an academic facet and a practical facet. The two facets are interdependent and demand forms of collaboration between academics and practitioners that are only perceptible within an overarching view of scientific knowledge and of its production and use. This article aims at proposing such a view. A main feature of the proposed view is that it involves distinguishing among different types of scientific knowledge and different modes of doing research. In particular, it involves emphasizing a form of research that is overlooked in IS - clinical research. Insights from the medicine domain are used to illustrate the place of clinical research and its role in connecting researchers and practitioners.

Keywords:
research; practice; medicine; relevance.

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1. Knowledge types and research modes

In what concerns the knowledge produced in academic settings, it is normally useful to distinguish between knowledge that conveys understanding of the world and knowledge that is created with some purpose in mind (i.e., constitutes a means for an end, or, as Gregor [2] puts it, knowledge that encompasses theories for design and action). In other words, a distinction between knowledge that corresponds to discovery and knowledge that corresponds to invention, namely inventions that put into practice the results of discovery. The distinction can also be presented as science and technology.

The validation of the former type of knowledge focuses on the existence of a match between its models/theories and what actually occurs in the world. The validation of the latter involves two aspects. In a first moment, it addresses its feasibility, i.e., whether an idea can be implemented into an artifact (method, technique, tool, machine, …). In a second moment, it addresses assessing its efficacy, efficiency and usefulness, i.e., whether the produced artifact actually serves, and how well it serves, the purpose that triggered its production.

The distinction between these two types of knowledge leads to the acknowledgement of two modes of research: basic research, that aims at satisfying curiosity about the world (leading to the production of knowledge that conveys understandings of the world); and applied (translational) research that aims at applying (to translate) the results of basic research into means for achieving some end - methods, techniques, tools, machines, … (thus leading to knowledge that is created with some purpose in mind).

In what concerns validation, applied/translational research typically covers the earliest stage of the assessment of an invention - its feasibility, i.e., whether the underlying ideas are implementable - the proof-of-concept. This can be carried out in a laboratorial setting, often through experimentation with a prototype - a rough implementation of some idea that is produced to test/demonstrate its feasibility. Although the results of applied/translational research aim at being used for some practical purpose, most likely under the direction of practitioners of some profession, this mode of research is most often carried out by academics.

Applied/translational research is, however, at the reach of practitioners. Whenever the existing knowledge does not provide an adequate basis for the design of a solution for a specific problem, practitioners might need to engage (alone or in collaboration with academics) in the production of new means for their action (new knowledge for some purpose). Such cases of applied/translational research demand going beyond the mere feasibility aspects of the new means for action. As they occur in a real-world environment, efficacy/efficiency/usefulness will also have to be addressed. So, attention will have to be paid to how well the proposed means for action enable achieving a solution that effectively solves the problem, whether it is more efficient than alternative means, or how useful it is for reaching the sought results. It is obvious that a convincing assessment of either feasibility or efficacy/efficiency/usefulness demands the employment of sound research approaches and methods. But there is no reason why practitioners cannot do it. And there are good reasons for them to be involved in that assessment. After all, they are inescapable stakeholders, possessing a key inside viewpoint of the problem-solving process. Furthermore, they are the creators of the invention.

Fully addressing the efficacy, efficiency or usefulness of inventions of any type cannot be limited to the boundaries of a laboratory. It involves studying the inventions at use in their natural environment. In the cases where the inventions correspond to machines, it is necessary to study their functioning in real situations. In the cases where the inventions are work instruments (techniques, methods, tools) it is inevitable to study them when they are being used by the practitioners that apply them. To adequately address this, it is helpful to consider a third mode of research - practice (clinical) research: a mode of research that aims at studying the practices of professionals and the solutions they propose for addressing the problems/situations they face, and thoroughly ascertaining the conditions for the efficacy, efficiency or usefulness of those practices and solutions.

Practice/clinical research demands considering a third type of knowledge: knowledge about the performance of the means for action of professionals and about the outcomes of the actions of these professionals. Although this third type of knowledge has similarities with the knowledge that results from basic research, it has a peculiarity: it is about the efficacy, efficiency or usefulness of the results of applied/translational research. Such knowledge is typically expressed as rules that state in what conditions some means-for-action is effective/efficient/useful to achieve some result. van Aken [3] proposed the term "technology rules" to refer to this type of knowledge.

Practice/clinical research cannot be carried out without the involvement of practitioners. But practitioners are not necessarily mere research subjects. Practitioners can be the leaders of this type of research. It has to be so if innovation is to be entrenched in scientific knowledge and if the evolution of professional practices is to be grounded on empirical evidence of their value.

Figure 1 depicts the relationships between the three modes of research - basic, applied/translational, and clinical - with the three types of knowledge: knowledge that conveys understandings of the world; knowledge for some purpose; and knowledge about the efficacy, efficiency or usefulness of the previous.

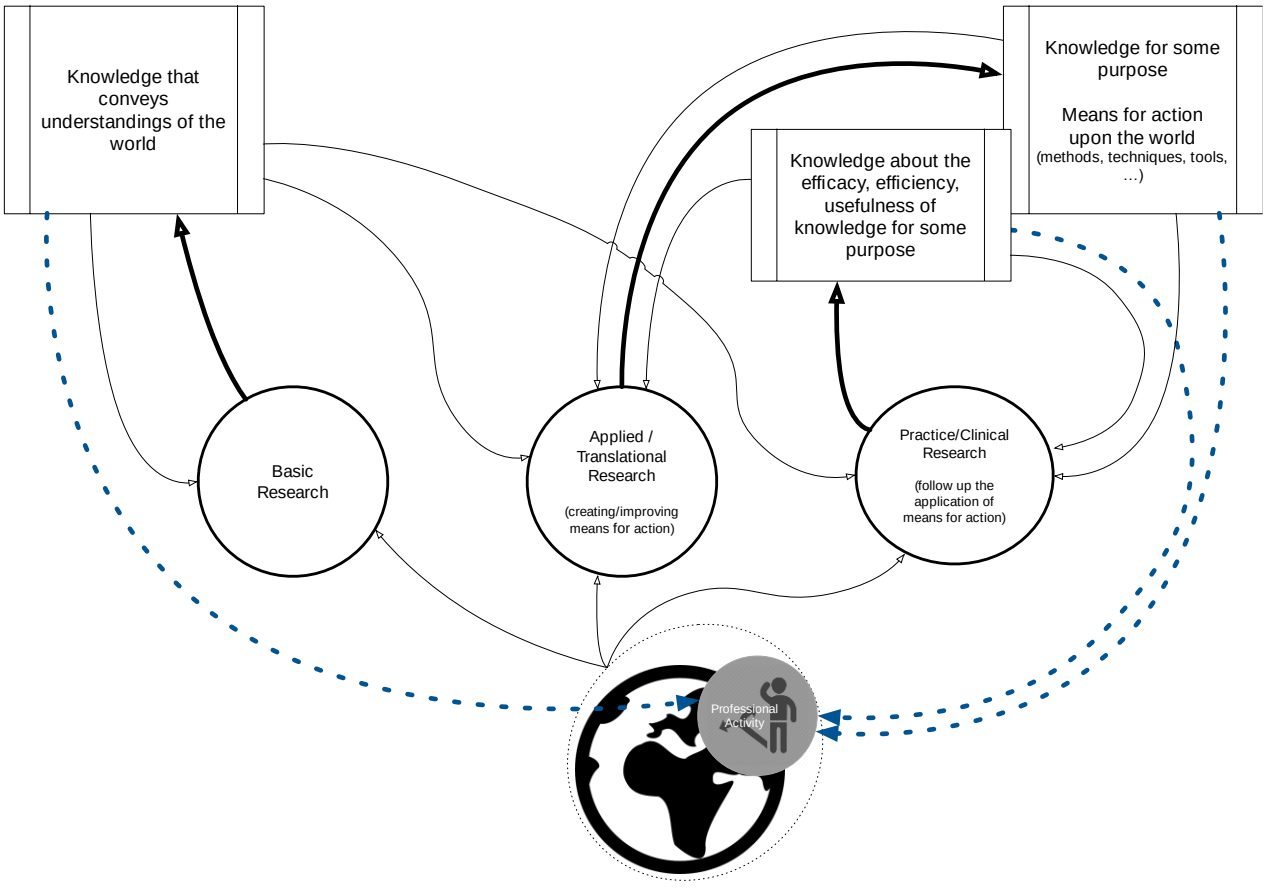

Figure 1. An overarching view of scientific knowledge and of its production and use,

distinguishing among different types of knowledge and different modes of doing research

2. Insights from the medicine domain

Some of the readers might already have recognized the influence of medicine in the view I presented. Not just the distinction among the mentioned research modes, but even the terms I use (translational research, clinical research) have been borrowed from the medicine domain. My point is that IS can greatly benefit from looking into the established practices of research and of collaboration between researchers and practitioners of a more mature domain, such as medicine. Although based in the medicine domain, the overarching view presented above, portrays interdependences between research and professional practice that make sense in any domain that encompasses academic and practical facets. Thus, it can be inspiring for the IS domain. Overcoming the relevance-related issues that the IS domain faces involves promoting partnerships between researchers and practitioners capable of filling the depicted interdependence spaces.

It should be noted that I am not claiming that a direct correspondence between medicine and IS can be established or is easy to establish. I am aware of many differences between the two domains in what concerns the objects of interest, their nature, among other. But I think the comparison is worth to do. So, I will explore a few aspects of the medicine domain that can bring some insights into the IS. The aspects I will look at, include: i) clarification of professional activities; ii) consideration of not just two, but three research modes: basic, translational, and clinical research; iii) demand for a thorough investigation of clinical practices as a request for their evolution - evidence-based professional practices.

i) Develop a repertoire of professional activities

The medical profession exhibits great detail about the different medical procedures and interventions. Comprehensive repertoires of medical actions can be found and are used by hospitals, governments, insurance companies, medical schools and other stakeholders (e.g., [4], [5]). In IS it is not easy to find such repertoires. Some professional profiles are sometimes mentioned but, most often, a myriad of different activities is hidden under the label of IS/IT consultancy. Even admitting the need for frequent updates due to the fast evolution of IT, such repertoires are crucial to the domain, both for defining its boundaries and for facilitating education in the domain.

Several issues will have to be tackled when developing a repertoire of IS professional activities. To illustrate the envisaged difficulties, let's take the example of IS development. This core activity of the IS domain is normally presented as involving the design and implementation of IT-based artifacts (e.g., "[…] conceptualizing and realizing information technology-based systems […]" [1]), However, the design and construction of IT applications is undoubtedly in the realm of the software engineering, a domain that encompasses aspects, not present in IS, that are crucial to the production of top-quality software artifacts. On the contrary, it is easy to argue that putting an IT application at the service of an enterprise is a key activity of IS professionals. An activity that involves dealing with the changes that will be necessary in the enterprise's structural, social, political and cultural dimensions [6]. Borrowing, once again, the terminology from medicine, we could talk of the *implantation of IT applications* in enterprises. Lamentably, in a time where COTS (commercial-off-the-shelf) applications are available to deal with most information processing needs of enterprises, the implantation of IT applications is still most often viewed as the later stage of the design and construction of IT applications, instead of being viewed as a free-standing professional activity.

ii) Research modes

Translational research and clinical research are two well-established forms of research in medicine that complement basic research on a wide diversity of topics relevant to health issues.

The IS domain lacks such an unambiguous distinction between different modes of research. "Practice research" is a term sometimes used to refer to forms of research that involve collaboration between researchers and practitioners. However, it fails to consider some of the aspects mentioned in this paper. An interesting example to consider is design science research (DSR). The interest that DSR has been attracting led to a situation where it is used to refer to a wide range of possibilities [7]. Sometimes, DSR corresponds to applied research - when research involves dealing with a

specific problem in which the solution cannot be drawn from the existing knowledge base. Other times it addresses the study of the design practices of IS professionals, a perspective that configures some form of clinical research. But, most often, DSR is carried out by academic researchers, without the involvement of IS practitioners in roles other than research subjects. If it is so, it is closer to basic research.

The transposition of the distinction among basic, translational and clinical research into the IS domain has a great potential for the clarification of different modes of doing research and of the spaces for the involvement of IS researchers, thus bridging the existing gap between IS researchers and IS practitioners

iii) Evidence based professional practice

Although a relatively recent concept (it has been established in the beginning of the 1990s), evidence-based medicine [8] constitutes the modern basis for the secure progress in medical practices. It also contributes to bringing research closer to clinic, both by increasing the application of research results in the decisions made by medicine practitioners and by engaging medicine practitioners in clinic research.

The development of evidence-based medicine demanded the establishment of a wide set of structures and mechanisms related with clinical research, including a classification of the quality of evidence (randomized controlled trials, cohort studies, observational studies and other forms of obtaining empirical evidence) and guidelines for the realization of systematic reviews of existing evidence (systematic literature reviews and meta-analysis) [8].

Evidence-based medicine also brought some demands to medical records and other information sources that are instrumental for establishing empirical evidence.

Evidence-based professional practice is unfamiliar to most members of the IS domain. Consequently, IS also lacks the aforementioned structures and mechanisms that enable clinical research and promote collaboration between academics and practitioners.

The advantages of an evidence-based culture in a domain that encompasses a practical facet are indisputable. So, we could expect IS to be following the example of medicine and other practice-related domains (e.g., management [9], software engineering [10]).

The transposition of the structures and mechanisms that exist in medicine to the IS domain is not simple. It raises a lot of challenges and interesting questions, such as: What could be a randomized controlled trail in IS? And a cohort study?; What is the equivalent to a medical record? Is it the documentation produced by project managers and other participants in the execution of a project?; Are IS practitioners prepared and willing to engage in evidence-based practices?; How do consultancy companies and other employers of IS practitioners view evidence-based practices? As an opportunity to improve their practices and provide better services to their customers? Or a threat to competitive differentiation based on proprietary methods, techniques and procedures?

3. Conclusion

Medicine is a well-respected domain where both practitioners and researchers are viewed as entrusted with the responsibility of developing the knowledge that enables the best possible healthcare to society. Because it addresses an invaluable matter for individuals and for society in general, medicine holds a special place in society. This also brings special demands and puts the domain under continuous scrutiny from society. These pressures force the domain to a constant search for improvement and advance. With a long history and with a generous provision of resources, medicine had the conditions to become a well-organized and mature domain, with very particular features in what concerns the collaboration (and interdependence) between researchers and practitioners. Medicine is therefore a good example to look at by domains that also encompass a practice facet but lack the same level of maturity.

In this article, I explored three aspects of a research-practice domain, borrowing some concepts and practices of medicine. With this, I hope to contribute to overcoming the relevance issues that the IS domain has been debating for many years (e.g., [11]).

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Biographical notes

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João Alvaro Carvalho is Full Professor and Head of Department at the Department of Information Systems, School of Engineering, University of Minho and researcher at Centro ALGORITMI. He is also Adjunct Professor at the United Nations University Operating Unit on Policy-Driven Electronic Governance (UNU-EGOV). His academic interests focus on the fundamentals of information systems and on enterprise development interventions that involve the implantation, use and exploitation of information technology. He is also interested on research approaches and methods and on information systems curricula and education.

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Causing factors, outcomes, and governance of Shadow IT and business-managed IT: a systematic literature review

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Abstract:
Shadow IT and Business-managed IT describe the autonomous deployment/procurement or management of Information Technology (IT) instances, i.e., software, hardware, or IT services, by business entities. For Shadow IT, this happens covertly, i.e., without alignment with the IT organization; for Business-managed IT this happens overtly, i.e., in alignment with the IT organization or in a split responsibility model. We conduct a systematic literature review and structure the identified research themes in a framework of causing factors, outcomes, and governance. As causing factors, we identify enablers, motivators, and missing barriers. Outcomes can be benefits as well as risks/shortcomings of Shadow IT and Business-managed IT. Concerning governance, we distinguish two subcategories: general governance for Shadow IT and Business-managed IT and instance governance for overt Business-managed IT. Thus, a specific set of governance approaches exists for Business-managed IT that cannot be applied to Shadow IT due to its covert nature. Hence, we extend the existing conceptual understanding and allocate research themes to Shadow IT, Business-managed IT, or both concepts and particularly distinguish the governance of the two concepts. Besides, we find that governance themes have been the primary research focus since 2016, whereas older publications (until 2015) focused on causing factors.

Keywords:
Shadow IT; Business-managed IT; IT governance; literature review; causes; outcomes.

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1. Introduction

Shadow IT and Business-managed IT describe the autonomous deployment/procurement or management of Information Technology (IT) by business units (BUs). The term BU refers to all types of business entities (e.g., individual users, business workgroups, departments, or divisions) and is subsequently used for the purpose of simplification [1]. Shadow IT happens covertly [2]; that is, IT instances—software, hardware, or IT services— are created/procured or managed by BUs without alignment with the IT organization [1, 3]. The term IT organization refers to internal IT organizations, e.g., company-internal IT departments. In contrast, the concept Business-managed IT refers to autonomous and open deployment/procurement or management of information systems (IS) by BUs in alignment with the IT organization or in a split responsibility model [1, 3]. Recent surveys show that Shadow IT is a widespread phenomenon: Kopper [4] finds that 80% of employees use software that has not been approved by the IT organization. However, the true extent of Shadow IT usage in companies is vastly underestimated by CIOs [5], even though Shadow IT is gaining increased research attention [6].

Currently, there is a lack of research that clearly distinguishes and separates Shadow IT and Business-managed IT, which impedes the discussion of specific IT governance issues in organizations [1]. Accordingly, a systematic literature review improves differentiation between the two concepts, provides valuable insights, and creates a basis for further research targeting the two concepts. In order to approach this research gap, the paper at hand provides a systematic literature review of the scientific literature on Shadow IT and Business-managed IT. We, therefore, pose the following research question: *Which themes exist in research on Shadow IT, Business-managed IT, and related concepts, and how can these research themes be categorized?*

In order to address this research question, we conducted a rigorous review of 107 scientific literature items. We categorized research themes according to causing factors, outcomes, and governance, and we present these research themes in a comprehensive framework. Hence, this paper creates transparency about the research themes within the developing research field of Shadow IT and Business-managed IT. Consequently, researchers can build on this framework and address identified gaps in the current research.

The remainder of the paper is organized as follows: Section 2 conceptualizes Shadow IT and Business-managed IT through an extended taxonomy and provides an overview of literature reviews in the research field. This is followed by a methodology overview in section 3, including the scope of this literature review, and the literature search, selection, and extraction. In section 4, we present the results of the literature review and introduce a framework to categorize the identified research themes as causing factors, outcomes, or governance. Additionally, this section provides a longitudinal analysis of the research focuses to date. Section 5 discusses the identified research themes for Shadow IT and Business-managed IT as well as specific governance recommendations. The paper then concludes with a summary of the results and limitations of this study as well as avenues for further research.

2. Background

2.1 Conceptualization

Kopper and Westner [7] provide a taxonomy for Shadow IT and the following five related concepts: Feral Practices, Workarounds, Shadow Systems, Un-enacted Projects, and Shadow Sourcing. Figure 1 illustrates this taxonomy and extends it. In the taxonomy defined in Kopper and Westner [7], five dimensions, with two characteristics each, are used to differentiate the related concepts:

- (a) Novelty: Unofficial IT, misuse of official IT;
- (b) Perspective: Creation, outcome;
- (c) Artifact: Devices, applications;

- (d) Infrastructure: Shadow infrastructure, official infrastructures;
- (e) Scale: Group, individual.

For precise definitions of these five dimensions and their associated characteristics, please refer to Kopper and Westner [7, p. 3]. Furthermore, Kopper and Westner [7] categorize Shadow IT as (a) unofficial IT, (b) outcome, (c) devices & applications, (d) shadow & official infrastructure, and (e) group & individual. In the paper at hand, we conceptualize Shadow IT as software, hardware, or IT services created or used by BUs without alignment with or awareness of the IT organization [1, 7, 8]. Hence, Shadow IT is *covert* [2, 9]*;* that is, IS activities are practiced in a hidden form [1, 10].

Furthermore, Kopper et al. [1] introduce the term *Business-managed IT* for IS for which the IT task responsibility [11, 12] resides in the BU. This characteristic is shared with Shadow IT; however, in contrast to Shadow IT, Business-managed IT is *overt* [9]. Hence, "the term 'Business-managed IT' describe[s] 'overt' information systems developed or managed by business entities" [1, p. 1]. In conclusion, the involvement in the organizational IT management is the main distinction between Shadow IT (IT instances are covert and thus "in the shadows" [1, p. 1]) and Business-managed IT (IT instances are overt [1]). In order to accommodate for Business-managed IT, we extend the taxonomy of Kopper and Westner [7] and add the characteristic *official IT* to dimension (a) novelty. Business-managed IT is, by definition, based on (d) official infrastructure, whereas Shadow IT uses shadow & official infrastructure. Business-managed IT and Shadow IT share the same characteristics of the three remaining dimensions: Business-managed IT is outcome-oriented ((b) perspective), it includes devices and applications ((c) artifact), and it can occur at group & individual level ((e) scale). Figure 1 provides a visualization of the extended taxonomy.

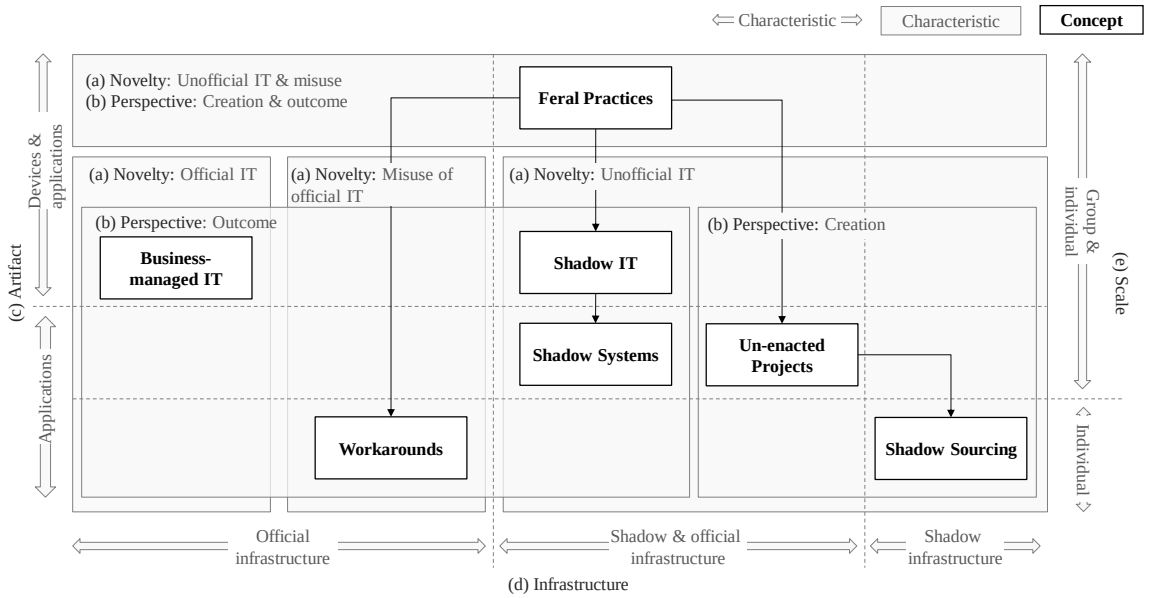

Figure 1: Extended taxonomy based on Kopper and Westner [7, p. 4]

2.2 Related works

In recent years, several literature reviews have been conducted on Shadow IT and related concepts; Table 1 provides an overview of these reviews. Most of the reviews target specific concepts of this research field or related fields. Almost all existing reviews analyze the scientific literature (i.e., scientific journal papers or papers in scientific conference proceedings); nevertheless, practitioner literature (i.e., white papers or internet articles targeting practitioners as audience) are also reviewed in a few existing publications.

Table 1. Overview of existing literature reviews and their targeted concepts as classified in the extended taxonomy (see Figure 1)

Source	Targeted concepts of extended taxonomy	Analyzed time-frame	Lit. search and selection	Types of sources	No. incl. lit. items	No. ident. research themes	Framework for research themes
[15]	Focused on workarounds	1967–2013	Search process vague	Scientific literature	300+	37	Phenomena associated with workarounds, types of workarounds, direct effects of workarounds, perspectives of workarounds, organizational challenges and dilemmas related to workarounds
[16]	Focused on Shadow IT	Until 02/2017	Rigorous	Scientific literature	45	41	Concerns associated with technology homogeneity, application landscape planning, support of business processes, project portfolio management, infrastructure management, interface, business object and service management
[17]	Focused on Shadow IT and Business-managed IT	Until 12/2016	Rigorous	Scientific literature	52	34	Five phases of Shadow IT integration: Terminology, pre-integration, integration decision, integration process, post-integration
[13]	Concept-overarching, incl. Feral Practices, Workarounds, Shadow IT, Shadow Systems, Un-enacted Projects, and Shadow Sourcing	2010–2015	Rigorous	Scientific literature	52	22	Causes, consequences, governance of Shadow IT
[18]	Focused on Shadow IT, Business-managed IT	09/2015–08/2016	Rigorous	Practitioner literature	397	10	Pressure on IT, consequences for IT, controlled use of business-managed IT, realignment of IT
[19]	Focused on Shadow IT	Until 04/2013	Rigorous	Scientific literature	21	25	Benefits of Shadow IT, downsides of Shadow IT
[20]	Focused on Shadow IT and Workarounds	1997–2016	Search process vague	Scientific & practitioner literature	43	n/a	Two dimensions of phenomena: short term/long term, technology/process
[14]	Concept-overarching, incl. Feral Practices, Workarounds, Shadow IT, Shadow Systems, Un-enacted Projects, and Shadow Sourcing	2006–2017	Rigorous	Scientific literature	70	4	Causes of Shadow IT, benefits of Shadow IT, risks of Shadow IT; internal controls
[21]	Focused on Workarounds	1987–2011	Search process not defined	Scientific & practitioner literature	Not explicit	n/a	n/a
[22]	Focused on Workarounds	1986–2014	Rigorous	Scientific literature	84	n/a	Organizational goal, information system, social climate, rule; working environment, organizational member, conflict neutralization, resistance, workaround, risks, benefits
[23]	Focused on Feral Practices	Not explicit	Search process not defined	Scientific literature	Not explicit	n/a	Organizational structure, social influences, technological influences, structural strain, supporting factor, deviance in the form of Feral Practice

The reviews by Kopper and Westner [13] and Magunduni and Chigona [14] provide foundational literature reviews that cover most of the concepts of the research field. However, none of the existing reviews cover the research field completely, that is, including all seven concepts as outlined in Figure 1. Consequently, a systematic literature review, which structures the body of research covering the concepts of Shadow IT and Business-managed IT, is missing. The article at hand closes this gap and differentiates between the research themes of Shadow IT and Business-managed IT.

3. Methodology

3.1 Review scope

We adapted the approaches proposed by Levy and Ellis [24], Okoli [25], and vom Brocke [26] in order to conduct a rigorous, systematic, and comprehensive review of the scientific literature [25–28]. To define the scope of this review and to position this paper's focus, goal, perspective, coverage, organization, and audience, we use the taxonomy developed by Cooper [29] and Cooper and Hedges [30], which was later adapted by vom Brocke [26]. It is often used in IS research, as in the papers by Herz et al. [31], Kopper and Westner [13], or Strasser and Westner [32]. The classification used in this literature review, along with the taxonomy, is shown in Table 2. We focus on research outcomes, research methods, and theories. The goal of this literature review is to integrate related research, aggregate it into themes, and describe central issues. Our literature review groups research themes based on a conceptual view. We maintain a neutral perspective "attempt[ing] to present all arguments or evidence for and against various interpretations of the problem" [30, p. 5]. As its audience, the review addresses specialized scholars, general scholars, and practitioners. Furthermore, it aims to exhaustively cover the relevant literature, enabling synthesis and discussions on a comprehensive basis.

Table 2. Classification of literature review along taxonomy developed by Cooper [29, p. 109] and Cooper and Hedges [30, p. 5], later adapted by vom Brocke [26, p. 8]; shaded cells illustrating the paper's classifications

Characteristics	**Categories**			
Focus	Research outcomes	Research methods	Theories	Applications
Goal	Integration	Criticism	Central issues	
Organization	Historical	Conceptual	Methodological	
Perspective	Neutral representation		Espousal of position	
Audience	Specialized scholars	General scholars	Practitioners	General public
Coverage	Exhaustive	Exhaustive and selective	Representative	Central/pivotal

3.2 Literature search and selection

We followed a three-step approach for the systematic literature search [33]. First, we conducted a database search [24] for references published between January 2000 and August 2018, which also ensures comparability with Kopper and Westner [13]. We limited the database search to peer-reviewed journal articles as well as the proceedings of major IS conferences [24, 28], and queried the AIS Electronic Library, Business Source Complete (EBSCO), Emerald Insight, IEEE Xplore, ScienceDirect (Elsevier), and SpringerLink. For our keyword set, we applied two approaches: (1) we combined the keywords: "shadow," "feral," "workaround," "un-enacted," "unsanctioned," "rogue," and "grey" with "IT," "systems," and "projects." We also (2) searched for "bottom-up IT," "Business-managed IT," "end-user

development," and "user-driven innovation" to cover all concepts of the research field (see Figure 1). We applied the set of keywords to title, abstract, and keywords [28, 29]. Second, we conducted a practicality screening of the identified results to separate non-relevant publications based on an evaluation of title, abstract, and keywords [34]. We limited the results of SpringerLink to the two disciplines potentially relevant for Shadow IT and Business-managed IT: "Computer Science" and "Business Management." Third, we performed forward and backward searches for authors and references [24, 26, 33] in order to ensure an exhaustive search [25, 34]. We used Google Scholar for the forward search [25, 28, 35]. The results of the literature search and selection are shown in Table 3.

Table 3. Search and selection results as the number of resulting literature items

Type	Database/search step	Comments	No. of results	No. of relevant results	No. of duplicates
Journals	Business Source Complete (EBSCO)	-	109	15	
	Emerald Insight	-	238	2	1
	IEEE Xplore	-	70	0	0
	ScienceDirect (Elsevier)	-	353	4	3
	SpringerLink	Limited to disciplines "Computer Science" and "Business Management"	214	6	
Conference contributions	AIS Electronic Library	ACIS, AMCIS, ECIS, ICIS, PACIS proceedings; HICSS proceedings (since 2016 accessible via the AIS Electronic Library)	148	25	
	IEEE Xplore	HICSS proceedings (accessible via IEEE until 2016)	0	0	
Forward/ backward search	Forward/backward author search	-	n/a	8	
	Forward/backward reference search		n/a	51	
		Total		**111**	**4**
		Total relevant literature items after deduplication		**107**	

Through these three steps, we identified a total of 107 relevant literature items after deduplication, 50 (47%) via database search and 57 (53%) via forward/backward reference and author search. Most of the relevant literature items appeared in conference proceedings (67; 63%), namely at AMCIS (15; 22%), ECIS (13; 19%), ICIS (12; 18%), PACIS (4; 6%), and ACIS (4, 6%). The remaining literature items (40; 37%) are journal articles appearing, for example, in the Communications of the Association for Information Systems (6; 15%). The remaining conference contributions (19; 28%) are distributed across 15 conferences and the remaining journal articles (34; 85%) across 25 further periodicals.

Most of the literature items were published since 2012. That is, 10 to 17 articles/contributions were published in the years since 2012 (7 until August 2018). In contrast, between 2003 and 2009, only a few articles were published each year (1 to 4). Figure 2 illustrates that Shadow IT and Business-managed IT has been attracting high and increasing research attention since 2012. Moreover, 35% of the literature was published since 2016; thus, this literature review provides further insight complementing previous reviews, for example, Kopper and Westner [13].

3.3 Extraction

In order to describe the research setup used in the literature items, we built on the research designs outlined by Creswell [36] that are commonly used in literature reviews, as in Stödberg [37], and particularly in IS literature reviews, as in Jalali and Wohlin [38] and Kopper and Westner [13]. Consequently, we coded the philosophical worldview, research design, research approach, and data gathering method of every literature item. Aditionally, we examined data analysis methods as well as the number of data points evaluated—i.e., the number of case interviews, cases, and quantitative datasets—if applicable. Most literature items espouse a constructivist worldview (77; 72%). A qualitative research design is used in 63 (59%) literature items of which the majority involve case/interview study research (45, 71%), that is, detailed case studies, briefer case vignettes, or overview studies based on case interviews. Thus, case interviews (56; 52%) and case documents (31; 29%) are the predominant methods used for gathering data across 107 literature items. Different forms of coding are primarily applied as the method for data analysis (30; 28%). Figure 3 provides an overview of the research setup used.

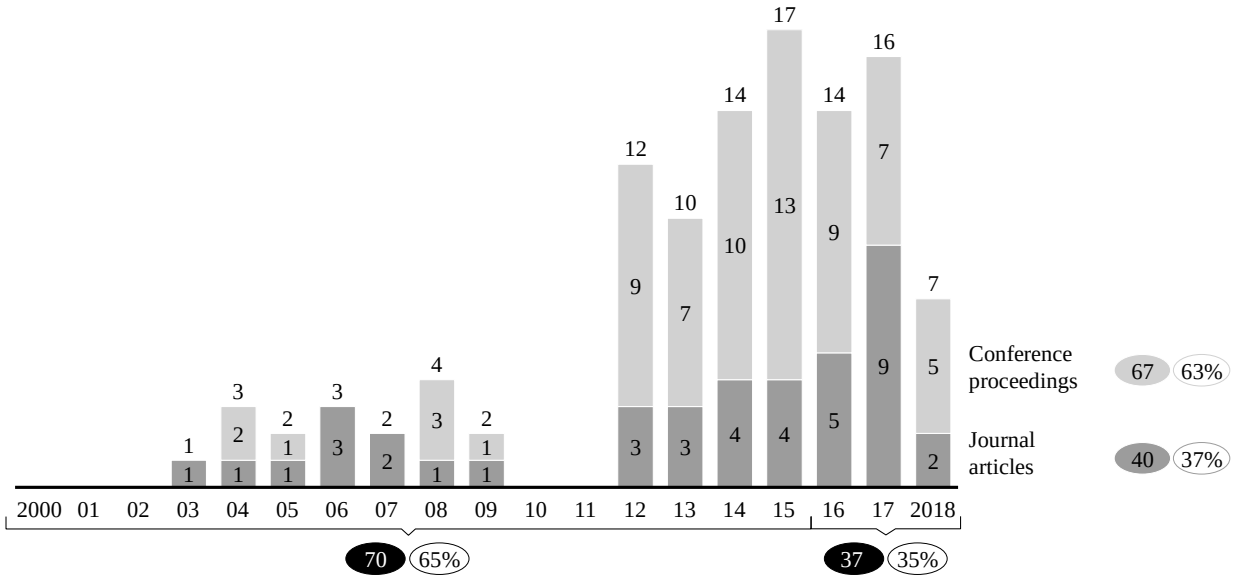

Figure 2. Number of published literature items over time, including relevant literature items from 01/2000 to 08/2018

In our literature review, we identified more than 30 reference theories and subsequent theories to describe and analyze Shadow IT and Business-managed IT, such as transaction cost economics, power relations, actor-network theory, the technology acceptance model, and agency theory. Hence, we draw a similar conclusion as Kopper and Westner [13]: researchers explain Shadow IT and Business-managed IT using a variety of theories, and demonstrate that a dominant approach does not exist.

We analyzed the content of the relevant literature items using open coding [39] with an initial coding scheme based on the research themes identified by Kopper and Westner [13] to ensure research continuity. We structured identified research themes in a framework and iterated the coding and the structuring of the research themes/codes several times (for the detailed coding scheme, please refer to Figure 7 in the appendix). The codes were validated by the second, third, and fourth authors using random sampling. Thus, 14 of the literature items were completely recoded during the coding validation with an exact match for most of the codes (125, 82%). The remaining 27 (18%) codes have been

discussed among the authors, and, as a result, 20 of the original codes (13%) were kept based on an aligned coding scheme, and 7 (5%) of the codes were adjusted. We portray the coding results and the research setup in a concept matrix [33], see Figure 8 in the appendix.

Research design							
	Qualitative	63	Quantitative	16	Mixed method	6	Non-empirical	22
Research approach	Case/interview study	45	Survey research	11	Convent parallel	4	Non-empirical	22
	Grounded theory	16	Experimental research	5	Exploratory sequential	2		
	Design science	4						
	Action design	3						
	Ethnography	2						
	Unspecific	4						

Worldview		Data gathering		Data analysis	
Constructivist	77	Case interview	56	Coding	30
Post-positivist	19	Case documents	31	Partial least squares	12
Pragmatic	8	Survey	22	Hypothesis test	3
Transformative	3	Non-empirical	22	Context–mechanism–outcome	1
		Observation	19	Network analysis	1
		Expert interview	11	(Logistic) regression	1
		(Laboratory) experiment	5	Average marginal effects	1
		Unspecific	4	Analysis of variance	1
				Risk map	1
				Unspecific	36
				Non-empirical	22

Figure 3. Research setup with absolute frequency of usage (Numbers may not add up to the total of 107 literature items due to the potential use of multiple research, data gathering, and data analysis approaches in literature items, based on Creswell [36])

4. Results

4.1 Categorization framework

We structure the research themes in a framework with three categories: causing factors, outcomes, and governance. Even though we use the framework of Kopper and Westner [13] as an initial coding scheme, we apply more neutral terminology for the categories in comparison to Kopper and Westner [13] since we cover both Shadow IT and Business-managed IT in this literature review. Thus, we refer to causing factors instead of causes and outcomes instead of consequences. Figure 4 shows the resulting framework of causing factors, outcomes, and governance with subcategories and research themes for the three categories. It also includes the relative representation of the research themes in the analyzed body of research covering the concepts of Shadow IT and Business-managed IT.

4.2 Causing factors

We distinguish three subcategories of causing factors: *Enablers (E)*, *Motivators (M)*, and *Missing barriers (MB)*.

E1 Technical accessibility. This occurs when the accessibility of the IT increases through a general decrease in the complexity of IT and an expansion of technological offerings [40]. As IT solutions become more user-friendly [2], it also becomes easier for BUs to deploy them autonomously [23, 41, 42]. Web services and solutions play a significant role in this evolution [43]. This also applies to cloud offerings with simpler application distribution models [9]. In addition, platforms for end-user development, such as low-code platforms, make it easier for business units to implement their solutions [18, 44, 45]. End-user hardware, such as smartphones [41], and IT consumerization [46] make it easier to access applications and solutions [47–49].

E2 IT user competence. The availability of IT knowledge increases in BUs [10, 42]. This enables BUs to employ or procure IT solutions [50]. In particular, digital natives, who grew up with IT and use it in their daily life, can easily create and access IT solutions [48, 51, 52].

M1 IT organization and BU non-alignment. A lack of business knowledge in the IT organization [53, 54] together with a lack of understanding due to insufficient communication [55] leads to unmet user needs [56–58]. Likewise, users are not sufficiently trained, for example, in operating the central system [59], and business processes are not sufficiently supported [22, 60, 61], for example, due to a high degree of process formalization with extensive documentation requirements even for small pilot projects [62, 63]. Consequently, BUs make detrimental experiences with the IT organization over time [61, 64], which leads to a low level of trust between BUs and the IT organization [41, 65, 66]. In conclusion, this lack of business-IT alignment motivates Shadow IT and Business-managed IT [67–69].

M2 IT system shortcomings. The limitations of existing systems might be overcome by Shadow IT or Business-managed IT [6, 70, 71]; therefore, inadequate IT solutions lead to the deployment of Shadow IT and Business-managed IT [72]. For example, formal IT systems might be perceived as complex and inflexible [21, 72, 73] and hence, insufficient [51, 74, 75] for processes such as enabling communication between employees [76]. Thus, a gap between the users' requirements and the provided systems exists [42, 61, 64], which can be termed an IT systems gap. Furthermore, malfunctioning IT solutions are in place [77, 78], which, for example, hold incorrect data [79–81]. As a particular example, shortcomings of the corporate ERP system are mentioned in multiple literature items [43, 82, 83].

M3 Employee motivation/impact orientation & peer behavior. Shadow IT users have a higher motivation and goal-orientation in comparison to co-workers not using Shadow IT [63, 74, 84]. Thus, the anticipation of increased individual task performance [85], job performance [76, 86, 87], or the prospect of reward [88] leads to Shadow IT and Business-managed IT. Employees even accept potential risks when employing IT autonomously [22, 89]. Moreover, peer behavior influences the use of Shadow IT [90–92]. Employees also might want to conceal their personal misconduct, for example, when a project was not finished in the given timeframe and thus continues as an Un-enacted Project [62].

M4 IT organization slowness. Slow responsiveness to requests [43, 57, 93] is a symptom of IT organizations' lack of agility [55, 58, 94]. A common contribution factor is a disadvantageous prioritization mechanism for requests [50, 95], resulting in long development times [12, 64, 67] and lengthy procurement processes [49]. This lack in the agility of the IT organization fosters the emergence of Shadow IT and Business-managed IT.

M5 Beneficial cost structure anticipation. Shadow IT and Business-managed IT are expected to have lower costs than solutions that are developed by the IT organization [60, 67, 71]. For example, low initial costs [12, 50, 60] are a typical result of renting technology rather than buying it upfront [96].

M6 Business environment uncertainty. Uncertain conditions increase the likelihood of Shadow IT development and implementation, including the need to react to volatile market conditions with high flexibility [6]. Uncertainty in the business environment can be caused by increased competition [67], the need to diversify the product portfolio [53, 54], or strategic needs [62, 63].

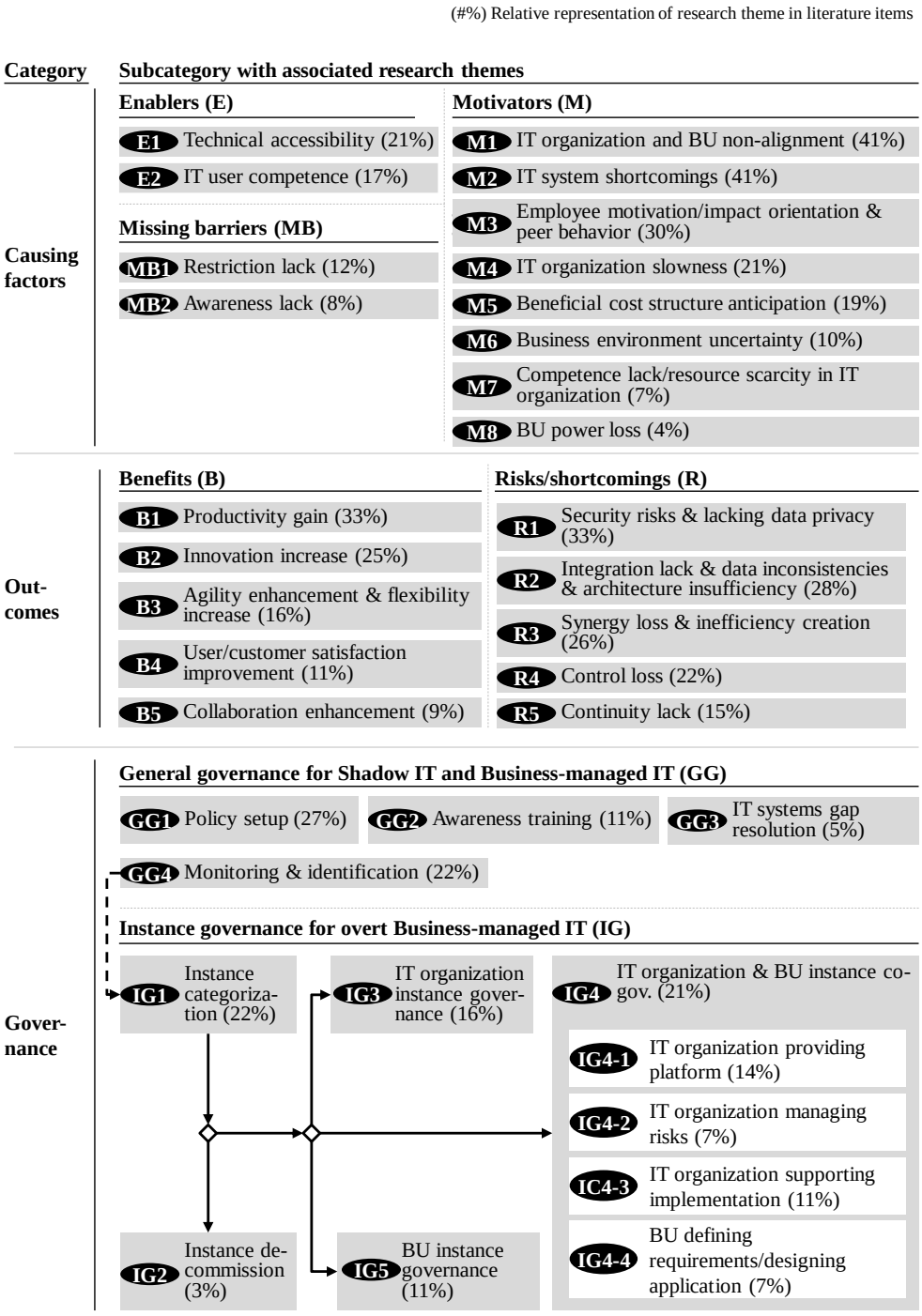

Figure 4. Framework for causing factors, outcomes, and governance of Shadow IT and Business-managed IT

M7 Competence lack/resource scarcity in IT organization. A less common motivator for Shadow IT and Business-managed IT comprises a lack of specific IT know-how [64, 71] or missing resources in the IT organization [1, 71]. For example, Ferneley [2] finds that "there was so much to implement and limited resources" in a case study [2, p. 66] which led to Shadow IT.

M8 BU power loss. Another less common theme is the loss of power of BUs [53, 54]. For example, the implementation of an ERP system can lead to a loss of control over business processes [68, 93]. Hence, the development of Shadow IT can provide employees with an opportunity to "gain back some control" [68, p. 149].

MB1 Restriction lack. Silic and Back [41] find that "[o]ut of nine organi[z]ations, four said that they do not have any IT policy that would encompass Shadow IT" (p. 279). On the one hand, non-existent or insufficient policies [53, 94, 97] are missing barriers to Shadow IT and Business-managed IT. However, prohibitions might have limited effects [98]. On the other hand, few companies officially support Shadow IT [41, 56].

MB2 Awareness lack. Employees are typically not aware of the policies in place. For example, Dittes et al. [99] find that "80% [of employees] who violate IT standards do not know that they violate them" (p. 6). Even if employees are aware that policies are in place, they typically do not know their specific content [75]. Besides, employees are not aware of the potential consequences of Shadow IT [55, 84, 94], for example, with concern to violating a regulation [100].

4.3 Outcomes

We designate *Benefits (B)* and *Risks/shortcomings (R)* as subcategories of the outcomes of Shadow IT and Business-managed IT and explore specific research themes of each.

B1 Productivity gain. Because Shadow IT and Business-managed IT, companies benefit from an increase in productivity [6, 51, 101], efficiency [22, 102, 103], and effectiveness [97]. This is mainly driven by productivity gains among employees [84] as Shadow IT leads to improved individual performance [60, 86, 104]. Thus, workflows are improved , and business processes are better supported [2, 43]. Moreover, McGill [105] supports the notion that users perform better with self-developed solutions over solutions developed by others.

B2 Innovation increase. Shadow IT and Business-managed IT can be a source of creativity [95] and innovation [23, 106, 107] as "a manifestation of users' creativity and personal innovativeness" [84, p. 14]. For example, Zimmermann et al. [6] identified a "web-based platform with highly specific construction drawing, order scheduling, and calculation functionalities to support the order-management process of sales representatives and engineers" (p. 6) that was developed by employees as Shadow IT. This shows that, innovations can materialize in new digital services [58] and the usage of consumer IT [108], digital platforms [44], or via lightweight IT [109].

B3 Agility enhancement & flexibility increase. Agility is another benefit of Shadow IT and Business-managed IT [1, 58, 104]. Generated agility can have multiple angles, e.g., shortened time-to-market or agile processes [58]. Moreover, Shadow IT and Business-managed IT usually provide higher flexibility [17, 77, 95] due to their adaptability [8], especially in comparison to large, rigid solutions such as ERP systems [95].

B4 User/customer satisfaction improvement. Shadow IT and Business-managed IT is popular with employees and can lead to higher user satisfaction [57] as it can provide specific functionality [95] or familiarity [51]. Besides, users attribute a higher quality to self-developed applications [83, 105], which leads to better decision performance [105]. If Shadow IT and Business-managed IT is customer-facing, it can also improve customer satisfaction [2, 61, 66].

B5 Collaboration enhancement. Certain Shadow IT and Business-managed IT instances enable better and faster communication [23, 41, 102], such as in the case of knowledge sharing [103]. Hence, the social presence of employees increases [90] and collaboration is fostered [95]. During the creation of Shadow IT and Business-managed IT, enhanced communication can also be observed [84].

R1 Security risks & lacking data privacy. Security risks are commonly associated with Shadow IT [71, 103, 110]; for example, 88% of interviewees mentioned security risks as a downside of Shadow IT [67]. Moreover, in Khalil et al.

[58] each of the ten interviewed IT managers shared security threats, but only four out of the ten interviewed business managers were concerned about security issues. Due to the covert organizational IT management of Shadow IT, typical risk assessment and prevention measures cannot be performed [6], which may lead to compliance issues [49, 60, 64]. Additionally, data privacy cannot be guaranteed [21, 22, 111], particularly for software as a service (SaaS) or for cloud applications [55, 100]. Consequently, Shadow IT poses regulatory risks for enterprises [19, 49, 100] and has the potential for fraud [112].

R2 Integration lack & data inconsistencies & architecture insufficiency. Shadow IT often lacks integration with the official systems [67, 111, 113], is not standardized [16, 54, 60], and might be based on poor architectural principles [53, 54, 98]. Moreover, Shadow IT solutions can lead to data inconsistencies [23, 54, 77] or errors [114, 115]. This results in Myers et al. [115] showing a loss of credibility of data compiled from Shadow IT in their experiments.

R3 Synergy loss & inefficiency creation. The diversification of the IT landscape increases [17, 53, 54] with a simultaneous decrease of standardization [1]. Consequently, synergies cannot be realized [19, 60, 116], redundancies exist [23, 50, 117], and automation is hindered [17, 54]. In summary, inefficiencies occur due to Shadow IT use [1, 64] that lead to higher costs [6, 16, 66], resource waste [57, 93], or resource conflicts with official systems and projects [62, 63, 118].

R4 Control loss. Due to the covert organizational IT management of Shadow IT, gaps in transparency develop [6, 100]; thus, Shadow IT cannot be formally controlled [1, 20, 61]. Hence, Shadow IT undermines IT governance [58], management intentions [22], and strategic goals [12, 40]. It also leads to shifting power relations [54, 58, 80]. Central operations might depend on Shadow IT instances [98], that may result in critical, organizational failrures [53]. In addition, uncontrolled vendor dependencies can exist [58, 71, 97].

R5 Continuity lack. An instance of Shadow IT is often implemented by one or a few employee(s), which leads to a high dependence on such employee(s) for continued operation [53, 95, 105]. Reinforced by lacking documentation [54, 98] and potentially low or non-existing support [43, 60, 103], a risk of system outages exists, leading to operation downtimes [58].

Other outcomes. We summarized three small themes for outcomes below, namely, anticipated economic benefits as well as increased company politics, and IT transformation issues as risks/shortcomings. Anticipated economic benefits have only been realized in a few cases, for example, in the form of reduced transportation costs [61] or via process automation [66]. Shadow IT imposes the risk of spurring political conflicts in companies [95] or even culture wars, perhaps, due to the stigma associated with Shadow IT [43, 69, 95]. Contextual changes, such as the restructuring of the organization or an IT transformation, might significantly impact or be impacted by Shadow IT [71]. One of the reasons for this is that interfaces usually change in an IT transformation and systems need to be updated accordingly [57].

4.4 Governance

Identified Shadow IT instances are overt and are thus Business-managed IT instances. Overt Business-managed IT instances allow for more specific measures as compared to unknown (covert) Shadow IT. After the categorization of Business-managed IT instances, two potential decision points exist: First, a decision for instance decommission or instance continuation can be made. Second, if Business-managed IT instances are continued, governance responsibility can be allocated on a spectrum between complete governance allocation to the IT organization and complete governance allocation to the BU. An intermediary solution on this spectrum would be co-governance between the IT organization and BUs. Below, we first detail the *General governance for Shadow IT and Business-managed IT (GG)* and continue with *Instance governance for overt Business-managed IT (IG).*

GG1 Policy setup. Considering the benefits of Shadow IT and Business-managed IT, a complete prohibition does not seem to be reasonable [6, 18, 119]. Such a measure would also negatively impact employee motivation [84] and innovation behavior [108]. Hence, it appears to be more promising to allow for Shadow IT and Business-managed IT in a controlled manner [60, 71, 95]. In fact, Ortbach et al. [120] state that trust, which is the underlying principle of a bring

your own device (BYOD) culture, might outweigh the need for stricter policies. However, for critical processes or highly regulated businesses, it may be more reasonable for Shadow IT to be strictly forbidden [12, 50, 60].

GG2 Awareness training. Communication of existing policies, which restrict Shadow IT [66, 67, 84] and aim to minimize potential threats of unapproved IT [87, 97], can increase awareness of the risks of Shadow IT and Business-managed IT. For example, training courses on existing policies can be held [41, 98, 100]. However, increased awareness of risks associated with Shadow IT might not lead to its reduction [58].

GG3 IT systems gap resolution. Shadow IT and Business-managed IT use can be reduced if existing shortcomings of the IT systems are addressed to fulfill unmet needs [40, 56, 97]. However, Haag et al. [84] find that "adapting, fine-tuning, and tailoring the mandatory system will probably not succeed if the aim is to prevent individuals from the usage of shadow systems" (p. 14) as "[t]here was no difference in the perceived usefulness of the mandatory system between those participants that used the shadow system/s and those that did not" (p. 14).

GG4 Monitoring & identification. Technical monitoring can be a measure to enforce policies on Shadow IT [41, 49, 121], but these may also be bypassed by employees [41]. Monitoring helps to identify covert Shadow IT instances, which would then become overt and thus Business-managed IT [1]. Other possibilities to identify Shadow IT include IT architecture assessments [71], the evaluation of help desk requests [52], employee surveys [52, 56], and scanning of installed software on end-user devices [41]. Support for Shadow IT might lead to employees actively engaging with the IT organization for assistance, which would also increase transparency [18, 100].

IG1 Instance categorization. Overt Business-managed IT instances can be categorized, for example, by type of IT/solution [92, 98, 104], creator of solution [103], type of project [62, 63], intention [121], or process/technology and time dimensions [20]. Nevertheless, a categorization by criticality and quality of instances [45, 122, 123], by functional scope and scope of use [17, 71, 122], or by strategic importance and stakeholder [96], is required to define a suitable governance approach.

IC2 Instance decommission. After instance categorization, a primary decision point with two potential outcomes exists: instance decommission or instance continuation. If Business-managed IT has a high architectural inflexibility, [71] or the associated risks are too high [54, 67], instances of Business-managed IT might be decommissioned and potentially replaced by other solutions [67].

IG3 IT organization instance governance. If the continuation of Business-managed IT instances was chosen at the primary decision point a secondary decision point arises to allocate the instance governance. Three potential governance allocations exist on a spectrum of governance responsibility being allocated to the IT organization (IG3) or the BU (IG5). The first potential governance allocation is governance transfer to the IT organization [6, 8, 95], such as for instances with high criticality [8, 54, 98], crucial security concerns [50], or for instances, for which the company-wide view is in favor of the integration with the IT organization [124], or when maintenance is too burdensome for the BU [57].

IG4 IT organization & BU instance co-governance. The second potential governance allocation is co-governance, that is, Business-managed IT instances can be split into service components or into tasks. Moving forward, an allocation of task responsibilities to the IT organization or the BU would be possible [125]. In the following passages, we detail the potential task allocation to the stakeholders.

IC4-1 IT organization providing platform. The IT organization may provide platforms for application development [46, 71]. Those platforms can include the infrastructure layer [1, 12, 109], the data layer [67, 119, 125], or even the application layer [67]. Enterprise app stores can provide a platform for mobile devices [55].

IC4-2 IT organization managing risks. Risk management of instances is usually considered to be ensured by the IT organization [1, 67]. For example, when BUs autonomously develop mobile apps, IT organizations can take over the security and privacy checks [66], or the IT organization ensures security arrangements in a BYOD environment [60] to ensure compliance with company security standards.

IC4-3 IT organization supporting implementation. The IT organization may provide continuous support for the development and implementation of projects conducted in BUs [6, 12, 21] and provide expertise in areas such as project management [67], vendor management [67], service management [1, 119, 125], and collaboration and knowledge exchange [83, 126].

IC4-4 BU defining requirements/designing application. The BUs perform IT-related tasks that require specific business knowledge [1, 119, 125]. Typical tasks include the definition of requirements [1, 119, 125] or the design and development of applications [50, 66, 96].

IC5 BU instance governance. The third potential governance allocation is that BUs govern Business-managed IT entirely [8, 60, 96], such as for instances with limited scope [6, 11] or when business-specific skills are needed for governing and running the Business-managed IT instance [1].

4.5 Longitudinal Analysis

We divided the analyzed time horizon January 2000–June 2018 at the transition point of December 2015–January 2016 to highlight how the research themes evolved, especially as reflected in the older 65% of literature items in comparison to the more recent 35% of items. Moreover, this breakdown illustrates the evolution of themes since the literature review by Kopper and Westner [13], which covers literature items until the end of 2015.

Figure 5 shows the evolution of the coverage of research themes over time.

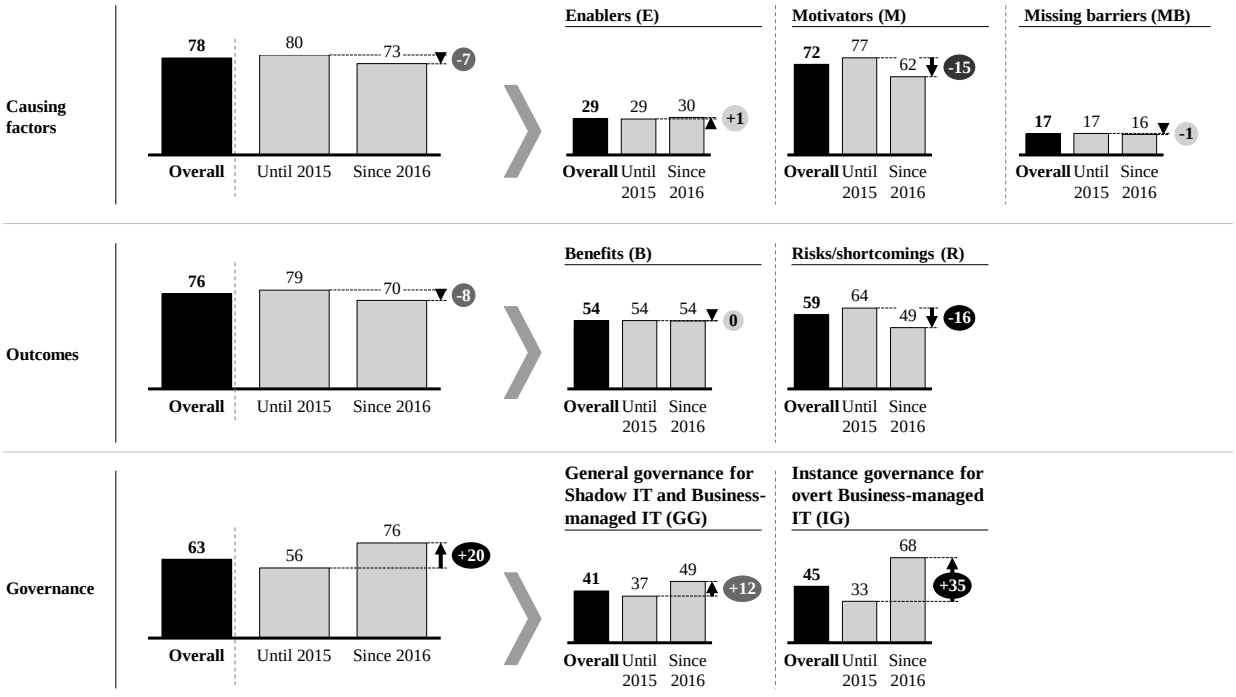

Figure 5. Longitudinal analysis of research attention, percentage of the literature identified mentioning themes in category and subcategory (70 literature items until 2015; 37 items since 2016)

The figure emphasizes that the attention of researchers (based on frequency of mentioned research themes according to the framework in Figure 4) shifted in recent years: recent literature items (since 2016) cover themes with a major focus on governance (76%), whereas causing factors were predominantly (80%) covered in older literature items (until 2015). Hence, themes on governance gained a significant increase in interest in the recent literature.

Besides, Figure 5 exhibits the evolution of themes on a smaller scale through the subcategories. The main subcategories examined in recent literature are: themes about *Instance governance for overt Business-managed IT (IG),* which are covered in 68% of recent literature as compared to 33% of the older literature. Themes about *Motivators (M)* are analyzed in 62% of recent publications. Themes about *Benefits (B)* have 54% coverage. *Risks/shortcomings (R)* and *General governance for Shadow IT and Business-managed IT (GG)* are both examined in 49% of publications. Research themes on *Enablers (E)* and *Missing barriers (MB)*—both subcategories of causing factors—are more specific and are covered in a lower proportion of the literature items.

The detailed evolution of the individual research themes over time is shown in Figure 9 in the appendix. On average, an increase of research coverage across research themes is notable for recent literature items (those published from 2016 onward) as compared to older literature (until 2015). Thus, researchers are, in general, more broadly covering the field of Shadow IT and Business-managed IT. However, several themes gained significant coverage in the literature (15% coverage in recent literature as compared to older literature), namely: *M6 Business environment uncertainty, R4 Control loss, IG1 Instance categorization, IG4-1 IT organization providing platform*, and *IG4-3 IT organization supporting implementation*. Hence, researchers have increasingly published research on the co-governance of Business-managed IT instances and the role of the IT organization in such co-governance settings.

5. Discussion

This paper creates transparency on research themes concerning Shadow IT and Business-managed IT with a deeper analysis of recent literature (since 2016), which comprises 35% of the body of research. As the field has evolved significantly—more than twice as many literature items could be identified compared to the review of Kopper and Westner [13]—research themes are broken down to a more specific level. We identified 34 research themes as compared to 22 themes in Kopper and Westner [13]. Specifically, we could characterize several additional motivators, such as *M1 IT organization and BU non-alignment*. In the outcome category, our results are more detailed for both benefits and risks/shortcomings. For example, we additionally include the themes *B3 Agility enhancement & flexibility increase* and *R5 Continuity lack*. In the governance category, we detail two decision points, namely, (a) instance decommission or continuation and (b) governance allocation, such as in the case of *IG4 IT organization & BU instance co-governance*.

The identified research themes for causing factors consider both Shadow IT and Business-managed IT as Shadow IT instances might become overt during their lifecycle and thus become Business-managed IT. Due to the overt organizational IT management of Business-managed IT, risks/shortcomings are more transparent, and some of these can, therefore, be better mitigated in comparison to Shadow IT [1]. In contrast, benefits can be realized for both Shadow IT and Business-managed IT, independent of their involvement in the organizational IT management (covert/overt). Moreover, Khalil et al. [58] noticed a different perception between business managers and IT managers: “While the business group particularly emphasizes the benefits generated by cloud technology (total frequency of 19), the IT managers group has less focus on benefits (freq. of 9)” [58, p. 8]. In contrast to this, “IT managers put more emphasis on the threats related to cloud computing (total freq. of 25) than the business manager (total freq. of 6)” [58, p. 9].

When Shadow IT instances are not known (“in the shadows” [1]) only a few governance measures can be applied, that is, the research themes in the category *General governance for Shadow IT and Business managed IT (GG),* including *GG4 Monitoring & identification*. Monitoring & identification can lead to Shadow IT instances becoming overt and thus becoming Business-managed IT instances as they are “not ‘in the shadows’ anymore” [1, p. 2]. If specific Business-managed IT instances are transparent, they can be categorized. A primary decision point for instance decommission or continuation exists. In the case of the decision for continuation, governance responsibility for

instances can be allocated based on a secondary decision point with three decision outcomes: Governance transferred to the IT organization (i.e., *IG3 IT organization instance governance)*, governance shared between the IT organization and the BU (i.e., *IG4 IT organization & BU instance co-governance)*, or governance kept at BU (i.e., *IG5 BU instance governance)*. The increased detail of Shadow IT and Business-managed IT governance in the scientific literature is also in line with the evolution of research themes over time. For example, the theme *IG4 IT organization & BU co-governance* for Business-managed IT instances has gained significant research attention since 2016. In addition, the longitudinal analysis shows a shift of research attention towards governance themes and away from motivators. This follows a somewhat expected pattern as the older literature (until 2015) sheds light on the motivators for Shadow IT and Business-managed IT in order to understand why these instances occur. As there is a better understanding of causing factors, recent research (since 2016) defines approaches to govern Shadow IT and Business-managed IT in general, as well as instance governance for overt Business-managed IT. Additionally, the recent literature covers a broader range of research themes as compared to literature published until 2015. Hence, future research needs be conducted enhance specific research themes.

Consequently, we argue for three governance recommendations, see Figure 6. First, the existing gaps in IT systems can be addressed. Typically, a gap between users' requirements and the existing systems/hardware/services exists. If this IT systems gap is reduced, a major motivator for Shadow IT and Business-managed IT can be resolved.

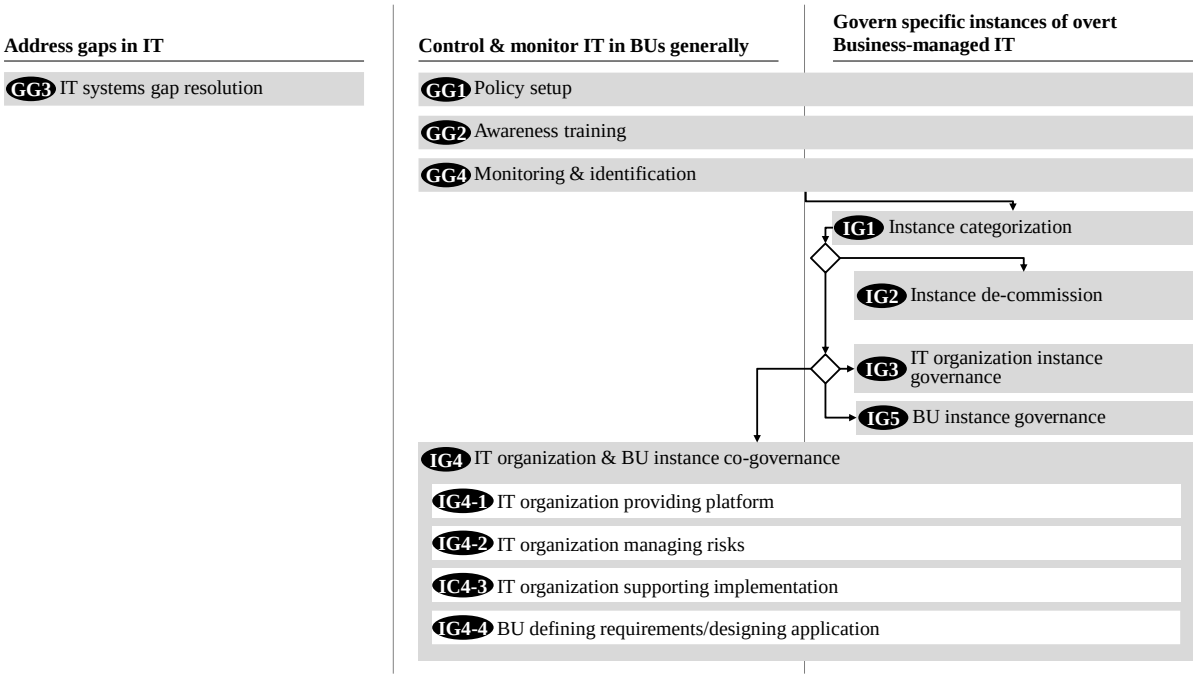

Figure 6. Governance recommendations based on literature review

Second, IT in BUs, that is, Shadow IT and Business-managed IT, can be controlled and monitored on a general level. Policies are governance measures to regulate the use of Shadow IT and Business-managed IT. Awareness creation for Shadow IT and Business-managed IT, as well as the existing policies, make these policies executable. Applications and user behavior can generally be monitored to identify Shadow IT and maintain the transparency of Business-managed IT

instances. Moreover, co-governance approaches can be implemented between the IT organization and the BUs to provide a general environment for IT in BUs, which in turn is based on existing policies.

Third, governance recommendations for specific, existing Business-managed IT instances can be implemented. Depending on the current governance status of specific instances, the previously described governance process can be used. That is, overt instances (e.g., Shadow IT instances that became overt instances after their identification) can be categorized, and thereafter, the governance can be defined via the two decision points: (1) continuation/decommission, (2) allocation of governance of specific instances to the IT organization, the BU, or in a co-governance model. Figure 6 illustrates the described approaches. However, a categorization and explicit governance allocation for specific instances is not possible for covert Shadow IT instances which limits governance measures for Shadow IT. Hence, for Business-managed IT, a broader range of governance measures exists.

6. Conclusion and outlook

In this systematic literature review, we provide a framework for Shadow IT and Business-managed IT assessing research themes within three categories: Causing factors, outcomes, and governance. For causing factors, we identify the subcategories enablers, motivators, and missing barriers. For outcomes, we find benefits and risks/shortcomings in the literature. As subcategories for governance, we identify general governance for Shadow IT and Business-managed IT and instance governance for overt Business-managed IT. The differences in the body of research until 2015 and since 2016 show that governance themes are gaining attention among researchers; in contrast, the older literature focused on motivators for Shadow IT and Business-managed IT. This is in line with the progress of the research field.

Moreover, we build on the recently introduced framework of Kopper et al. [1]. We differentiate Shadow IT (covert instances) and Business-managed IT (overt instances) and provide an allocation of relevant research themes for the two concepts. Shadow IT and Business-managed IT may share the same causing factors since different trajectories for instances exist. For example, instances can start as covert Shadow IT and become overt Business-managed IT due to monitoring mechanisms and subsequent identification. However, Business-managed IT promises to avoid some of the risks/ shortcomings of Shadow IT due to its involvement in the organizational IT management, while providing similar benefits [1]. Particularly, additional governance measures exist if Business-managed IT instances are overt, as compared to covert Shadow IT instances.

Practitioners can build on the framework of causing factors, outcomes, and governance to evaluate instances of Shadow IT and Business-managed IT. In general, organizations should take advantage of the benefits of Shadow IT and Business-managed IT, but also need to address the risks/shortcomings of Shadow IT in such instances. The provided governance recommendations can be used by practitioners as references to allocate governance responsibilities on a general level and for existing instances.

The paper helps to structure areas for further research on Shadow IT and Business-managed IT. First, further research could embed the two concepts of Shadow IT and Business-managed IT in related IS research streams. Related research streams include, (a) agile/embedded IT, (b) outsourcing (as Business-managed IT could also be understood as IT outsourcing from the perspective of the IT organization), or (c) central/decentral IT among others. Hence, an overarching taxonomy of related research streams would be beneficial to illustrate the commonalities and differences and to provide a basis for leveraging research findings across the streams. Second, further differentiation of the two concepts, Shadow IT and Business-managed IT, would be beneficial for the field. For example, researchers can shed light on the trajectory of instances of Shadow IT and Business-managed IT. Moreover, researchers could study the practitioner perceptions of both concepts. Third, as Business-managed IT was very recently introduced as a concept, further research could advance the concept and its facets. Due to the development of the research field and the broad focus of the existing literature, focused research on specific themes would advance the field considerably. Future research should target outcomes and governance themes because causing factors have been widely studied in existing research. Consequently, an evaluation of the business value of Shadow IT or Business-managed IT that considers the benefits and risks/shortcomings is a fourth area for future research. Accordingly, the business value might be different

for the BU (on a local level) as compared to the whole organization (on a general level). Fifth, the existing governance approaches as well as further governance approaches should be discussed, particularly as low-code platforms become a basis for Business-managed IT.

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Appendix A. Coding scheme

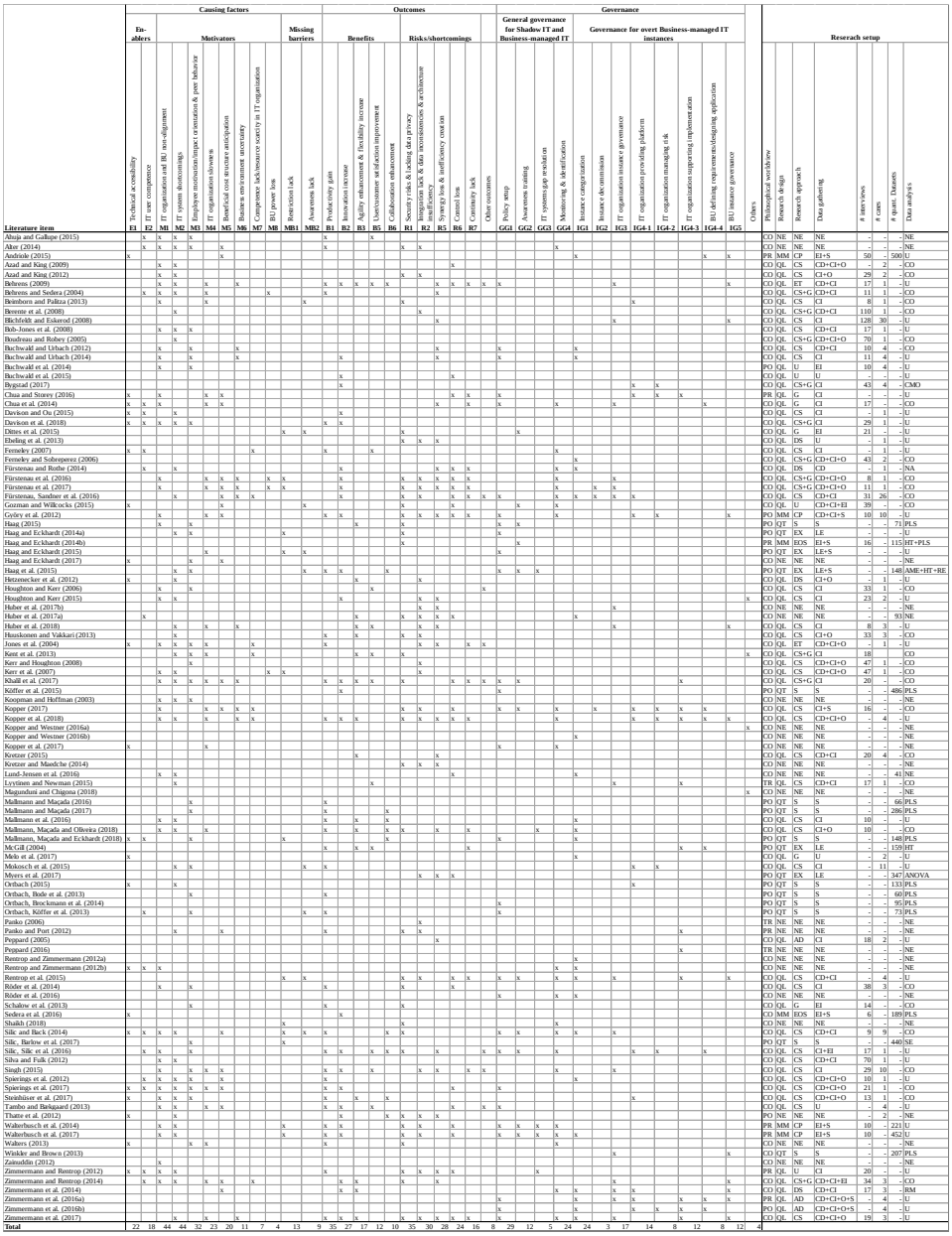
Category	Subcategory	Research theme	Keywords/phrases for coding
Causing factors	Enablers	E1 Technical accessibility	▪ Cloud/web services and solutions/SaaS ▪ IT becoming user friendly/open source ▪ Smartphones, iPads, BYOD ▪ Platforms for end-user development
		E2 IT user competence	▪ IT knowledge in BU ▪ Digital natives, tech savvy users
	Motivators	M1 IT organization and BU non-alignment	▪ Unsatisfied needs of business/users ▪ Lacking business knowledge in IT ▪ Unsupported business processes ▪ Bad past experiences/low level of trust ▪ Lack of alignment/poor business-IT alignment
		M2 IT system shortcomings	▪ Inadequate IT solutions ▪ IT systems gap ▪ Malfunctioning of existing IT solution ▪ Limitations of IT system/tools ▪ Inflexibility/complexity of IT system ▪ Shortcomings of ERP system
		M3 Employee motivation/ impact orientation & peer behavior	▪ Efficient individual task performance/goal-orientation/high motivation ▪ Experienced individual frustration ▪ Peer behavior
		M4 IT organization slowness	▪ Slow responsiveness/lacking agility ▪ Disadvantageous prioritization ▪ Long development/purchase times
		M5 Beneficial cost structure anticipation	▪ Lower cost than central solution/transaction costs ▪ Low initial costs
		M6 Business environment uncertainty	▪ Uncertain environment
		M7 Competence lack/resource scarcity in IT organization	▪ Lack of knowledge/competence ▪ Missing resources
		M8 BU power loss	▪ Loss of power of BU
	Missing barriers	MB1 Restriction lack	▪ Lack of restrictions
		MB2 Awareness lack	▪ Lack of awareness
Out-comes	Benefits	B1 Productivity gain	▪ General productivity/efficiency/effectiveness gain ▪ Employee productivity/efficiency/effectiveness gain ▪ Improved workflows/business processes
		B2 Innovation increase	▪ Innovation increase/creativity
		B3 Agility enhancement & flexibility increase	▪ Flexibility enhancement ▪ Agility increase
		B4 User/customer satisfaction improvement	▪ User/employee satisfaction ▪ Perceived higher quality of own applications ▪ Customer satisfaction
		B5 Collaboration enhancement	▪ Shadow IT instances fostering collaboration ▪ Enhanced collaboration during creation of Shadow IT
	Risks/short-comings	R1 Security risks & lacking data privacy	▪ IT security/compliance threats ▪ Data privacy threats ▪ Regulation risks

Figure 7. Coding scheme used to identify and structure research themes

Category	Subcategory	Research theme	Keywords/phrases for coding
Out-comes (cont.)	Risks/short-comings (cont.)	R2 Integration lack & data inconsistencies & architecture insufficiency	▪ Integration lack with existing systems ▪ Errors/inconsistencies ▪ Credibility loss/hindered decision making ▪ Architectural challenges
		R3 Synergy loss & inefficiency creation	▪ Synergies loss/standardization prevention ▪ Inefficiencies/redundancies ▪ Investment increase/resource waste
		R4 Control loss	▪ Control lack/governance harm ▪ SIT dependence ▪ Vendor dependence
		R5 Continuity lack	▪ Key personnel dependencies/missing documentation ▪ Low support risk ▪ Breakdown risk
Gover-nance	General governance for Shadow IT and Business-managed IT	GG1 Policy setup	▪ IT policy design considerations ▪ Policy setup considering value of Shadow IT Allow Shadow IT in controlled manner ▪ Restrict critical Shadow IT
		GG2 Awareness training	▪ Awareness training
		GG3 IT systems gap resolution	▪ IT system gaps ▪ Closing gaps might not help
		GG4 Monitoring & identification	▪ Control considerations ▪ Technical monitoring ▪ Categorization overt/covert ▪ Shadow IT identification
	Instance governance for overt Business-managed IT	IG1 Instance categorization	▪ Shadow IT types ▪ Categorization criticality/quality ▪ Functional scope/scope of use ▪ Other categorizations
		IG2 Instance decommission	▪ Instance decommission
		IG3 IT organization instance governance	▪ Instance responsibility transfer to IT/integration/replacement ▪ Criticality/quality assessment
		IG4-1 IT organization providing platform	▪ Provide general platform ▪ Provide architecture layer ▪ Provide data layer ▪ Provide service layer ▪ BYOD & enterprise app stores
		IG4-2 IT organization managing risks	▪ IT organization manages risks
		IG4-3 IT organization supporting implementation	▪ Continuous support ▪ Manage vendors ▪ Project management ▪ Service management ▪ Manage collaboration/knowledge exchange
		IG4-4 BU defining requirements/ designing application	▪ Define requirements ▪ Design application ▪ Perform tasks requiring specific business knowledge
		IG5 BU instance governance	▪ Limited scope/SaaS solution ▪ High business-specific skills needed

Figure 7. Coding scheme used to identify and structure research themes (continued)

Appendix B. Detailed coding results and research setup of literature items



Literature item	Causing factors: Enablers: Technical accessibility (E1)	Enablers: IT user competence (E2)	Motivators: IT organization and BU non-alignment (M1)	Motivators: IT system shortcomings (M2)	Motivators: Employee motivation/impact orientation & peer behavior (M3)	Motivators: IT organization slowness (M4)	Motivators: Beneficial cost structure anticipation (M5)	Motivators: Business environment uncertainty (M6)	Motivators: Competence lack/resource scarcity in IT organization (M7)	Motivators: BU power loss (M8)	Missing barriers: Restriction/Lack (MB1)	Missing barriers: Awareness lack (MB2)	Outcomes: Benefits: Productivity gain (B1)	Benefits: Innovation increase (B2)	Benefits: Agility enhancement & flexibility increase (B3)	Benefits: User/customer satisfaction improvement (B5)	Benefits: Collaboration enhancement (B6)	Risks/shortcomings: Security risks & lacking data privacy (R1)	Risks/shortcomings: Integration lack & data inconsistencies & architecture insufficiency (R2)	Risks/shortcomings: Synergy loss & inefficiency creation (R5)	Risks/shortcomings: Control loss (R6)	Risks/shortcomings: Continuity lack (R7)	Other outcomes	Governance: General governance for Shadow IT and Business-managed IT: Policy setup (GG1)	General governance for Shadow IT and Business-managed IT: Awareness training (GG2)	General governance for Shadow IT and Business-managed IT: IT system/gate resolution (GG3)	General governance for Shadow IT and Business-managed IT: Monitoring & identification (GG4)	Governance for overt Business-managed IT instances: Instance categorization (IG1)	Governance for overt Business-managed IT instances: Instance decommission (IG2)	Governance for overt Business-managed IT instances: IT organization instance governance (IG3)	Governance for overt Business-managed IT instances: IT organization providing platform (IG4-1)	Governance for overt Business-managed IT instances: IT organization managing risk (IG4-2)	Governance for overt Business-managed IT instances: IT organization supporting implementation (IG4-3)	Governance for overt Business-managed IT instances: BU defining requirements/designing application (IG4-4)	Governance for overt Business-managed IT instances: BU/instance governance (IG5)	Others	Reserach setup: Philosophical worldview	Reserch design	Reserch approach	Data gathering	# interviews	# cases	# quant. Datasets	Data analysis
Ahuja and Gallupe (2015)		x	x	x	x								x			x																	CO	NE	NE	NE	-	-	-	NE
Aker (2014)		x	x	x	x	x							x					x	x														CO	NE	NE	NE	-	-	-	NE
Andriole (2015)	x					x																								x	x		PR	MM	CP	EI+S	50	-	500	U
Azad and King (2009)			x	x																x													CO	QL	CS	CD+CI+O	-	2	-	CO
Azad and King (2012)			x	x														x	x														CO	QL	CS	CI+O	29	2	-	CO
Behrens (2009)			x	x		x		x					x	x	x	x				x	x	x	x	x						x			CO	QL	ET	CD+CI	17	1	-	U
Behrens and Sedera (2004)		x	x	x		x				x			x								x												CO	QL	CS+G	CD+CI	11	1	-	CO
Beimborn and Palitza (2013)			x			x					x							x															CO	QL	CS	CI	8	1	-	CO
Beremt et al. (2008)				x																x													CO	QL	CS+G	CD+CI	110	1	-	CO
Bichfeldt and Eskerod (2008)																					x										x		CO	QL	CS	CI	128	30	-	U
Bob-Jones et al. (2008)			x	x	x																												CO	QL	CS	CD+CI	17	1	-	U
Boudreau and Robey (2005)				x																													CO	QL	CS+G	CD+CI+O	70	1	-	CO
Buchwald and Urbach (2012)			x		x			x												x													CO	QL	CS	CD+CI	10	4	-	CO
Buchwald and Urbach (2014)			x		x			x						x						x													CO	QL	CS	CI	11	4	-	U
Buchwald et al. (2014)			x		x																												PO	QL	U	EI	10	4	-	U
Buchwald et al. (2015)														x								x											CO	QL	U	U	-	-	-	U
Bygstad (2017)														x																x	x		CO	QL	CS+G	CI	43	4	-	CMO
Chua and Storey (2016)	x		x			x	x			x			x								x			x						x	x	x	PR	QL	G	CI	-	-	-	U
Chua et al. (2014)	x	x	x			x	x														x		x									x		CO	QL	G	CI	17	-	-	CO
Davison and Ou (2015)	x	x		x										x																				CO	QL	CS	CI	-	1	-	U
Davison et al. (2018)	x	x	x	x									x	x																				CO	QL	CS+G	CI	29	1	-	U
Dittes et al. (2015)											x	x						x							x								CO	QL	G	EI	21	-	-	U
Ebeling et al. (2013)																		x	x	x													CO	QL	DS	U	-	1	-	U
Fernekley (2007)	x	x							x				x			x																	PR	QL	CS	CI	-	1	-	U
Fernekley and Sobreperez (2006)																													x				CO	QL	CS+G	CD+CI+O	43	2	-	CO
Fürstenau and Rothe (2014)		x		x										x							x	x	x					x	x				CO	QL	DS	CD	-	1	-	NA
Fürstenau et al. (2016)			x			x	x	x		x				x					x	x	x							x					CO	QL	CS+G	CD+CI+O	8	1	-	CO
Fürstenau et al. (2017)			x			x	x	x		x	x			x					x	x	x	x	x					x	x				CO	QL	CS+G	CD+CI+O	11	1	-	CO
Fürstenau, Sandner et al. (2016)				x		x	x	x						x					x	x		x	x	x	x			x	x	x			CO	QL	CS	CD+CI	31	26	-	CO
Gozman and Willcocks (2015)	x					x								x								x											CO	QL	U	CD+CI+EI	39	-	-	CO
Cyley et al. (2012)			x			x	x						x	x					x	x	x	x	x							x	x		PO	MM	CP	CD+CI+S	10	10	-	U
Haag (2015)			x		x											x			x														PO	QT	S	S	-	-	71	PLS
Haag and Eckhardt (2014a)				x	x														x														PO	QT	EX	LE	-	-	-	U
Haag and Eckhardt (2014b)																			x														PR	MM	EOS	EI+S	16	-	115	HT+PLS
Haag and Eckhardt (2015)						x					x	x																					PO	QT	EX	LE+S	-	-	-	U
Haag and Eckhardt (2017)	x				x		x																										CO	NE	NE	NE	-	-	-	NE
Haag et al. (2015)					x	x						x	x	x			x																	PO	QT	EX	LE+S	-	-	148	AME+HT+RE
Hetzenecker et al. (2012)	x				x										x					x														CO	QL	DS	CI+O	-	1	-	U
Houghton and Kerr (2006)				x		x										x									x								CO	QL	CS	CI	33	1	-	CO
Houghton and Kerr (2015)				x	x									x						x	x												x	CO	QL	CS	CI	23	2	-	U
Huber et al. (2017b)																				x	x									x				CO	NE	NE	NE	-	-	-	NE
Huber et al. (2017a)			x												x					x	x	x							x					CO	NE	NE	NE	-	-	93	NE
Huber et al. (2018)					x		x		x						x	x				x	x									x				CO	QL	CS	CI	8	3	-	U
Huuskonen and Vakkari (2013)					x								x		x					x	x													CO	QL	CS	CI+O	33	3	-	CO
Jones et al. (2004)	x		x	x	x		x						x							x	x		x	x										PO	QT	ET	CD+CI+O	-	1	-	U
Kent et al. (2013)				x	x	x			x							x	x		x														x	CO	QL	CS+G	CI	18	-	-	CO
Kerr and Houghton (2008)					x														x															CO	QL	CS	CD+CI+O	47	1	-	CO
Kerr et al. (2007)			x	x						x	x								x															CO	QL	CS	CD+CI+O	47	1	-	CO
Khalil et al. (2017)			x	x	x	x	x	x					x	x	x	x		x				x	x	x	x	x						x		CO	QL	CS+G	CI	20	-	-	CO
Köffer et al. (2015)														x																				PO	QT	S	S	-	-	486	PLS
Koopman and Hoffman (2003)			x	x	x																													CO	NE	NE	NE	-	-	-	NE
Koppor (2017)			x			x	x	x	x																									CO	QL	CS	CI+S	16	-	-	CO
Koppor et al. (2018)			x	x		x		x	x				x	x	x		x	x	x	x														CO	QL	CS	CD+CI+O	-	4	-	U
Koppor and Westner (2016a)																																	x	CO	NE	NE	NE	-	-	-	NE
Koppor and Westner (2016b)																																		CO	NE	NE	NE	-	-	-	NE
Koppor et al. (2017)	x					x																												CO	NE	NE	NE	-	-	-	NE
Kretzer (2015)															x							x												CO	QL	CS	CD+CI	20	4	-	CO
Kretzer and Maedche (2014)																				x	x	x												CO	NE	NE	NE	-	-	-	NE
Lund-Jensen et al. (2016)			x	x																		x												CO	NE	NE	NE	-	-	41	NE
Lyytinen and Newman (2015)				x											x																			TR	QL	CS	CD+CI	17	1	-	CO
Magundani and Chigona (2018)																																	x	CO	NE	NE	NE	-	-	-	NE
Mallmann and Maçada (2016)					x								x																					PO	QT	S	S	-	-	66	PLS
Mallmann and Maçada (2017)					x								x			x																		PO	QT	S	S	-	-	286	PLS
Mallmann et al. (2016)			x	x									x		x	x																		CO	QL	CS	CI	10	-	-	U
Mallmann, Maçada and Oliveira (2018)			x	x		x							x		x	x		x				x												CO	QL	CS	CI+O	10	-	-	CO
Mallmann, Maçada and Eckhardt (2018)	x	x			x						x		x			x																		PO	QT	S	S	-	-	148	PLS
McGill (2004)													x		x	x							x											PO	QT	EX	LE	-	-	159	HT
Melo et al. (2017)	x																																	CO	QL	G	U	-	2	-	U
Mokosch et al. (2015)				x	x							x	x																					CO	QL	CS	CI	-	11	-	U
Myers et al. (2017)																				x	x	x												PO	QT	EX	LE	-	-	347	ANOVA
Orthach (2015)	x			x																														PO	QT	S	S	-	-	133	PLS
Orthach, Bode et al. (2013)					x								x																					PO	QT	S	S	-	-	60	PLS
Orthach, Brockmann et al. (2014)																																		PO	QT	S	S	-	-	95	PLS
Orthach, Köffer et al. (2013)		x			x						x	x																						PO	QT	S	S	-	-	73	PLS
Panko (2006)																		x																TR	NE	NE	NE	-	-	-	NE
Panko and Port (2012)				x			x						x					x	x			x												PR	NE	NE	NE	-	-	-	NE
Peppard (2005)																																		CO	QL	AD	CI	18	2	-	U
Peppard (2016)																																		TR	NE	NE	NE	-	-	-	NE
Rentrop and Zimmermann (2012a)																																		CO	NE	NE	NE	-	-	-	NE
Rentrop and Zimmermann (2012b)	x	x	x																															CO	NE	NE	NE	-	-	-	NE
Rentrop et al. (2015)										x	x							x	x			x	x											CO	QL	CS	CD+CI	-	4	-	U
Röder et al. (2014)			x		x								x					x				x												CO	QL	CS	CI	38	3	-	CO
Röder et al. (2016)																																		CO	NE	NE	NE	-	-	-	NE
Schallow et al. (2013)					x								x					x																CO	QL	G	EI	14	-	-	CO
Sedera et al. (2016)	x													x																				CO	MM	EOS	EI+S	6	-	189	PLS
Shaikh (2018)											x							x																CO	NE	NE	NE	-	-	-	NE
Silic and Back (2014)	x	x	x	x			x				x	x	x				x	x							x	x								CO	QL	CS	CD+CI	9	9	-	CO
Silic, Barlow et al. (2017)					x						x																							PO	QT	S	S	-	-	440	SE
Silic, Silic et al. (2016)		x	x		x								x	x	x	x	x		x			x	x	x										CO	QL	CS	CI+EI	17	1	-	U
Silva and Fulk (2012)			x	x																														CO	QL	CS	CD+CI	70	1	-	U
Singh (2015)			x		x	x	x						x	x		x			x	x			x	x										CO	QL	CS	CI	29	10	-	CO
Spierings et al. (2012)		x	x	x	x		x						x																					CO	QL	CS	CD+CI+O	10	3	-	U
Spierings et al. (2017)	x	x	x	x	x	x							x	x																				CO	QL	CS	CD+CI+O	21	1	-	CO
Steinhüser et al. (2017)	x		x	x	x								x		x	x																		CO	QL	CS	CD+CI+O	13	1	-	CO
Tambo and Bækgaard (2013)			x		x		x						x	x		x																		CO	QL	CS	U	-	4	-	U
Thatte et al. (2012)	x			x										x			x	x	x															PO	NE	NE	NE	-	2	-	NE
Walterbusch et al. (2014)			x	x							x		x	x			x	x				x			x	x	x							PR	MM	CP	EI+S	10	-	221	U
Walterbusch et al. (2017)			x	x							x		x	x			x	x				x			x	x								PR	MM	CP	EI+S	10	-	452	U
Walters (2013)	x				x	x							x					x								x								CO	NE	NE	NE	-	-	-	NE
Winkler and Brown (2013)																																	x	CO	QT	S	S	-	-	207	PLS
Zainuddin (2012)			x																															CO	NE	NE	NE	-	-	-	NE
Zimmermann and Rentrop (2012)	x	x	x	x									x					x	x	x					x									PR	QL	U	CI	20	-	-	U
Zimmermann and Rentrop (2014)		x	x	x		x	x		x					x	x			x		x							x						x	CO	QL	CS+G	CD+CI+EI	34	3	-	CO
Zimmermann et al. (2014)						x								x	x											x	x	x					x		CO	QL	DS	CD+CI	17	3	-	RM
Zimmermann et al. (2016a)																																		PR	QL	AD	CD+CI+O+S	-	4	-	U
Zimmermann et al. (2016b)																																		PO	QL	AD	CD+CI+O+S	-	4	-	U
Zimmermann et al. (2017)				x		x		x					x	x	x		x	x	x															CO	QL	CS	CD+CI+O	19	3	-	U
Total	22	18	44	44	32	23	20	11	7	4	13	9	35	27	17	12	10	35	30	28	24	16	8	29	12	5	24	24	3	17	14	8	12	8	12	4								

Worldview
CO Constructivist
PR Pragmatic
PO Post-positivist
TR Transformative

Reserach design
NE Non-empirical
MM Mixed method
QL Qualitative
QT Quantitative

Research appreach
AD Action design
CP Convent parallel
CS Case/interview study
DS Design science
EOS Exploratory sequential
ET Ethnography
EX Experimental research
G Grounded theory
NE Non-empirical
S Survey research
U Unspecific

Data gathering
CD Case documents
CI Case interview
EI Expert interview
LE (Laboratory) experiment
NE Non-empirical
O Observation
S Surveys
U Unspecific

Data analysis
ANOVA Analyis of variance
CMO Context–mechanism–outcome
CO Coding
HT Hypothesis test
NA Network analysis
NE Non-empirical
PLS Partial least squares
RE (Logistic) Regression
RM Risk map
SE Structural eugation model
U Unspecific

Figure 8. Concept matrix of coding results and research setup of all literature items

Appendix C. Longitudinal analysis of research themes

⬆ Increase of coverage >5% until 2015/since 2016 | ➡ Coverage delta until 2015/since 2016 <=5% | ⬇ Decrease of coverage >5% until 2015/since 2016 | #% Coverage delta until 2015/since 2016 >15%

Category	Subcategory	Research theme	Overall	Received attention: Until 2015	Received attention: Since 2016	Delta
Causing factors	Enablers	E1 Technical accessibility	21%	19%	24%	⬆ 6%
		E2 IT user competence	17%	19%	14%	⬇ -5%
	Motivators	M1 IT organization and BU non-alignment	41%	43%	38%	⬇ -5%
		M2 IT system shortcomings	41%	46%	32%	⬇ -13%
		M3 Employee motivation/impact orientation & peer behavior	30%	31%	27%	➡ -4%
		M4 IT organization slowness	21%	17%	30%	⬆ 13%
		M5 Beneficial cost structure anticipation	19%	17%	22%	➡ 4%
		M6 Business environment uncertainty	10%	4%	22%	⬆ 17%
		M7 Competence lack/resource scarcity in IT organization	7%	6%	8%	➡ 2%
		M8 BU power loss	4%	3%	5%	➡ 3%
	Missing barriers	MB1 Restriction lack	12%	10%	16%	⬆ 6%
		MB2 Awareness lack	8%	13%	0%	⬇ -13%
Out-comes	Benefits	B1 Productivity gain	33%	33%	32%	➡ 0%
		B2 Innovation increase	25%	21%	32%	⬆ 11%
		B3 Agility enhancement & flexibility increase	16%	13%	22%	⬆ 9%
		B4 User/customer satisfaction improvement	11%	13%	8%	➡ -5%
		B5 Collaboration enhancement	9%	6%	16%	⬆ 11%
	Risks/short-comings	R1 Security risks & lacking data privacy	33%	33%	32%	➡ 0%
		R2 Integration lack & data inconsistencies & architecture insufficiency	28%	27%	30%	➡ 3%
		R3 Synergy loss & inefficiency creation	26%	26%	27%	➡ 1%
		R4 Control loss	22%	16%	35%	⬆ 19%
		R5 Continuity lack	15%	11%	22%	⬆ 10%
Gover-nance	General governance for Shadow IT and Business-managed IT	GG1 Policy setup	27%	23%	35%	⬆ 12%
		GG2 Awareness training	11%	11%	11%	➡ -1%
		GG3 IT systems gap resolution	5%	4%	5%	➡ 1%
		GG4 Monitoring & identification	22%	19%	30%	⬆ 11%
	Instance governance for overt Business-managed IT	IG1 Instance categorization	22%	16%	35%	⬆ 19%
		IG2 Instance decommission	3%	0%	8%	⬆ 8%
		IG3 IT organization instance governance	16%	14%	19%	➡ 5%
		IG4-1 IT organization providing platform	13%	7%	24%	⬆ 17%
		IG4-2 IT organization managing risks	7%	3%	16%	⬆ 13%
		IG4-3 IT organization supporting implementation	11%	6%	22%	⬆ 16%
		IG4-4 BU defining requirements/designing application	7%	3%	16%	⬆ 9%
		IG5 BU instance governance	11%	11%	11%	➡ -1%

Figure 9. Longitudinal analysis of research attention of individual research themes (the percentage of identified literature items mentioning themes in category and subcategory, 70 literature items until 2015, 37 items since 2016)

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Improving and embedding project management practice: generic or context dependent?

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Abstract:
Taking into account the contingency theory, this paper explores the extent to which key project management improvement initiatives and key embedding factors, identified in a previously developed conceptual framework, are dependent on organizational context, namely sector of activity, organization size, geographic area and project types. Therefore, aiming to guide professionals on making use of such framework in their organizations. Statistically significant contextual correlations were looked for in a worldwide sample of 793 questionnaire responses from project management professionals, using Principal Component Analysis, ANOVA test and post-hoc Tukey test. Context related differences found were limited, suggesting that the framework for improving and embedding project management practice is substantially generic. Therefore, the paper shows the explanatory power of the framework, which can be used by any organization independent of its sector of activity, dimension, geographic area and project types, however indicating the existence of slight differences. For example, Information Technology companies might give more relevance to initiatives such as corporate standardization and tailoring of project management processes tools and techniques than Engineering and Construction companies.

Keywords:
improving initiatives; embedding factors; project management practice; organizational dependency.

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1. Introduction

Project management (PM) has been shown to deliver tangible and intangible benefits to organizations [1-4]. Lappe and Spang [5] found a clear relationship between the investment in PM and the benefits resulting from its application. The study of Joslin and Müller [6] show that the application of a project management methodology account for 22.3% of the variation in project success.

Nevertheless, PM remains a highly problematical endeavor. Mir and Pinnington [7] argue that despite the advancements in PM processes and tools (many methods, techniques and tools have been developed, covering all aspects of managing projects from their genesis to their completion [8, 9]) project success rates have not significantly improved. Often unsuccessful projects are even rooted in management's failure to select the right PM approach to the specific project [10].

PM approaches might be predictive or adaptive [11]. The predictive approach (waterfall) can be applied to any project environment, but in situations where projects involve requirements volatility, high degree of uncertainty of change, ambiguity (unknown cause and effect interdependencies) and when dealing with complexity in project environment, this waterfall approach presents difficulties in responding quickly [12]. These situations may sometimes lead to conflicting relationships with clients or partners when pursuing compliance with the deadline [13]. In this scenario the adaptive (agile) approach can and should be considered, since agile development has proved to be adequate to dominate the presented situations and to capitalize the changes as opportunities [14]. Different PM approaches even might adopt different criteria to measure project success [15].

Shi [16] argues that how to implement and improve PM in the 'right way' is still a relevant topic to study. One important issue is that PM is highly contingent on the organizational context, such as structure of business or industry sector, size, and its environment [17-20]. For example, Cooke-Davies et al. [19] argue that the value of PM is a function of what is implemented and how well it fits the organizational context. Value can be defined as the ratio of benefits over costs or alternatively the ratio of satisfaction of needs over use of resources [21]. Spalek [22] demonstrated that a change in the PM maturity level reduces the cost of forthcoming projects with different degrees of intensity, depending on the PM maturity and industry type.

PM value is created or destroyed depending on the extent of 'fit' or 'misfit' between the organization's strategic drivers and the characteristics of its PM system [19]. However, the PM paradigm has been defined through generic bodies of knowledge, such as the PMBoK® from Project Management Institute [11] or the APM BoK® from the Association for Project Management [23], as well as through standard textbooks on project management such as the handbooks from Kerzner [24] and Turner [25]. More recently a handbook edited by Sankaran, Müller and Drouin [26], has been added to this body of knowledge, presenting an organizational perspective on project management, which aggregates a significant number of well recognized contributors, resulting in twenty-five insightful chapters. Although, even PMBoK® recognizes that 'Good practice' does not mean that the knowledge described should always be applied uniformly to all projects; the organization and/or PM team is responsible for determining what is appropriate for any given project [11]. Similarly, in the research study "Researching the value of project management", sponsored by the Project Management Institute, Thomas and Mullaly [4] concluded that there is no unique way being adopted when PM practice is improved in organizations; there are many different PM initiatives for improving PM practice in organizations. For example, different strategies are employed for training and employee development, namely through the implementation of a PM career path or a PM certification system. There are different approaches adopted in introducing project support groups (such as project management offices), and these support groups differ in focus, structure and influence [27, 28]. The implementation of PM methodologies varies considerably, from the very *ad hoc* and informal to methodologies that are formally defined and consistently adhered to. These show that firms do not necessarily have a clear or consistent approach to improve PM practice. As argued by Besner and Hobbs [29], there have been few studies examining the difference in PM practice within different industries and project types. However, improving PM is for many companies crucial to survival in a fast-changing environment [30]. Organizations need

guidance on which project management improvement initiatives (PMIIs) they should concentrate their efforts [4, 16, 31].

A related issue is how to facilitate the embedment of these initiatives in organizations. Cranefield and Yoong [32] argue that there is a need for better understanding of the embedding process. Organizations tend to focus their attention on what to improve (i.e., the selection of PMIIs), and pay less attention to the process of embedding these initiatives into the organization. In particular, there is little evidence in the PM literature of the factors contributing to facilitating the embedding process of PMIIs and how these factors are dependent on the organizational context. Therefore, a framework for improving and embedding PM practice was previously conceived and validated [33].

The framework considers that the two concepts 'improving PM practice' and 'embedding PM practice' are different, as illustrated in Fig. 1. 'Improving PM practice' focus on the identification of key PMIIs. PMIIs include specific PM practices that practitioners use to 'execute a process', such as Work Breakdown Structure or Earned Value Management, as well as, and particularly, the development of activities that would help to improve PM practices, such as: i) the standardization of PM processes, tools and techniques; ii) the designation of formal titles and roles for those in charge of projects, and their adequate training; or iii) the alignment of PM activities with the whole organization's activities (for example, the strategic planning of the organization should be tightly coupled with the project identification and prioritization). 'Embedding PM practice' focus on the identification of key facilitating factors, during the embedding process (diffusion, dissemination, implementation and routinization) that can foster PM practices embedment.

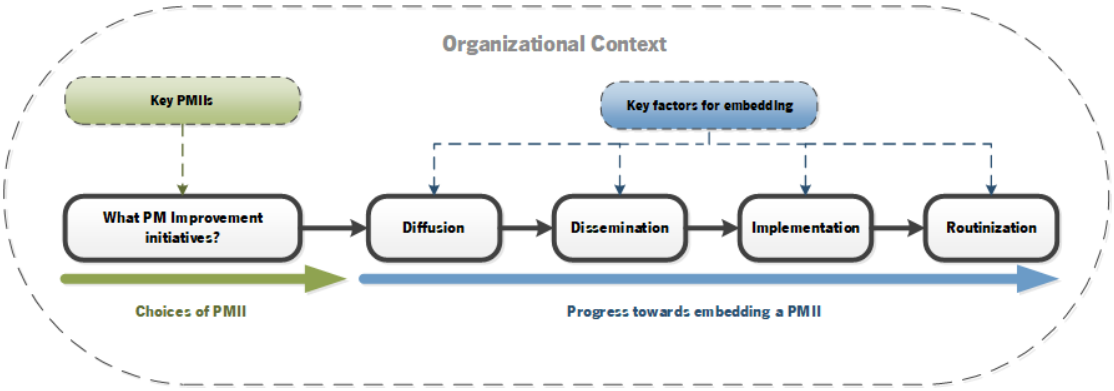

Fig. 1. Conceptualization of 'improving' and 'embedding' PM practice in organizations adapted from [34]

The research described in this paper is based on the contingency theory [35], which is being applied in the PM area in the last two decades [10]. The contingency approach in PM investigates the extent of fit or misfit between project characteristics and PM [10, 36]. Engwall [37] emphasizes the importance of a contingency approach and defends that projects are open systems dependent on history and organizational context.

Therefore, this research aims to find if respondents from different organizational contexts identify different relevance levels of the framework's key PMIIs and of the key factors to facilitate the embedment of these initiatives. More specifically, this paper seeks to answer the research question: How do the set of key PMIIs and the key factors to facilitate initiatives embedment vary in different organizational contexts, namely: industry, organization size, geographic area, and project types?

The empirical component of this research provides insights into both the contextual variation of PMIIs in organizations and the contextual variation of the factors that facilitate the embedment process of these PMIIs in organizations.

The remainder of this paper is organized as follows. The second section makes a synopsis of the framework for improving and embedding PM practice. The third section describes the research methodology applied in this study. The fourth section presents the dataset of the 793 practitioners worldwide, covering 75 different countries that have participated in the questionnaire survey. The fifth and sixth section specifies the results and discusses them. Finally, the main findings that emerged from this study, as well as the conclusions and suggestions for future work are discussed.

2. Synopsis of the framework for improving and embedding PM practice

The framework for improving and embedding PM practice is conceptualized into two constructs: 'improving' and 'embedding' PM practice, although the two concepts are linked since an organization engaged in embedding a PMII is consequently improving PM (see Fig. 2). However, in the framework conceptualization 'improving' is seen as the identification and selection of potentially useful PMIIs which must then be embedded into the organization to be effective. Therefore, with respect to the 'improving' construct, it identifies the most useful PMIIs, particularly the key activities that would help to improve PM practice, such as the standardization of PM processes, tools and techniques. In respect to the 'embedding' construct, the framework identifies factors contributing to the successful embedment of PMIIs. The assumption is that if an organization is aware of these factors and addresses them during the stages of the embedding process of a PMII, i.e., sets actions to enhance their effect in the embedding process of a PMII, then embedment is more likely to be achieved.

In the development of the framework an 'innovation lens' perspective was adopted, using concepts of diffusion, dissemination, implementation and routinization, from other disciplines [38, 39] to develop an understanding of the process of embedding PMIIs in organizations. The process of embedding PMIIs into organizations implies the diffusion, dissemination, implementation and routinization of the PMIIs. Diffusion is the passive spread of PMIIs, whereas dissemination involves active and planned efforts to convince target groups to adopt PMIIs. The implementation of the PMII includes active and planned efforts to incorporate a PMII within an organization. The routinization is the institutionalization of a PMII, which is routinely used within an organization, meaning that the PMII is embedded in the organization. Therefore, embedding PMIIs is presented as a process rather than an event, whereas the embedment of PMIIs into the organization is the result, i.e., one can say that a PMII is considered to be embedded in the organization when: 1) a PMII is strongly contextualized (customized or personalized); 2) integrated with other contextualized management practices in the organization; and 3) there is a sense of 'ownership' facilitated by the staff involvement at all levels.

Adopters have particular influence in the innovation process [40]. However, some features of organizations (both structural and "cultural") have been shown to influence the likelihood that an innovation will be successfully implemented [41, 42], and factors beyond the organization/ external factors also play a role [43, 44]. The conducted process of diffusion, dissemination, implementation and routinization also has an important influence on the embedment of innovations [38]. In the framework (Fig. 2), the diffusion and dissemination of PMIIs is seen as the process of 'communication and influence' seeking the adoption of the PMII by the organization. 'Implementation' comprises the set of efforts made to introduce the use of a PMII in the organization. As argued by Meyers et al. [45, p. 295], implementation is "the early usage activities that often follow the adoption decision". The PMII implementation and routinization success is also dependent on the organizational context [19] as it is explored in this research paper. As argued by Eskerod and Larsen [46] a project should not be seen as a single unit of analysis isolated from both temporal and environmental context.

Therefore, while adopter features are an important group of factors to be considered, organizations should not neglect a broader perspective which considers inner context-related factors, outer context-related factors, communication and influence-related factors, implementation-related factors, and routinization-related factors (Fig. 2). This expanded list of facilitating factors can act as levers that organizations can use in devising strategies to promote the embedment of PMIIs into their systems.

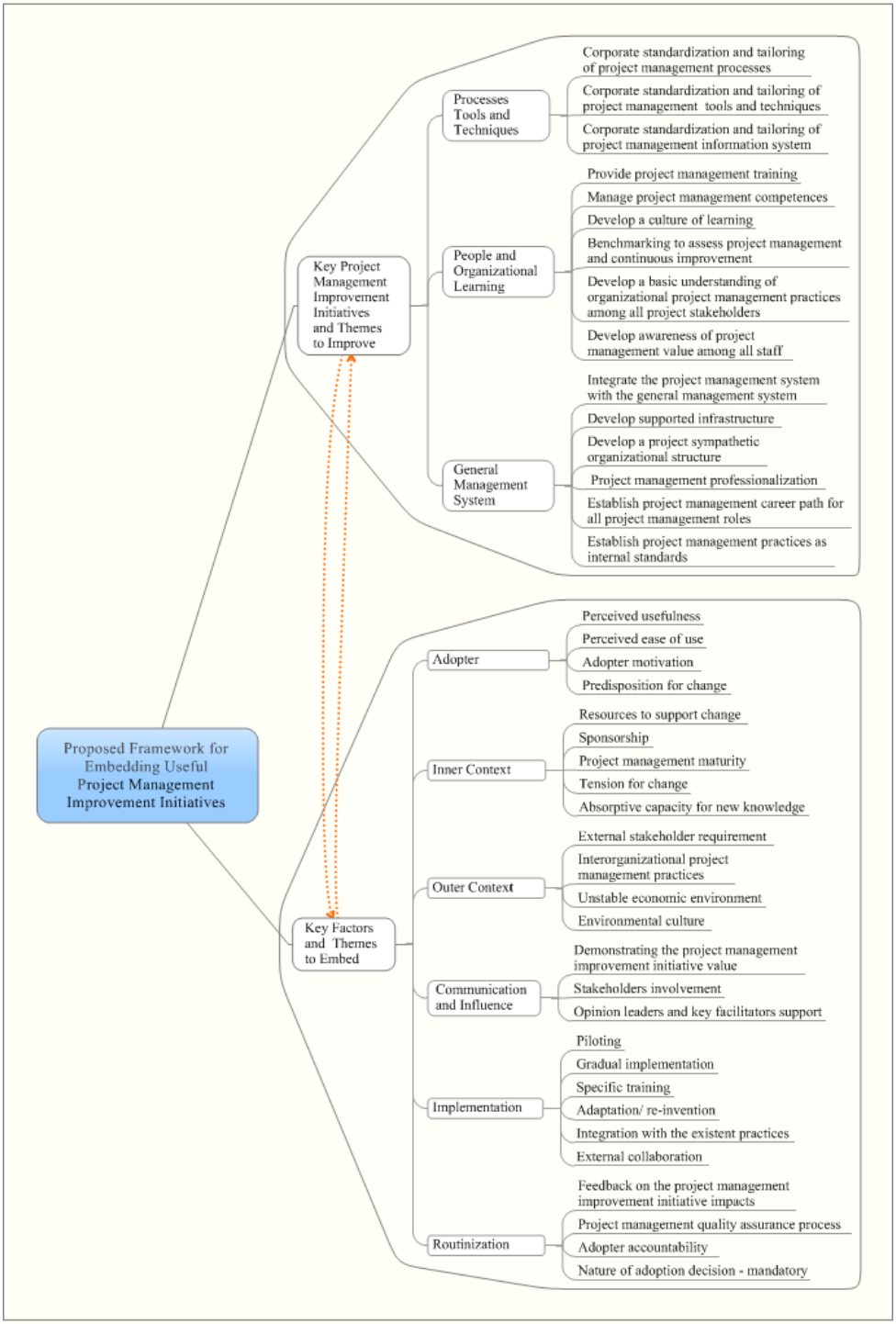

Fig. 2. Framework for embedding useful project management improvement initiatives from [33]

In summary, the framework for improving and embedding PM practice was developed in four main phases:

- An 'initial framework' of key PMIIs and key embedding factors was derived from the literature (e.g., Greenhalgh et al. [38]; Shi [16]; Venkatesh and Bala [39]) and the researchers' professional experience.
- A revised framework' was constructed following an exploratory study, consisting of thirty semi-structured interviews with PM practitioners. Analysis of this interview data: (a) identified three new key PMIIs and ten key factors for embedding; (b) confirmed twelve key PMIIs and sixteen embedding factors; (c) merged into other PMIIs three key initiatives and five embedding factors; and (d) discredited eleven embedding factors, resulting in a modified total of 15 key PMIIs and 26 embedding factors. More detailed information on the development of the 'revised framework' from the interviews data analysis (new, confirmed, merged and discredited factors) can be found in paper [34].
- 793 responses from a worldwide web-based questionnaire were analyzed to test the 'revised framework' and produce a 'refined framework'. The questionnaire survey confirmed all the PMIIs and embedding factors presented in the 'revised framework'. However, some of these initiatives and embedding factors were re-categorized into different themes based on the survey data analysis.
- The final 'proposed framework', called Framework for improving and embedding PM practice in organizations, see Fig. 2, was derived from the consolidation of interviews data and questionnaire survey data analysis. The consolidation of the findings was a straightforward process, because, the questionnaire survey confirmed most of the conceptualization resulting from the interview analysis. More detailed information on the questionnaire survey data analysis and development of the framework can be found in the paper [33].

The framework comprises 15 key PMIIs reduced into three 'improving' themes through Principal Component Analysis: 'processes, tools, and techniques', 'people and organizational learning' and 'general management system'; and 26 embedding factors reduced into six main 'embedding' themes: 'adopter', 'inner context', 'outer context' 'communication and influence (diffusion/ dissemination)', 'implementation', and 'routinization'.

3. Research method

3.1 Conducting the questionnaire

This paper reports on the data collected through a web-based questionnaire with support from the PMI Research Department (the survey link was posted directly on the PMI's website www.pmi.org), and several PMI chapters, as well as other project management associations. On-line questionnaires allow a large quantity of data collection at a lower cost [47].

The questionnaire was lengthy and took around 15 to 20 minutes to complete. However, the questionnaire was built with a consistent structure that facilitated responses. For simplicity and ease completion, the same scale was used for all sub questions. Respondents were asked to indicate the degree of influence of questionnaire items on a 5-point Likert scale, where "5" indicates "very high" and "1" indicates "very low". The questionnaire was divided into four parts: Part A — key PMIIs; Part B — key factors for embedding PMIIs; Part C — the most useful project management practices (out of scope of this paper); and Part D — characteristics of the respondent and respondent's organization, such as: business activity, size and projects characteristics, such as internal versus external projects, which have been shown to be an important characteristic of the project context [48]. The questions of Part D allowed to answer the research question: How do the set of key PMIIs and the key factors to facilitate initiatives embedment vary in different organizational contexts, namely: industry, organization size, geographic area, and project types?

This research study used a non-probabilistic technique for sampling, the 'snowball' technique, assuming that there was no possibility of a predetermination of sample size [47, 49]. However, the number of responses is substantially larger than the minimum sample size required for generalization for 'infinite' population sizes (377 responses at a confidence level of 95 percent at margin of error ±5 percent) [50]. It was intended to cover PM practitioners over the world and the 'snowball' sampling technique seems to be suitable to pursue this objective.

3.2 Questionnaire data analysis

The Statistical Package for the Social Sciences (SPSS) software was used to analyze the quantitative response data. The analysis of the dependency of improving and embedding factors on the organizational context warranted some simplification due to the high number of PMIIs and embedding factors to be analyzed. The analysis under so many factors would have been very complex with a correlation matrix of 15 PMIIs by 26 embedding factors, resulting in the analysis of 390 correlation coefficients. Consequently correlation analysis was conducted between improving and embedding 'themes' comprising groups of PMIIs and embedding factors (see Fig. 2), rather than individual PMIIs and embedding factors. Principal Component Analysis was used to achieve the reduction of the number of PMIIs and embedding factors to a smaller set of improving and embedding themes (for more details see the paper [33]).

To detect differences in the improving and embedding themes related to the organizational contextual variables (sector of activity, organization size, geographic area and different project types, in terms of scope, time and cost), an ANOVA analysis was carried out. This identified differences between categories of organizational contextual variables by comparing the mean responses of different categories for each organizational contextual variable [51].

ANOVA test was selected as means of identifying significant differences because it is a more robust approach than several t-tests or the use of non-parametric procedures, such as the Mann-Whitney test, the Wilcoxon signed-rank test, Friedman's test and the Kruskal-Wallis [50]. However, to use ANOVA, the four assumptions of parametric tests needed to be assured: normality, independence of the observations, the dependent variable should be measured on at least an interval scale, and homogeneity of the variances.

Data was collected from 793 respondents. According to Field [50] and Greasley [52] this can be considered a large sample, therefore the sampling distribution should be tending to a normal distribution. However, in order to assure that the three improving themes and six embedding themes variables created by the exploratory Factor Analysis are normally distributed, several analyses through the SPSS were conducted. Firstly, the Kolmogorov–Smirnov test and Shapiro–Wilk test was run. However, an important limitation was identified as large sample sizes tend to get significant results when small deviations from normality are identified. This limitation was also identified in the skewness and kurtosis analysis, whose values should be zero in a normal distribution but when used in large samples, they are likely to be significant even when not too different from normal [50, 52]. Therefore, Greasley [52] proposes that for large samples an observatory analysis of the P-P plots or the Q-Q plots, which produce similar results, should be performed. If the data are normally distributed, then the observed values identified by the dots on the chart, should fall along the straight line (meaning that the observed values are the same as would be expected to get from a normally distributed data set). The analysis of the obtained P-P plots allowed the assumption that all the nine improving and embedding themes (variables) are normally distributed. In order to illustrate the results, an example of the theme 'outer context' P-P plot is presented in Fig. 3.

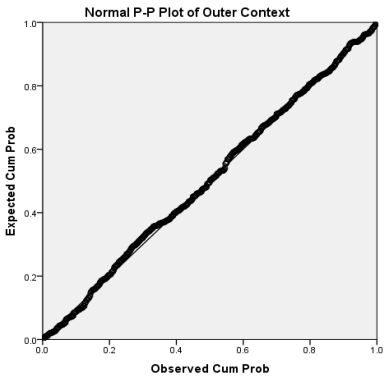

Fig.3. P-P Plot of the theme 'outer context'

Regarding the assumption of the independence of the observations, scores are independent, which is true as they come from different people. The assumption related to the interval scale was tested based on the idea that data are interval if equal intervals on the scale represent equal differences in the property being measured. The assumption "homogeneity of the variances" means that the variances should be the same throughout the data. When testing several groups of respondents, as in this case, this assumption means that each of these samples comes from populations with the same variance. The homogeneity of variance can be assured by the Levene's test that can be performed at the same time as ANOVA test in SPSS.

However, as well as the Kolmogorov–Smirnov test for test normality, when the sample size is large, small differences in group variances can produce a Levene's test that is significant. Therefore, it is necessary to also look at Hartley's FMax also known as the variance ratio [50]. This is the ratio of the variances between the group with the biggest variance and the group with the smallest variance. This ratio should be compared to critical values in a table published by Hartley (in Field [50]), and should be less than the critical value. During the analysis of the homogeneity variance, six Levene's tests presented values below <0.05, which *per se* indicates a violation of the homogeneity variance assumption. Therefore, the analysis of the variance ratio was performed. The six variance ratios presented values between 1.13 and 1.6, and all of them below the critical values in the Hartley's graph. Consequently, the homogeneity of variance was assumed, and ANOVA test was applied for all the analysis.

4. The dataset

Almost 72% of the 793 respondents were between 30 and 50 years old, 23% were over 50 years old and only 5% up to 29 years old. Most of the respondents were male (83%), which perhaps gives an idea of the female presence in PM area worldwide. Regarding the main occupation on the companies, most of the respondents marked as primary role a Project manager position (43%). 20% were Portfolio and Program managers; 16% were in a Director position, 7% were in Team member position and 6% were in Functional manager position, and about 8% of the respondents indicated an unspecified role.

Almost 50% of the respondents had more than 10 years of experience as a project manager and 15% had more than 10 years of experience as a Portfolio or Program manager, and appeared well qualified to provide valuable information. A vast majority of them, had a graduate degree (83%), 13% had an undergraduate degree and only 4% a technical qualification. From the total of the graduated respondents, 40% had a postgraduate degree, 53% a master degree and 7% a doctorate degree.

The sample is weighted toward the information and technology (IT) sector but includes a sufficient number of respondents in five different sectors, allowing for comparisons between the following subgroups: Information and technology (37%); Business services (17%); Engineering and construction (14%); Telecommunications (8%); Industrial services (3%); other project types (21%). Respondents were from organizations of varying sizes (large, medium, small and micro), with most (44%) coming from large organizations.

The countries with the highest participation were: Portugal (41%), United States (9%), United Kingdom (6%), Australia, Brazil and Netherlands (4% each), Canada, Italy, Spain and India (2% each). Participation is concentrated in these ten countries which accounted for 76% of the responses leaving the remaining 24% participation to the other sixty five countries. As several countries had just one or two respondents it was necessary to group the countries, according to the continent to which they belong, to conduct the analysis of the contextual variable geographic area. The highest participation comes from Europe (68%) followed by North America (13%) and Central and South America (6%). The lowest percentage came from Asia and Australia (4% each), Middle East (3%), and Africa (2%).

Table 1 summarizes the respondents' characterization by their typical project type. Table 1 shows that 44% of respondents work on projects that vary in scope, whereas 56% work on projects that are fairly similar in scope. About 44% of respondents were involved in projects with a high level of technical innovation, while 24% and 32% work on projects with low level of technical innovation and a standard product and technology, respectively. Almost half of the

responses were clustered on the intervals 50.000€ and 250.000€ and 1.000.000€ and 5.000.000€. Most questionnaire respondents (79%) had experience of projects with durations between 3 months and 2 years. Approximately 35% work on projects between 6 months to 1 year. Table 1 also shows the type of deliverable produced by the respondent's typical project. For example, an individual working on engineering and construction or business services, may be working on information technology projects as well.

Table 1. Respondents' characterization by typical project type

Projects internal/ external or both	Internal (27%)	External (33%)	Both Internal and external (40%)			
Project Scope (deliverable produced)	Engineering and construction (17%)	Business services (19%)	Information and technology (46%)	Telecommu-nications (6%)	Industrial services (3%)	Other project types (9%)
Project Scope (scope similarity)	Fairly similar in scope (56%)	Quite different in scope (44%)				
Project Scope (technical innovation level)	High level of technical innovation (44%)	Low level of technical innovation (24%)	Standard product and technology (32%)			
Project Cost	Up to €50.000 (16%)	€50.000– €250.000 (25%)	€250.000– €500.000 (12%)	€500.000 – €1.000.000 (12%)	€1.000.000– €5.000.000 (19%)	More than €5.000.000(16%)
Project Duration	Up to 3 months (5%)	3 - 6 months (20%)	6 months -1 year (35%)	1 - 2 years (25%)	More than 2 years (15%)	

5. Results

Table 2 shows a summary of the results of ANOVA, and only the significant values, $p<0.05$ [50], are presented. Several main dependencies of the improving and embedding themes are evident in respect of several organization contextual variables. For example, in the first row of Table 2, the ANOVA test shows that respondents from different sectors of activity have scored significantly differently the variables under the four themes: 'processes, tools, and techniques' ($p\approx0.000$); 'people and organizational learning' ($p=0.029$); 'communication and influence' ($p=0.016$); and 'routinization' ($p\approx0.000$), i.e., respondents from different sectors of activity have different perceptions on the importance of the PMIIs under the improving themes and of the embedding factors under the embedding themes.

The results of ANOVA test, in Table 2, just show that there are significant differences between categories within a context variable; it does not provide specific information about which categories involve differences. For example, Table 2 signals differences between the different categories (groups) under the contextual variable sector of activity (engineering and construction; business service; IT; telecommunications; industrial services; and others). A further study is then required in order to understand the differences between the different categories. Therefore, the post-hoc Tukey test, the most used test for large samples [50], was performed.

Table 3 presents the results of the post-hoc Tukey test under the themes with significant category variations spotted with the ANOVA. This test allows the identification of which categories from the organizational context variable are influencing the spotted differences. Once again only the significant values, $p<0.05$ [50], are presented. For example, in the first row of Table 3, the Tukey test shows that under the theme 'processes, tools, and techniques' there are significant differences between the categories: IT/ engineering and construction ($p=0.015$); IT/ telecommunications ($p=0.029$); and IT/ other ($p<0.001$).

Table 2. ANOVA results on the themes for improving and embedding and the contextual variables

Context variable	Processes, tools, and Techniques	People and organi-zational learning	General manage-ment system	Adopter	Inner context	Outer context	Communi-cation and influence	Implemen-tation	Routiniza-tion
Sector of activity	<.001	.029	-	-	-	-	.016	-	<.001
Organization size	-	.001	-	-	-	-	-	.002	-
Geographic area:									
▪ 7 groups	-	-	-	-	-	.002	-	-	-
▪ Portugal/ Europe/ Rest of the world	.001	.048	-	-	-	-	-	-	-
▪ Portugal/ Rest of the world	.001	.022	-	-	-	-	-	-	-
Project Type:									
▪ Projects internal/ external or both	-	-	-	-	-	-	-	-	.042
▪ Scope (delivery produced)	.001	.003	-	.028	-	-	-	-	.009
▪ Scope (scope similarity)	-	-	-	-	-	-	-	-	-
▪ Scope (technical innovation level)	-	.028	.026	-	-	-	.015	-	-
▪ Cost	-	-	-	-	-	-	-	-	-
▪ Duration	-	-	-	-	-	-	-	-	-

Table 3. Tukey test results for significant differences in means on the improving and embedding themes and the organizational contextual variables

Context variable	Theme	Category 1	Category 2	Tukey (p)
Sector of activity	Processes, tools, and techniques	IT	Engineering and construction	.015
			Telecommunications	.029
			Other	<.001
	Communication and influence	Industrial services	Business services	.015
			IT	.026
			Other	.041
	Routinization	IT	Telecommunications	.017
			Industrial services	.012
Organization size	People and organizational learning	Micro	Small	.031
			Medium	.002
			Large	.002
	Implementation	Large	Micro	.004
			Small	.050
Geographic area (7 groups)	Outer context	Africa	Europe	.038
			North America	.005
			Middle East countries	.027
			Australia	.029
		North America	Central and South America	.012
Geographic area (Portugal/Rest of Europe/ Rest of the world)	Processes, tools, and techniques	Portugal	Rest of Europe	.001
	People and organizational learning	Portugal	Rest of Europe	.044
Geographic area (Portugal/Rest of the world)	Processes, tools, and techniques	Portugal	Rest of the world	.001
	People and organizational learning	Portugal	Rest of the world	.022
Project type (Scope - delivery produced)	Processes, tools, and techniques	IT	Engineering and construction	.008
			Other	.020
	People and organizational learning	Business services	Engineering and construction	.015
			IT	.001

Context variable	Theme	Category 1	Category 2	Tukey (p)
	Adopter	Business services	Other	.044
	Routinization	Business services	IT	.037
Project type (Scope- technical innovation level)	People and organizational learning	Standard product and technology	High level of innovation	.022
	General management system	Standard product and technology	High level of innovation	.023
	Communication and influence	Standard product and technology	High level of innovation	.030
			Low level of innovation	.031

6. Discussion

The summary of the significant differences results under the improving and embedding themes for different organizational contexts (see Table 2 and 3) are discussed below. In order to make some inferences and try to understand why these differences are observed, particular responses in the questionnaire were examined. Each item under a theme was analyzed and compared to see how respondents from different categories, have scored these items. For example, on the spotted difference between the sector of activity information and technology and the sector engineering and construction ($p=0.015$) under the theme ‘processes, tools, and techniques’, statistical results show that information and technology sector score higher, i.e., a higher percentage of respondents have selected the 4 (high) or 5 (very high) answers, on the PMIIs under the theme 'processes, tools, and techniques' than respondents in the sector engineering and construction. An example of the statistical results of this analysis is presented in Appendix A, in Tables 5, 6 and 7 for the single items or variables ‘corporate standardization and tailoring of PM processes’, ‘corporate standardization and tailoring of PM tools and techniques’ and ‘Corporate standardization and tailoring of PM tools and techniques’, respectively.

6.1 Sector of activity

When comparing the survey results from different sectors of activity, ANOVA tests show differences under four themes: ‘processes, tools, and techniques’ ($p<0.001$); ‘people and organizational learning’ ($p=0.029$); ‘communication and influence’ ($p=0.016$); and ‘routinization’ ($p<0.001$) (Table 2). However, the Tukey test does not show exactly in which sectors are these differences under the theme ‘people and organizational learning’, because the differences are too small to be shown when the sample is separated on different sectors of activity. However, Burnes et al. [53] argued that there are sectors of activity where change remains relatively slow and therefore organizational learning does not play such an important role as in other sectors.

Under the improving theme ‘processes, tools, and techniques’, the Tukey test shows differences between the categories of information and technology/engineering and construction ($p=0.015$); information and technology/ telecommunications ($p=0.029$), and information and technology/other ($p<0.001$) (Table 3). Particular responses in the questionnaire show that the information and technology sector scores higher, i.e., a higher percentage of respondents have selected the 4 or 5 (high and very high degree of influence) in the Likert-scale, on the PMIIs (items) under the theme 'processes, tools, and techniques' than in the sectors engineering and construction, telecommunication, and others. This might indicate that respondents from the information and technology sector recognize more the importance of standardization of PM processes, tools, and techniques than other sectors. For example, Teubner [54] studied five information and technology program case studies, and recommended the standardization of planning and reporting processes, in order to facilitate the program supervision and the coordination of the projects involved, showing the processes standardization recognition by the information and technology sector. In Portugal, it is commonly perceived by the PM community, that the engineering and construction sector has a lower PM maturity level than the information and technology sector.

Under the theme ‘communication and influence’, the Tukey test shows differences between industrial services/business services ($p=0.015$); industrial services/ information and technology ($p=0.026$) and industrial services/ others ($p=0.041$) (Table 3). Respondents from industrial services sector score lower embedding factors (items) under the theme 'communication and influence' than in the sectors business services, information and technology, and others. This might

happen because, in general, industrial organizations are much more process oriented than people oriented, therefore embedding factors under the theme ‘communication and influence’, oriented to the involvement of people are not perceived as so important as in other sectors. For example, the study of Moe, Dingsøyr and Rollan [55] on two large-scale software development programs, showed the importance of early identifying important schedule meetings, as meetings allow to develop a common understanding of domain knowledge. Indicating the importance of the theme ‘communication and influence’, particularly on the factor ‘stakeholders involvement’, for this sector of activity (see Fig. 2).

Lastly, under the theme ‘routinization’ the Tukey test shows differences between information and technology/ telecommunications (p=0.017); information and technology/industrial services (p=0.012) (Table 3). Respondents from information and technology sector score higher embedding factors (items) under the theme 'routinization' than the sectors: industrial services and telecommunications. ‘Routinization’ is a theme related to the continuous involvement of people on the PMIIs embedment process, and maybe for similar reasons, industrial services are not, in general, people oriented, and respondents scored lower the embedding factors under this theme. For example, the embedding factor continuous ‘feedback on the PMII impacts’ in the organization is scored much higher by information and technology respondents than respondents from industrial services sector.

6.2 Organization size

When the responses for different organization sizes (large, medium, small and micro) were compared, differences were observed under only two themes: ‘people and organizational learning’ (p=0.001) and ‘implementation’ (p=0.002) (Table 2).

Under the theme ‘people and organizational learning’ the Tukey test shows differences between micro/small (p=0.031), micro/medium (p=0.002), and micro/ large (p=0.002) (Table 3). Respondents from micro organizations scored higher PMIIs under the theme 'people and organizational learning' than small, medium and large organizations, which from the researcher’s professional experience, was also expected. People in micro organizations assume a much important role on the management of projects than for example on the ‘standardization of project management processes, tools, and techniques’ which are very important in large companies.

Furthermore, the Tukey test shows differences between large/small (p=0.050) and large/micro organizations (p=0.004) under the theme ‘implementation’. Respondents from large organizations score lower embedding factors under the theme ‘implementation’ than respondents from micro and small organizations. A possible explanation is that the factor ‘external collaboration’ under the theme ‘implementation’ might be more important for micro and small organizations than for large companies, because the necessary knowledge to implement a PMII most probably exists in large organizations rather than in micro or small organizations, which need more external support.

6.3 Geographic area

Respondents were from 75 different countries. Respondents were grouped into seven different geographic areas: Europe, North America Central and South America, Middle East countries, Asia, Africa and Australia. Ex ante, the researcher believed that these areas could have significant cultural differences that might impact on the perceived influence of the key PMIIs and embedding factors by respondents.

Comparing the responses from these seven different geographic areas, the ANOVA test only shows differences between the different geographic areas under the theme: ‘outer context’ (p=0.002) (Table 2). Analysing the results from the Tukey test, there are differences between Africa/Europe; Africa/North America; Africa/Middle East countries and Africa/Australia and also between North America/Central and South America (Table 3). Respondents from Africa score higher embedding factors (items) under the theme ‘outer context’ than in Europe, North America, Middle East countries and Australia. Respondents from Central and South America score higher the embedding factors under the theme 'outer context' than in North America.

These differences are not surprising, because in general, less developed countries, as in Africa, are much more influenced by the 'outer context' than more developed countries, as in North America. Organizations from more developed countries usually have better defined internal strategies and are not so directly influenced by organizational external events.

Because the participation of Portugal is very high (41%), and the results are particularly relevant in this context, as this research was funded by the Portuguese government, additional comparative analysis was conducted, dividing the sample in three respondent groups: Portugal, rest of Europe, and rest of the world.

ANOVA test shows differences between the three different geographic areas under the themes 'processes, tools, and techniques' (p=0.001) and 'people and organizational learning' (p=0.044) (Tables 2 and 3). Respondents from Portugal score higher PMIIs under the theme 'processes, tools, and techniques' than in the rest of Europe. On the other hand respondents from Portugal score lower initiatives under the theme 'people and organizational learning' than the rest of Europe. In general terms, Portugal is less developed than the most industrialized countries of Europe, and this might be the reason for Portuguese respondents, in general, be more process oriented than people oriented. However, there were no spotted differences between the rest of the world, maybe because, in the rest of the world group, there is a large mix of countries, from Africa to North America.

6.4 Project types: scope, time and cost

When comparing questionnaire responses by different project types in terms of scope, time and cost, there were statistically significant differences only under different types of scope. There were no significant differences on the improving and embedding themes, when comparing responses from respondents with experience of different project durations (up to 3 months to more than 2 years), as well as experience of different project costs (less than 10.000 to more than 5.000.000 euros).

Under experience of different project scopes, three contextual variables were studied: 'type of deliverable produced'; 'technical innovation'; and 'similarity of projects". However, on the variable 'similarity of projects' no significant differences between responses were observed (respondents were asked if the projects they usually work on are similar to one another –'fairly similar' or different – 'quite different').

Note that the variable 'type of deliverable produced' by a respondent's typical project was surveyed because an individual working in engineering and construction or business services sector maybe working in information and technology projects. So, when the results from different 'type of deliverable produced' were compared, differences were observed under four themes: 'process, tools, and techniques' (p=0.001); 'people and organizational learning' (p=0.003); 'adopter' (p=0.028); and 'routinization' (p=0.009) (Table 2). Differences in responses on all of these themes were also observed when the 'sector of activity' variable was studied, except on the theme 'adopter'.

Under the theme 'process, tools, and techniques' the Tukey test shows significant differences between information and technology/ engineering and construction (p=0.008); and information and technology/ other (p=0.020). Respondents from information and technology project types score higher PMIIs under the theme 'processes, tools, and techniques' than respondents with engineering and construction project types. Maybe for the same reason already mentioned under the contextual variable 'sector of activity' of the organization.

Furthermore, under the theme 'people and organizational learning' the Tukey test shows significant differences between business services/engineering and construction (p=0.015); and business services/ information and technology (p=0.001). Respondents from business services projects score higher PMIIs under the theme 'people and organizational learning' than respondents from engineering and construction and information and technology projects, as well as, in the theme 'adopter' from other project types. This might indicate that business services projects are more focused on people than, for example, engineering and construction, which might be more focused on the project's product deliveries.

Additionally, under the theme 'routinization' the Tukey test shows significant differences between business services/ information and technology (p=0.037). Respondents from business services project types score lower embedding factors

under the theme 'routinization' than respondents from information and technology project types. It is difficult to suggest a reason for this difference.

Lastly, when comparing the results from project scope variable ‘technical innovation’ (three categories surveyed: high level of innovation; low level of innovation; and standard product and technology), significant differences were identified under three themes ‘people and organizational learning' ($p=0.028$); 'general management system' ($p=0.026$); and ‘communication and influence’ ($p=0.015$). Under the themes ‘people and organizational learning’ and ‘general management system’ the Tukey test shows significant differences between standard product and technology/ high level of innovation ($p=0.022$) and ($p=0.023$) respectively. Respondents with a standard product and technology project scope score lower PMIIs under the themes: ‘people and organizational learning’ and ‘general management system’ than respondents with a high level of innovation project scopes. This might suggest that the higher is the project scope level of innovation, the more critical the role played by these two themes. Under the theme ‘communication and influence’ the Tukey test shows significant differences between the project categories ‘standard product and technology’/‘high level of innovation’ ($p=0.030$); and standard product and technology/ low level of innovation ($p=0.031$). Respondents involved with a ‘standard product and technology’ project scope tend to score lower embedding factors under the theme ‘communication and influence’. This suggests that respondents from projects with a high level of project innovation tend to value more communication, which is also not a surprise.

7. Conclusions

The analysis of questionnaire responses showed that the improving and embedding themes are dependent to a certain extent on the organizational context, namely: sector of activity, organization size, geographic area and project types. The themes where more significant differences were observed were the two improving themes: ‘people and organizational learning’ and ‘processes, tools, and techniques’.

In order to highlight the main results obtained, Table 4 shows a summary of the statistically significant dependencies spotted on the data analysis ($p<0.05$). For example, the first row of Table 4, shows that respondents from information and technology sector perceived more relevance of the PMIIs under the improving theme ‘processes, tools, and techniques’ than the sectors engineering and construction and telecommunications.

The main contribution of this paper is the provision of relevant information for decision makers in organizations interested in increasing their performance in the management of projects, by identifying their priority to certain PMIIs and focusing their attention on their respective embedding factors, taking into account the organizational contextual variables. Therefore, it contributes to guide professionals on making use of such framework in their organizations. Attending to the results summarized in Table 4, for example for the embedding process, organizations from the information and technology sector may give more attention to factors under the theme ‘routinization’ than organizations in the industrial services sector. Organizations from African countries may give more focus to factors under the theme ‘outer context’ than organizations from countries in Europe, North America, Middle East and Australia.

Nevertheless, the significant differences in response found associated with organization context were limited; and therefore the framework for improving and embedding PM practice seems reasonably robust as a generally applicable framework. The results support both the image of PM as a field with relatively uniform generic practice, as well as showing some differences across different organizational contexts, as also found by the Besner and Hobbs [56] study of the PM tools and techniques most used by PM practitioners.

We acknowledge the drawbacks of this research, which mainly resulted from inferences made to try to understand why certain categories from the organizational context variable identified by the Tukey test are influencing the spotted differences (see Table 3). Therefore, particular responses in the questionnaire were examined. Each item or variable under a theme was analyzed and compared to see how respondents from different categories have scored these items. The analysis was made taking into account the percentage of respondents that made their selection with the two highest scores, 4 (high) or 5 (very high). The researchers assume full responsibility for the given final interpretation.

Table 4. Summary of the improving and embedding themes dependency on the organizational contextual variables

Category (group)	Perceived relevance	Of the PMIIs/ embedding factors under theme	Category (group)
Information and technology sector	more	Processes, tools, and techniques	• Engineering and construction • Telecommunications
		Routinization	• Industrial services • Telecommunications
Industrial services sector	less	Communication and influence	• Business services • Information and technology
Micro organizations	more	People and organizational learning	• Small • Medium • Large
Large organizations	less	Implementation	• Micro • Small
Africa countries	more	Outer context	• Europe • North America • Middle East countries • Australia
Central and South America countries	more	Outer context	• North America
Type of deliverable produced: Information and technology projects	more	Processes, tools, and techniques	• Engineering and construction
Type of deliverable produced: Business services	more	People and organizational learning	• Engineering and construction • Information and technology
		Routinization	• Information and technology
Standard product and technology project scopes	Less	People and organizational learning and General management system	• High level of innovation projects
		Communication and influence	• High level of innovation projects • Low level of innovation projects

Additionally, the framework for embedding useful project management improvement initiatives, itself, has some limitations, namely the unknown effects of the interactions between different embedding factors, which have not been studied before. Furthermore, the framework is limited to the management of 'individual projects'. However, the extension of the framework to embrace the worldview of PM (i.e., project, program and portfolio management) might bring theoretical and some practical contributions on its dependency on the organizational context.

Future research work can expand the scale of the survey to consolidate the research findings. Case studies will be very valuable, namely in understanding the weight that different organizations (industry, size, strategy, geographic area, project types) place on different PMIIs and factors in promoting the embedment of PM practice in organizations. The results of exploratory studies such as this require replication.

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Appendix A. Survey detailed results

Table 5. % of Respondents that have selected the 4 or 5 answers to Variable 1: 'Corporate standardization and tailoring of PM processes'

	Engineering & construction	**Business services**	**IT**	**Telecommunications**	**Industrial services**	**Other**
1- Very low	6%	2%	0%	3%	0%	4%
2- Low	9%	9%	5%	8%	0%	13%
3- Medium	25%	20%	18%	28%	38%	19%
4- High	33%	27%	39%	32%	42%	35%
5- Very high	27%	41%	38%	29%	19%	29%
Total % of 4 and 5	**60%**	69%	**76%**	62%	62%	64%

Table 6. % of Respondents that have selected the 4 or 5 answers to Variable 2: 'Corporate standardization and tailoring of PM tools and techniques'

	Engineering & construction	**Business services**	**IT**	**Telecommunications**	**Industrial services**	**Other**
1- Very low	4%	4%	0%	5%	0%	3%
2- Low	14%	8%	7%	9%	12%	16%
3- Medium	27%	26%	21%	32%	27%	28%
4- High	41%	38%	42%	40%	46%	38%
5- Very high	14%	25%	31%	14%	15%	16%
Total % of 4 and 5	**55%**	63%	**73%**	54%	62%	53%

Table 7. % of Respondents that have selected the 4 or 5 answers to Variable 3: 'Corporate standardization and tailoring of PM information system'

	Engineering & construction	**Business services**	**IT**	**Telecommunications**	**Industrial services**	**Other**
1- Very low	5%	6%	2%	6%	4%	6%
2- Low	16%	9%	7%	9%	20%	15%
3- Medium	28%	29%	21%	31%	20%	29%
4- High	32%	34%	46%	35%	40%	35%
5- Very high	19%	21%	24%	18%	16%	16%
Total % of 4 and 5	**51%**	55%	**70%**	54%	56%	51%

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Gabriela Fernandes is a researcher and an invited assistant professor at the University of Minho, Portugal, on project management. She spent 10 years in the coordination and management of projects in different industries. Throughout her career, she served as an executive director of some companies. She was responsible for various communications and author of several publications in the project management area. She developed and taught many project management training courses and as a consultant, coordinated the implementation of project management systems, as well as the implementation of project management office structures. She holds a degree in industrial engineering and management from the University of Minho, a master's degree in industrial engineering with specialization in evaluation and project management and innovation from the same university, and a PhD in management from the University of Southampton, United Kingdom. She was director of the PMI Portugal Chapter, and is a PMP® credential holder.

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Project resilience: a conceptual framework

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Project resilience: a conceptual framework

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Abstract:
Resilience is a novel but promising concept in project management studies. Resilience thinking can help projects maintain their performance through flexible, systemic and context-specific approaches once faced with disruptive events. That said, the main goal of this paper is to advance an interdisciplinary understanding of project resilience by proposing a definition and a conceptual framework of this concept. To achieve this article's objectives, the literature on project risk management is first reviewed to identify current research effort and limitations of dealing with disruptions. Consecutively, the concept of resilience in its broader applicability is explored, where two dimensions are sieved; awareness and adaptive capacity. The literature on the new concept of project resilience is also scrutinized, where its novel nature, the lack of scientific studies to conceptualize it, and its significance to project management are demonstrated. These facts helped propose a definition and a conceptual framework of project resilience, where a set of relationships are instigated, which constitute a base line to perform further disquisitions to assess their validity. Implications for future contributions advocate conceptual exchanges with more advanced research fields (e.g. organizational resilience). These exchanges can assist in the development of indicators to evaluate the ability of projects to deal with disruptive events and enhance their resilience.

Keywords:
project risk management; resilience; project resilience; awareness; adaptive capacity; recovery.

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1. Introduction

A project is a temporary organization, where diverse and skilled resources work together, on a specific endeavor, for a limited period of time, in order to achieve unique objectives [1]. During the project life-cycle, disruptive events, either known or unknown at the beginning of the project, can cause interruption of planned tasks, and, in many cases, the whole project to fail [2], [3]. These events can affect "*everything from technical feasibility to cost, market timing, financial performance, and strategic objectives*" [4, p. 1]. Thus, responding to these disruptions is considered a major challenge for practitioners as well as a relevant research topic [5], [4], [3], [6].

Project risk management (PRM) is the knowledge area responsible for dealing mainly with disruptions. It aims to reduce the impact of negative risks (disruptive events that may or may not occur [6]) while taking advantage of positive risks to help ensure project success [7], [8]. However, current PRM practices are often described as time-consuming and inflexible under high-uncertainty conditions [9]. These practices tend to focus on sources of disruptions, to reduce vulnerabilities, without developing a general capacity to recover from their negative consequences [10]. Therefore, these practices "… *should incorporate the capacity for projects to evolve in response to the consequences of unexpected risks"* [10, p. 410].

To overcome the PRM limitations, recent studies have suggested integrating the concept of resilience into project management [2], [3], [5], [11]. Resilience can be broadly defined by the system's ability (e.g. ecological, organizational, psychological, etc.) to be aware of its surroundings and to adapt for recovering once faced with disruptions [12]. This multidimensional concept has been the subject of several research studies over time in many disciplines and domains. The concept of resilience helps recognize the inherent fallibility of a project so it can successfully recovers, when confronted with disruptive events [5].

Therefore, the aim of this study is to define the concept of resilience from a project management perspective, which requires an in-depth analysis of its various components. A conceptual framework of project resilience is formulated to set the foundations for future studies of resilience in project management. This article tackles Thomé et al.'s challenge when they recently suggested that [13, p. 1342]*:* "*the lack of coverage of the concept of resilience project management literature deserves more attention by scholars and is an opportunity to aid project management*."

Consequently, this paper is organized into four parts. First, the literature on PRM, resilience and project resilience is reviewed. The objectives are to explore the limitations of PRM practices, to sieve the resilience dimensions in their broader applicability, and to understand the current research efforts on the concept of project resilience. Second, the methodology adopted to achieve this study is discussed. Third, a definition and the conceptual framework of project resilience are presented where the relationships between its building blocks are exposed. Finally, implications for future disquisitions are proposed.

2. Literature review

2.1 Project Risk Management

The knowledge area of Project Risk Management includes the processes to identify risks, analyze risks, plan risks' responses, and control risks through the project life-cycle [7], [8]. It adds value to other project management methods by helping in the mitigation of uncertain conditions [6], [14]. Project risk management has a direct effect on project success because it maximizes the efficiency of processes such as decision-making and communication, among others [15].

Many approaches have been proposed to manage project risks. The latter often refer to complex and sophisticated concepts and architectures. To name few examples, Lee and Baby (2013) [16] developed a conceptual framework for risk management based on the principles of service-oriented architecture (SOA). According to these researchers, this framework helps identifying risks related to the dynamic interactions that exist between human resources, processes and

technology. Alternatively, López & Salmeron (2014) [17] have proposed a fuzzy logic system to mathematically model the risks associated with the maintenance of ERP implementation projects. This system makes it possible to analyze the impacts of risks on the objectives of the project with a reasonable degree of precision.

Despite this advancement, PRM still faces several challenges when dealing with disruptive events mostly due to the project increased complexity [4], [18]. This complexity is caused by many varied and interrelated elements operationalized in terms of differentiation and interdependence [19]. It mainly leads to "*uncertainties, ambiguities, and arrays of risk factors that are often intricately connected*" [4, p. 21]. Uncertainty is defined as the inability to evaluate the project's objectives and characteristics, as well as the consequences of actions and decisions on the entire project environment [20]. It tends to be high at the beginning of a project and is supposed to diminish when approaching the closure phase [6], [21].

Alternatively, ambiguity is "*associated with lack of clarity because of the behavior of relevant project players, lack of data, lack of detail, lack of structure to consider issues, working and framing assumptions being used to consider the issues, known and unknown sources of bias, and ignorance about how much effort it is worth expending to clarify the situation.*" [6, p. 99]. Ambiguity often derives from cultural differences and optimism levels by stakeholders [22] consequently increasing the probability of project failure [14].

Finally, As mentioned by Vidal [8], non-linear and dynamic interdependencies exist between the components of the project and between the project and its environment. So, every change in any facet of the project may propagate through the other elements and therefore lead to additional, unforeseen and unpredictable risks [23].

2.2 Limitations of Project Risk Management

As noted by Crawford et al. (2013), PRM practices are criticized for being time consuming and inflexible when dealing with disruptive events that require quick response. Geambasu (2011) explains this inflexibility by referring to the "hard" theories behind these practices. "*These theories emphasize the planning and control dimensions of a project anchored in a system of engineering methods and related tools*" [3, p. 19].

She also mentions that in many cases the poor performance of projects is due to the optimism bias and strategic misrepresentation of the projects' scope, budget and schedule. The latter lead stakeholders to ignore or underestimate risks [3].

On the other hand, Blay (2017) notes that current PRM practices focus on the source of the disruptive events in order to minimize the level of vulnerability. For instance, risk management helps manage known sources, whereas uncertainty management and crisis management focus on unknown sources [7], [6], [11]. This vulnerability-reduction perspective is limiting because the "*focus is on identifying strategies to implement on disruptions perceived and also work towards predicting threat, without critically developing the general capacity (response and preparedness) for dealing with shock (sudden distress) these disruptions cause*" [2, p. 1].

To address these challenges, the following avenues are proposed:

1. More flexible and context-specific methods need to be integrated in PRM. This adds a dynamic and proactive perspective to PRM where the focus is on the evolution of the project, and its ability to deal with disruptive events during its life-cycle [9].
2. PRM practices necessitate progressing beyond the common and simplistic perspective of detecting obvious risks during the project planning phase and monitoring and controlling them on a regular basis. New methods are required to cope with unknown, unpredictable and completely unexpected disruptive events [10].
3. The focus should not only be on vulnerability reduction, but also on factors and conditions' identification that enables a successful response to disruptive events [3]. Recognizing the inherent fallibility of projects helps understand how projects maintain and recover their performance once faced with disruptive events [5].

That is why recent academic research are exploring the concept of resilience in project management. In fact, "*responding to emerging unknown unknowns requires that we make our systems—and, by extension, our development projects located within these systems—more resilient. Resilient projects are nimble, flexible, and adaptable*" [10, p. 412].

2.3 Resilience and Its Definitions

Resilience is a widely used concept in many domains including ecology [24], psychology [25], climate change [26], critical infrastructure [27], [28] and organization science [29]–[31]. Its definitions vary depending on the subject to be analyzed whether it is a community, an organization, a project, an engineering system or others [12].

In 1973, Holling [24] pioneered studies in resilience from the ecological perspective. He differentiates between stability and resilience. Stability is the ability to emphasize the presence of a unique steady state for a system, and to conserve equilibrium around it. Resilience, on the other hand, focuses on maintaining existence of function. It is related to a complete change of the system's state into another regime of behavior.

Later, in 1996, Holling [32] advanced his research and distinguished between engineering and ecological resilience. Engineering resilience accentuates efficiency, constancy, rigidity and predictability of a system as measured by resistance to disturbance and speed of recovery [12], [32]. Consequently, a system that follows this perspective of resilience is designed to recover quickly from small disruptive events with difficulties to recover from the large ones. It is a highly controlled system that works within limited possible states [33].

Alternatively, ecological resilience focuses on the persistence, change, renewal, reorganization and unpredictability of a system. It is measured by the levels of disturbance that can be absorbed before necessitating changes to the system's structure (changes are made on variables and processes that operate the system behavior). Hence, the system that follows this perspective of resilience endures larger disruptive events through adaptation and evolution. It functions within an expansive spectrum of possible states and tends to return gradually to its equilibrium point. Under certain circumstances this system may switch to a new equilibrium point with major changes to its requirements and structure [33].

The differentiation between engineering resilience and ecological resilience shaped the studies on resilience from many perspectives [12], [34].

Table 1 presents a summary of the resilience's definitions in diversified contexts. From these definitions, key words and key activities are observed. First, resilience usually refers to a specific unit of analysis (a system, an organization, an individual, etc.). Second, it often corresponds to a function (capacity, ability, capability, etc.) of the unit to be aware of its surroundings (proactive activities) and adapt (reactive activities) to recover following a disruptive event. Therefore, resilience is composed of two dimensions: awareness and adaptive capacity [12], [35]–[38].

Table 1. Definitions of resilience

Context	Definition	Reference
Ecological systems	Measure of resistance of systems, and ability to absorb shocks, while maintaining relationships among state variables.	(Holling, 1973) [24]
Ecological systems	The capacity of a system to absorb a disturbance and reorganize itself while retaining its functionality and structure.	(Walker et al., 2004) [39]
Engineering systems	The ability to sense, recognize, adapt and absorb disruptions.	(Hollnagel et al., 2006) [40]
Organizational	The ability of firms to develop specific responses to disruptions and engage in transformative activities.	(Akgün & Keskin, 2014) [41]
Organizational	The ability of an organization to adapt to changes and maintain its operation.	(Murray, 2013) [42]
Organizational	The capacity to adapt to changes in the environment to prevent disruptions.	(Mafabi et al., 2013) [43]

Context	Definition	Reference
Psychology	The ability to improvise, accept reality, and maintain the belief that life is meaningful.	(Coutu, 2002) [25]
Socio-ecological systems	Ability to maintain functionality of a system under perturbations, or ability to maintain elements when disturbances alter system structure or function.	(Walker et al., 2004) [39]
Psychology	Acquired capacity to rebound from adversity.	(Luthans et al., 2006) [44]
Disaster management	The application of learning, innovation, and development skills at individuals, communities and operational level to recovery from disasters.	(Crawford et al., 2013) [9]
Disaster management	The ability to function at a higher psychological level based on individual abilities and experiences.	(Paton & Johnston, 2001) [45]
Engineering systems	The ability to anticipate, adapt and recover from disruptions.	(Madni & Jackson, 2009) [46]
Engineering systems	The ability of a system to adjust function to disturbances and maintain operations under certain conditions.	(Saurin et al., 2014) [47]
Ecological systems	The magnitude of disturbance absorbed by a system before its structure and behavior are transformed.	(Gunderson, 2000) [48]
Supply chain	The ability of the supply chain to prepare for unexpected events, adapt to and recover from disruptions.	(Ponomarov & Holcomb, 2009) [34]
Supply chain	The ability of a system either to return to its original state or to shift to a superior state desirable following disturbance.	(Carvalho et al., 2012) [49]

2.3.1 Awareness

Awareness is a holistic understanding of the system's internal and external elements [50], [51]. This understanding enhances responsiveness to disruptive events due to effective monitoring of the changes in the system environment [25], [44]. Responsiveness means knowing the actions and/or the modes of functioning that need to be adopted in order to face future disruptions, while monitoring is knowing what to look for and what can affect the system's performance [40].

Awareness requires proactive behavior towards disruptive events and knowledge of the system inputs, outputs and vulnerabilities [27]. Vulnerability can be represented by a system's disturbance thresholds that can potentially prevent it from maintaining an acceptable functioning [52]. Hence, deficiencies in system internal connectivity, and lack of available resources, among other factors, are internal and external threats that increase susceptibility to disruptive events [27]. The longer the system is vulnerable, the most likely it will face disruptions, and its probability to fail increases [53]. The level of the system's vulnerability is measured by the gap between available versus required resources to operate [50].

2.3.2 Adaptive Capacity

The concept of adaptive capacity has its origins in biology and denotes structural and functional changes in species as a result of an environmental change [54]. It refers to structural and behavioral transformation [55]. Therefore, adaptive capacity requires a specific system (ecological, organizational, etc.) to be aware of its surroundings in order to alter its structure, operations, and strategies and to cope with disruptive events [56].

From the engineering perspective, adaptive capacity is the ability of the system to return quickly to its equilibrium point once faced with a disruptive event. Therefore, the speed to return to the equilibrium point is a main characteristic of the system. On the other hand, adaptive capacity from the ecological perspective, also includes the ability to transform its structure and behavior when a return to its equilibrium point is no longer viable [32].

Woods & Wreathall [57] and Vogus & Sutcliffe [58] also confirm this by distinguishing two types of adaptive capacity. The first type is when the system bounces back using existing predetermined planning and strategies. The second type is when the system develops new capacities to respond to events that are outside of its preconfigured design. Accordingly, as proposed by Hémond [27], a system can adapt by the application of existing available responses, of an existing response in a new context, or of a novel response to address a disruptive event.

However, regardless of the adaptive capacity's types and the perspective from which it is perceived, the main objective of the adaptation, once faced with a disruptive event, is to recover. This recovery can be achieved by returning to a steady state or by changing to a new equilibrium point (a new state) [34], [59]. Learning through adaptation is essential to reinforce what worked well and change or adjust what was considered a failure [40], [60]. Thus, knowing what happened to acquire the right lessons can improve the system's global awareness and its capacity to adapt to future disruptive events [59]. This learning can also be achieved through negative feedback [34], which allows systems to cross boundaries, explore alternative new situations and collect information to avoid potentially non-viable states. Negative feedback is also the main principle of the cybernetics theory, which is mainly concerned with the functioning of self-regulating systems. To this matter, learning through negative feedback loop "*minimizes discrepancies between environmental characteristics and relevant reference criteria*" [61, p. 238]. Thus, resilience is linked to the cybernetic theory through the adaptive capacity dimension especially from the "engineering resilience" perspective [62].

2.4 Project resilience

The concept of project resilience is still new and largely undefined and ambiguous despite the growing recognition of this concept within academic publications [13].

Geambasu [3] was the first to introduce the concept of project resilience after an empirical study on major infrastructure projects. The author defines it as "*1) the project system's ability to restore capacity and continuously adapt to changes 2) to fulfill its objectives in order to continue to function at its fullest possible extent, in spite of threatening critical events.*"[3, p. 133]. Geambasu proposed a framework for project resilience composed of three levels; Strategy, culture and structure. For each level, a set of resilience enablers (project resilience facilitators) is suggested. For instance, the legitimacy and clear vision of the project objectives facilitate the strategic level of resilience. On the other hand, partnerships, risk attitude, safety culture, effective communication, proactive planning, positive work relationships, and the diversity of skills and expertise are enablers for the cultural level of resilience. Finally, having a flat organizational structure to facilitate communication, having a financial structure, using technology to reduce complexity, and having flexible contracting practices are all enablers for the structural level of resilience.

In 2017, Blay [2] conducted an empirical study to conceptualize project resilience. Thus, the author defines this concept as the capacity to respond to, prepare for, and reduce the disruptions' impact to recover and ensure successful completion of project objectives. Her conceptual framework of project resilience is composed of four dimensions; proactivity, coping ability, flexibility, and persistence. Each dimension has several antecedents (similar to enablers in Geambasu's conceptual framework of resilience). First, project management procedures, project management mechanisms and experience are antecedents for proactivity. Second, contract, training, contingency and experience are antecedents to the coping ability dimension. Third, open-mindedness, planning, continuous monitoring and continual identification of ideas are antecedents for flexibility. Finally, the continuous monitoring, planning, and negotiation are the antecedents for the persistence dimension.

Turner & Kutsch (2015) [11] proposed another interpretation of project resilience. These authors elaborated on the meaning of project resilience and defined it as the art of detecting changes in the project environment, understanding these changes, planning answers, minimizing damage when a change occurs, and adapting to a new reality.

Prevention, response, and adaptation were also present in the definition of project resilience proposed by Giezen et al. (2015) [63]. These researchers mentioned the presence of two types of project resilience; reactive resilience and proactive resilience. Reactive resilience takes into consideration that the project is in a stable situation that allows it to protect itself against disruptive events. On the other hand, proactive resilience emphasizes the project's environment and considers that an unstable environment requires some form of adaptation. For these authors "*Resilience related to the availability of a redundancy of options, alternatives, and recombinant pathways*" [63, p. 171].

Alternatively, being a significant part of a project, the resilience of the project team is an important aspect of the project's resilience as a system [60]. Amaral et al. (2015) [64], and after conducting a quantitative study among project teams, define the team's resilience as the team's ability to deal with issues, bypass obstacles, or resist to adverse cases

without being ruptured. They suggest 10 actions to improve the team's resilience. These actions emphasize the collaboration and solidarity between project team members, the recognition, appreciation and efficient use of the team members' competences, the ability to learn from mistakes, the stimulation of a positive team environment, and the capability to be creative and innovative. Table 2 presents the definitions of project resilience found in the literature.

Table 2. Definitions of project resilience

Definitions	Reference
The ability to restore capacity and continuously adapt to changes, and to achieve its objectives in the face of disruptive events.	(Geambasu, 2011) [3]
The capacity to evolve in response to f risks emerging after the project planning stage.	(Schroeder & Hatton, 2012) [10]
The capacity to maintain purpose and integrity under external or internal shocks.	(Hillson, 2014) [23]
The art of noticing, interpreting, containing, preparing for and recovering from disruption.	(Turner & Kutsch, 2015) [11]
The capacity to overcome unexpected events.	(Giezen et al., 2015) [63]
The ability to cope with uncertainty.	(Zhu, 2016) [5]
The capability to respond to, prepare for and reduce the impact of disruptions caused by changes in the project environment.	(Blay, 2017) [2]

As noticed and already discussed, the concept of project's resilience still new and largely undefined and ambiguous despite the growing recognition of this concept within academic publications [13]. In fact, resilience, in project management, can help projects maintain their performance through flexible, systemic and context-specific approaches [9], [65]. Resilience helps focus on the project behavior, and the efficient utilization of resources once faced with disruptive events or conditions [66]. In other words, resilience is concerned with how processes, methods, organizational structure, etc. evolve and realign to face disruptive events. This is achieved through continuous monitoring of the project complexity and uncertainty levels during the project life-cycle [5]. As mentioned by Schroeder and Hatton (2012) [10], the focus should be on redundancy, diversity, transparency, decentralization in processes and structures, decreased connectivity between methods, and increasing communication and sharing of information. In fact, unlike the critical success factors that do not take into consideration the context of the project once faced with the disruptive event, resilience offers insights to which elements mostly contribute to maintain an acceptable project functioning at a specific point in time (the time once the project is faced with a disruption) [3].

3. Methodology

This theoretical article aims to develop a clear understanding of the concept of project resilience. Therefore, a theory building approach is adopted to develop the project resilience conceptual framework and to set the foundation for future research studies. The main characteristic of theory building is to develop definitions and relationships, and to compare existing emergent key concepts, constructs and theories in order to draw conclusions [67]–[69].

Accordingly, the importance of developing a conceptual framework is to provide a general understanding of the main elements of a concept [69]. Therefore, the proposed conceptual framework of project resilience will set the basis for future research activities on this newly emergent concept by borrowing the previously discussed dimensions of resilience; awareness and adaptive capacity. Consecutively, this framework will also describe the link that exists between current project risk management practices and the concept of resilience to successfully respond to disruptive events during the project life-cycle.

The development of the project resilience conceptual framework is achieved by following the same process as many authors (e.g. the works of [34], [70]) who utilized literature review to establish a conceptual framework. As noted by Burnard and Bhamra [69] "*conceptual frameworks aid in not only providing construct validity, but also provide an outline for future research activities*" [69, p. 5585]. Therefore, to build this conceptual framework, the literature was reviewed to identify current research efforts and limitations of project risk management. Consecutively, the concept of

resilience in its broader applicability was reviewed where two main dimensions were sieved: awareness and adaptive capacity. The literature on the newly introduced concept of project resilience was also reviewed where its novel nature, the lack of scientific studies to conceptualize it, and its significance to project management were demonstrated. This confirmation will help propose a definition and a conceptual framework of project resilience where a set of relationships will be instigated. The definition and the conceptual framework, proposed in this paper, constitute a base line to perform further studies to assess their validity.

4. Project Resilience: A General Definition and Conceptual Framework

In this section, a definition and a conceptual framework for project resilience are presented. Thus, given the plethora of definitions and perspectives summarized in the previous literature review, a generalized definition of project resilience is proposed: It is *the capacity of the project system to be aware of its surroundings and vulnerabilities, and to adapt in order to recover from disruptive events and achieve its objectives.* This definition borrows the dimensions from the previously reviewed literature on resilience; awareness and adaptive capacity. It also emphasizes the visualization of the project as a system.

4.1 Project as a System

The main unit of analysis in studies on resilience is the system [12], [34], [71]. Systems are delimited by spatial and temporal boundaries, determined by structure and objectives, and influenced by their surrounding environment [72], [73]. Two types of systems are distinguished: while open systems constantly interact with their environments by exchanging information, resources, or energy, closed systems are isolated from their environments. As a result, closed systems are more autonomous and able to self-adapt [74], [75], whereas open systems are required to adapt to changes imposed by the environment in order to preserve its equilibrium. Therefore, either self-adaptation or adaptation to environmentally imposed changes are crucial to the survival and functionality of systems [72].

Figure 1 presents the project system and the interaction with its environment.

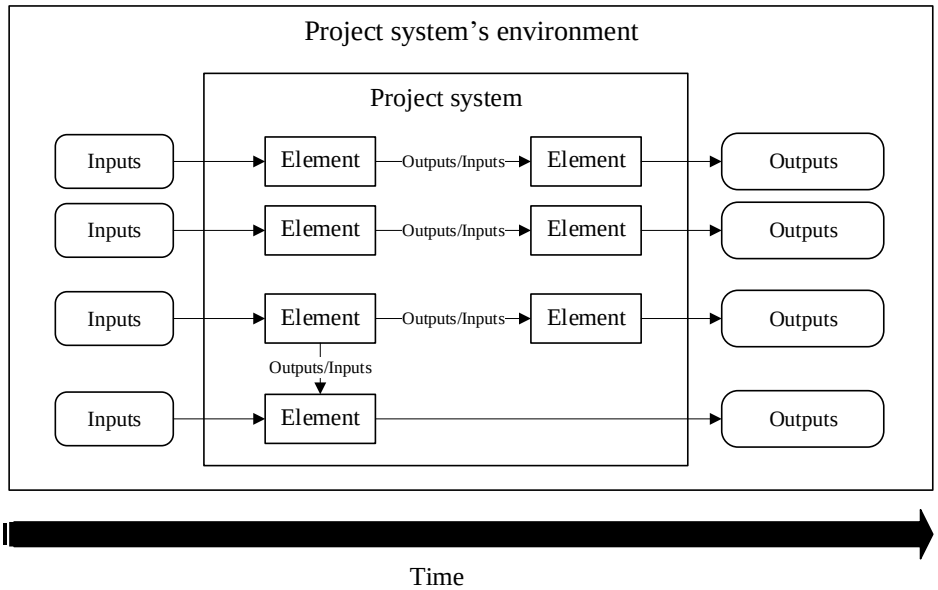

Fig. 1. Representation of the project system and its interaction with its environment

Applications of systems thinking in project management have been proposed for a number of years [5], [8], [75]–[77]. From the system perspective, projects are composed of several interdependent subsystems including processes, activities, tangible and intangible resources, and information. Those elements or activities convert inputs into outputs, which are mostly resources such as tangible and intangible assets, and knowledge [27]. The project system's environment is the main provider of inputs and the main receptor of outputs. It is where the project goes through its life-cycle to fulfill its objectives. Given its continuous interaction with the environment, it must be concluded that project systems are open systems.

4.2 Project Resilience: Conceptual Framework

The framework provided by the concepts of awareness and adaptive capacity related to resilience also applies to the specific context of project management. Project resilience depends on awareness of disruptive events and of the gap between available versus required resources; projects' vulnerabilities.

Adaptive capacity is also central to the transformation (e.g. changes on structure, processes, methods, etc.) of the project system to recover from negative known or unknown risks (*disruptive events or conditions that may or may not occur*) [3], [5]. Therefore, recovery is the result of a successful adaptation. For instance, when unpredicted changes related to budget or schedule contingencies, critical paths, or client satisfaction provoke modifications in the project trajectory and development, project systems can either adapt and restore the original baseline, or, after approval of main stakeholders, create a new baseline [78]. Both cases exemplify successful recovery as they avoid a terminal or dead state where the project can no longer achieve its original objectives [14]. Thus, shifting from a state to another while avoiding the "death state" is a main attribute of a project system. Furthermore, project resilience should be classified as an example of ecological resilience, as projects exhibit multiple baselines or equilibrium points over time (possible multiple baselines).

To this matter, three adaptation strategies are suggested at the elements level of the project's system: deploying new inputs recruited from other project elements or environments, changing input-output conversion mechanisms, or changing outputs after consultation with stakeholders. The relationship between awareness and adaptive capacity is essential to ensure an efficient recovery once faced with a disruptive event. In fact, awareness is the force driving the project's capacity to adapt when facing a disruptive event. Thus, the following relationship between awareness and adaptive capacity is proposed:

RP1: the greater the project's awareness, the better it adapts and successfully recovers once faced with disruptive events.

Developing project awareness and its capacity to adapt when facing disruptive events, increase the project's capacity to assess the impact of events, actions and decisions as to predict and control the project evolution [20]. This is done by evaluating the project elements' objectives and characteristics, as well as the actions and decisions' consequences on the entire project environment [21]. In other words, developing project resilience helps manage the consequences of uncertainties over the project life-cycle and efficiently deal with unpredictable or unknown risks [10], [79]. Therefore, the following relationship between project resilience and managing uncertainties is proposed:

RP2: The greater the project's resilience, the better is the management of uncertainties during the project life-cycle

Developing project resilience helps deal with ambiguities. It improves the stakeholders' knowledge about the elements of the project and their characteristics. It helps eliminate the bias of the stakeholders' perception about the project and its environment. This perception is influenced by the stakeholders' mental representations and cultural differences [22]. Therefore, a project without well-developed awareness and adaptive capacity will have great challenges to face risks related to factors such as change management and user resistance, requirements management, project planning (budget, schedule, quality, communication, etc.), organizational structure, etc. [80]. Therefore, the following relationship between project resilience and managing ambiguities is proposed:

RP3: The greater the project's resilience, the better is the management of ambiguities during the project life-cycle

Focusing on the development of project awareness and its capacity to adapt when dealing with disruptive events, helps manage the risks caused by the interdependencies that exist between the elements of the project and between the project and its environment. These interdependencies can be strong enough to modify the characteristics of certain, already identified, risks and potentially lead to additional unknown risks [10]. Therefore, the following relationship between project resilience and managing risks caused by non-linear and dynamic interdependencies is proposed:

RP4: The greater the project's resilience, the better is the management of risks caused by non-linear and dynamic interdependencies during the project life-cycle

The continuous evolution of the project environment increases the likelihood that contingency and risk response plans, which were developed at the beginning of the project, become ineffective for managing known risks [3], [81]. Therefore, developing project resilience empowers current PRM practices to better deal with known risks by continuously monitoring changes to their characteristics during the project life-cycle. To this matter, the following relationship between project resilience and the management of known risks is proposed:

RP5: The greater the project's resilience, the better is the management of already identified and analyzed risks by current PRM practices.

Figure 2 presents the overall conceptual framework underlying project resilience and including the capacity to learn from successful recoveries. This capacity enhances project resilience by developing, context specific, new strategies, processes and practices to better deal with future disruptions. The learning aspect provides the means for project resilience to continuously evolve, advance and grow [34].

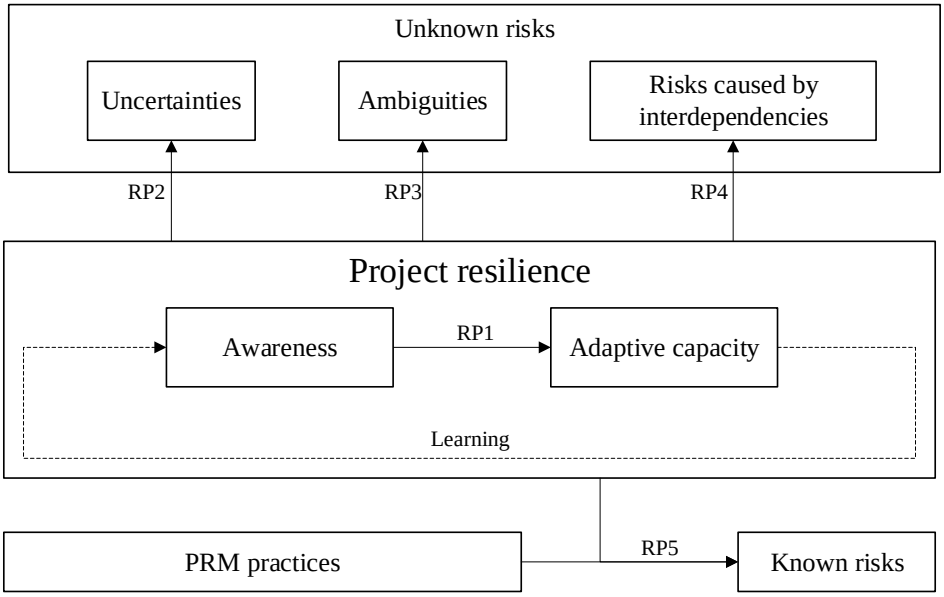

Fig. 2. Conceptual framework of project resilience

5. Conclusion

The presented framework of project resilience provides a new conceptual methodology to identify intrinsic risks of project systems and to accelerate project adaptation to known and unknown risks, thereby reinforcing risk management approaches and enhancing risk management strategies.

However, project resilience is still a very recent field of research that needs to be reinforced by qualitative and quantitative academic studies. From this perspective, the main objective of this paper is to propose a conceptual definition and framework of project resilience. Therefore, project resilience is defined by the capacity of the project system to be aware of its surroundings and vulnerabilities, and to adapt in order to recover from disruptive events and achieve its objectives. Also, a conceptual framework of project resilience is presented that potentially can set the basis for additional research on this new, very promising, concept.

However, as any new research concept, what is presented is one of many possible ways to define project resilience. As such, this is considered an obvious limitation. Thus, to continue reinforcing what was presented in this paper, the following agenda is suggested.

Next steps should firstly include conceptual exchanges with more advanced research fields. For example, organizational resilience is a more established concept among researchers and could catalyze the conceptual development on project resilience.

Second, a set of indicators to estimate the ability of projects to manage disruptive events should be developed. The goal of this development is to provide project stakeholders with a diagnostic tool to assess the impact of efforts required to improve current and future projects' resilience. This tool can help determine the project's strengths and weaknesses as well as suggest action plans to improve its resilience.

Third, once a validated set of indicators is developed to assess project resilience, rigorous empirical studies are required to validate the propositions and the developed conceptual framework of project resilience.

Finally, the concept of project resilience neither eliminates the need nor denies the relevance of current PRM practices and may, instead, redirect and strengthen them. Project resilience strategies should coexist with the current PRM practice to promote more efficient project management.

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Biographical notes

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